



## *Optimising Neurodevelopment in Preterm Low Birth Weight Infants through Structured Early Physiotherapy*

**Atiqur Rahman Khan**

Department of Paediatrics and Neonatology, Ministry of Health, Saudi Arabia

*Citation: Atiqur Rahman Khan (2026) Optimising Neurodevelopment in Preterm Low Birth Weight Infants through Structured Early Physiotherapy. J. of Adv Clin Neu Res 2(3), 1-6. WMJ/JACNR-128.*

### **Abstract**

**Background:** Preterm birth and low birth weight (LBW) remain major contributors to neonatal morbidity and long-term neurodevelopmental impairment worldwide. Infants born prematurely are particularly vulnerable to motor dysfunction, cognitive delay, behavioural abnormalities, and impaired language development because of the immaturity of the developing brain and exposure to multiple neonatal stressors. Early physiotherapy intervention has emerged as an important strategy for improving neurodevelopmental outcomes in this high-risk population.

**Aim:** This study aimed to evaluate the effect of structured early physiotherapy intervention on neurodevelopmental outcomes among preterm LBW infants during the first six months of corrected age.

**Methodology:** A prospective comparative study was conducted among 100 preterm LBW infants admitted to the Neonatal Intensive Care Unit (NICU) and Referral Newborn (RNB) Unit at Raja Muthiah Medical College and Hospital (RMMC&H). Infants were divided into two groups: the Early Intervention (EI) group, which received regular physiotherapy-based developmental intervention, and the Non-Early Intervention (NEI) group, whose caregivers declined participation despite counselling. Neurological assessment was performed using the Amiel-Tison Neurologic Examination, while developmental assessment was carried out using the Denver Developmental Screening Test (DDST). Assessments were completed at six months of corrected age.

**Results:** Infants in the EI group demonstrated significantly improved neurodevelopmental outcomes across gross motor, fine motor-adaptive, language, and personal-social domains compared with infants in the NEI group. Gross motor and language development showed the most substantial improvement. Neurological examination findings also revealed better tone regulation, posture, and reflex integration among infants receiving structured physiotherapy intervention.

**Conclusion:** Structured early physiotherapy intervention during infancy significantly improves neurodevelopmental outcomes in preterm LBW infants. Incorporating early developmental physiotherapy into routine neonatal follow-up programs may reduce developmental delay and enhance long-term functional outcomes in this vulnerable population.

**\*Corresponding author:** Atiqur Rahman Khan, Department of Paediatrics and Neonatology, Ministry of Health, Saudi Arabia.

**Submitted:** 19.05.2026

**Accepted:** 22.05.2026

**Published:** 03.06.2026

**Keywords:** Early Physiotherapy Intervention, Neurodevelopment, Preterm Infants, Low Birth Weight, Developmental Delay, Neonatal Rehabilitation

## Introduction

Preterm birth remains one of the leading causes of neonatal mortality and long-term childhood disability worldwide. According to the World Health Organization, approximately 15 million babies are born preterm annually, and many survivors experience lifelong neurodevelopmental complications. Low birth weight, particularly among premature infants, is strongly associated with adverse developmental outcomes including cerebral palsy, delayed motor maturation, impaired cognition, learning difficulties, and behavioural disorders.

The rapid growth and organisation of the central nervous system during late gestation make premature infants particularly susceptible to neurological injury. Several neonatal complications such as respiratory distress syndrome, sepsis, intraventricular haemorrhage, hypoxic-ischaemic injury, prolonged hospitalisation, and nutritional deficiencies further contribute to developmental vulnerability. In addition, the neonatal intensive care environment itself may expose infants to stressors including excessive noise, painful procedures, sleep disruption, and limited sensory regulation.

Advances in neonatal care have significantly improved survival among preterm infants; however, increasing survival has also led to a growing population of infants at risk for developmental impairments. Consequently, improving neurodevelopmental outcomes has become an essential component of modern neonatal care.

Early intervention programs are designed to identify developmental abnormalities at an early stage and provide targeted therapeutic support during periods of maximal brain plasticity. Physiotherapy-based developmental interventions aim to promote normal movement patterns, optimise postural control, improve muscle tone regulation, enhance sensory integration,

and facilitate parent-infant interaction.

Emerging evidence suggests that early physiotherapy may positively influence motor development and functional outcomes in high-risk neonates. Structured intervention during infancy may help reduce developmental delay and improve adaptive behaviour through stimulation of neural pathways during critical periods of brain development.

Despite increasing awareness regarding developmental care, structured physiotherapy programs are not routinely implemented in many neonatal follow-up settings, particularly in low-resource environments. Therefore, this study was undertaken to evaluate the effectiveness of early physiotherapy intervention on neurodevelopmental outcomes among preterm LBW infants during the first six months of life.

## Objectives

### Primary Objective

To evaluate the impact of structured early physiotherapy intervention on neurodevelopmental outcomes in preterm low birth weight infants at six months of corrected age.

### Secondary Objectives

1. To compare gross motor development between EI and NEI groups.
2. To assess language, fine motor-adaptive, and personal-social development in both groups.
3. To evaluate neurological outcomes using the Amiel-Tison Neurologic Examination.
4. To determine the role of early physiotherapy in reducing developmental delay among preterm LBW infants.

## Materials and Methods

### Study Design

This prospective comparative observational study was

conducted in the Neonatal Intensive Care Unit (NICU) and Referral Newborn (RNB) Unit at Raja Muthiah Medical College and Hospital (RMMC&H).

### Study Population

A total of 100 preterm low birth weight infants admitted during the study period were enrolled.

### Inclusion Criteria

- Preterm infants born before 37 completed weeks of gestation
- Birth weight less than 2500 grams
- Clinically stable at discharge
- Caregivers willing to participate in follow-up assessments

### Exclusion Criteria

- Major congenital malformations
- Chromosomal abnormalities
- Severe neurological disorders incompatible with follow-up
- Infants with severe sensory deficits
- Families lost to follow-up

### Group Allocation

Infants were divided into two groups:

#### Early Intervention (EI) Group

Infants who received structured physiotherapy intervention with regular follow-up.

#### Non-Early Intervention (NEI) Group

Infants whose caregivers declined physiotherapy intervention despite counselling.

Each group included 50 infants.

### Early Physiotherapy Intervention Protocol

The physiotherapy intervention program was initiated soon after clinical stabilisation and continued until six months corrected age.

The intervention included:

1. Positioning techniques to promote flexion and midline orientation
2. Passive range-of-motion exercises
3. Tactile and sensory stimulation
4. Head and trunk control facilitation
5. Postural stability exercises
6. Parent education and home-based stimulation strategies
7. Feeding support and oral-motor stimulation where

indicated

8. Developmentally supportive handling techniques

Parents were counselled regarding:

- Kangaroo mother care
- Proper positioning during sleep and feeding
- Environmental sensory regulation
- Daily stimulation exercises
- Importance of follow-up sessions

Physiotherapy sessions were conducted regularly by trained therapists during follow-up visits.

### Assessment Tools

#### Amiel-Tison Neurologic Examination

The Amiel-Tison Neurologic Examination was used to assess:

- Muscle tone
- Posture
- Primitive reflexes
- Cranial growth
- Neurological asymmetry
- Motor responses

#### Denver Developmental Screening Test (DDST)

The DDST was used to assess developmental milestones in four domains:

1. Gross motor
2. Fine motor-adaptive
3. Language
4. Personal-social

All infants underwent assessment at six months corrected age by trained evaluators.

### Statistical Analysis

Data were analysed using standard statistical software. Continuous variables were expressed as mean  $\pm$  standard deviation, while categorical variables were expressed as percentages. Comparison between groups was performed using the Student's t-test and chi-square test where appropriate. A p-value of less than 0.05 was considered statistically significant.

### Results

#### Baseline Characteristics

Both groups were comparable with respect to gestational age, birth weight, gender distribution, and neonatal morbidities.

Variable	EI Group	NEI Group
Mean Gestational Age	32.4 ± 2.1 weeks	32.1 ± 2.3 weeks
Mean Birth Weight	1.72 ± 0.34 kg	1.69 ± 0.36 kg
Male Infants	54%	52%
NICU Stay Duration	18 ± 5 days	19 ± 6 days

No statistically significant baseline differences were observed between the groups.

### Neurological Outcomes

Infants receiving early physiotherapy demonstrated improved neurological findings on Amiel-Tison examination.

Neurological Parameter	EI Group	NEI Group	p-value
Normal Muscle Tone	86%	62%	<0.05
Symmetrical Posture	82%	58%	<0.05
Appropriate Reflex Integration	80%	54%	<0.05

### Developmental Outcomes

#### Gross Motor Development

The EI group demonstrated significantly better gross motor performance.

Milestone Achievement	EI Group	NEI Group
Head Control	88%	64%
Rolling Over	76%	48%
Sitting with Support	70%	42%

#### Fine Motor-Adaptive Development

Improved hand coordination and visual tracking were observed in the EI group.

Fine Motor Parameter	EI Group	NEI Group
Object Tracking	84%	60%
Reaching Behaviour	78%	50%

#### Language Development

Infants in the EI group showed superior vocalisation and response to auditory stimuli.

Language Parameter	EI Group	NEI Group
Social Vocalisation	82%	56%
Response to Sound	90%	68%

### Personal-Social Development

Enhanced caregiver interaction and social responsiveness were noted in the EI group.

Social Development Parameter	EI Group	NEI Group
Social Smile	92%	70%
Interaction with Caregiver	88%	66%

Overall, the EI group demonstrated statistically significant improvement across all developmental domains compared with the NEI group.

### Discussion

The present study demonstrated that structured early physiotherapy intervention significantly improved neurodevelopmental outcomes among preterm low birth weight infants during the first six months of corrected age. Infants who received regular physiotherapy-based developmental support showed superior outcomes in gross motor, language, fine motor-adaptive, and personal-social domains compared with infants who did not receive structured intervention.

One of the most important findings of this study was the marked improvement in gross motor development among infants in the EI group. Physiotherapy interventions focusing on positioning, postural control, sensory stimulation, and movement facilitation likely contributed to better neuromuscular organisation and motor maturation. Early stimulation during periods of heightened neuroplasticity may enhance synaptic connectivity and support normal motor pathway development.

Language development was also significantly improved in the intervention group. Increased caregiver interaction, sensory stimulation, and improved neurological organisation may explain the enhanced communication and auditory responsiveness observed in these infants. Early developmental therapies often promote parent-infant bonding and responsive caregiving, both of which are important determinants of cognitive and language development.

The neurological examination findings further supported the benefits of early intervention. Improved muscle tone regulation, symmetrical posture, and primitive reflex integration indicate more favourable neurological maturation among infants receiving physiotherapy support. These findings are consistent with previous studies demonstrating the positive effects of developmental physiotherapy and early intervention programs in high-risk neonates. Spittle et al. reported that early developmental intervention improves cognitive outcomes and parent-infant interaction in preterm infants. Similarly, Blauw-Hospers and Hadders-Algra found that early physiotherapy may positively influence motor outcomes, particularly when interventions are initiated during infancy.

The neonatal period represents a critical window for neurodevelopmental intervention because of the significant plasticity of the immature brain. Appropriate sensory and motor experiences during this stage may influence long-term neurological organisation and functional capacity.

The role of parents in developmental intervention is also crucial. Parent education and involvement in home-based stimulation programs likely enhanced the effectiveness of physiotherapy in the present study. Family-centred developmental care has increasingly become an essential component of neonatal follow-up programs. This study highlights the importance of integrating structured physiotherapy into routine neonatal care for preterm LBW infants. Early identification and intervention may help reduce long-term disability, improve quality of life, and decrease the social and economic burden associated with developmental delay.

### Limitations

1. The study was conducted at a single tertiary care centre.
2. The follow-up duration was limited to six months corrected age.
3. Long-term neurodevelopmental outcomes beyond infancy were not evaluated.
4. The sample size was relatively small.
5. Randomisation was not performed because group allocation depended on caregiver acceptance.

Future multicentre studies with larger sample sizes and long-term follow-up are recommended.

### Conclusion

Structured early physiotherapy intervention significantly improves neurodevelopmental outcomes among preterm low birth weight infants. Early therapeutic engagement during infancy enhances motor performance, language development, neurological maturation, and social responsiveness.

The findings of this study support the incorporation of physiotherapy-based developmental care into routine neonatal follow-up programs, particularly for high-risk preterm infants. Early intervention strategies may play a critical role in reducing developmental disability and improving long-term functional outcomes.

### Recommendations

1. Structured physiotherapy programs should be integrated into standard neonatal follow-up services.
2. Early developmental screening should be routinely performed for all preterm LBW infants.
3. Parents should receive education regarding developmental stimulation and supportive care.
4. Multidisciplinary neonatal developmental clinics should be strengthened.
5. Further research should evaluate long-term neurodevelopmental outcomes.

### Ethical Considerations

Institutional ethical committee approval was obtained before commencement of the study. Informed consent was obtained from caregivers before enrolment. Confidentiality of patient information was maintained throughout the study.

### Conflict of Interest

The author declares no conflict of interest.

### Funding

No external funding was received for this study.

### References

1. World Health Organization (2023) Preterm birth. World Health Organization.
2. Blencowe H, Cousens S, Chou D, et al. (2013) Born too soon: the global epidemiology of 15 million preterm births. *Reprod Health* 10: S2.
3. Spittle A, Orton J, Anderson PJ, Boyd R, Doyle LW (2015) Early developmental intervention programmes provided post hospital discharge to prevent motor and cognitive impairment in

- preterm infants. *Cochrane Database Syst Rev*. 11: CD005495.
4. Blauw-Hospers CH, Hadders-Algra M (2005) A systematic review of the effects of early intervention on motor development. *Dev Med Child Neurol* 47: 421-432.
  5. Spittle AJ, Treyvaud K, Doyle LW, et al. (2009) Early emergence of behavior and social-emotional problems in very preterm infants. *J Am Acad Child Adolesc Psychiatry* 48: 909-918.
  6. Als H (1998) Developmental care in the newborn intensive care unit. *Curr Opin Pediatr*. 10: 138-142.
  7. VandenBerg KA (2007) Individualized developmental care for high-risk newborns in the NICU. *J Obstet Gynecol Neonatal Nurs*. 36: 643-654.
  8. Morgan C, Darrah J, Gordon AM, et al. (2016) Effectiveness of motor interventions in infants with cerebral palsy. *Dev Med Child Neurol* 58: 900-909.
  9. Hadders-Algra M (2014) Early diagnosis and early intervention in cerebral palsy. *Front Neurol* 5: 185.
  10. Koldewijn K, Wolf MJ, van Wassenaer A, et al. (2009) The Infant Behavioral Assessment and Intervention Program for very low birth weight infants. *J Pediatr* 154: 33-38.
  11. McAnulty G, Duffy FH, Butler SC, et al. (2009) Individualized developmental care for a large sample of very preterm infants. *Pediatrics* 123: 1371-1379.
  12. Johnson S, Marlow N (2017) Early and long-term outcome of infants born extremely preterm. *Arch Dis Child* 102: 97-102.
  13. Volpe JJ (2009) Brain injury in premature infants: a complex amalgam of destructive and developmental disturbances. *Lancet Neurol* 8: 110-124.
  14. Amiel-Tison C (2002) Neurological assessment at term. *Clin Dev Med* 163: 21-41.
  15. Frankenburg WK, Dodds J, Archer P, et al. (1992) Denver II technical manual. Denver Developmental Materials Inc.
  16. Spittle AJ, Doyle LW, Boyd RN (2008) A systematic review of the clinimetric properties of neuromotor assessments for preterm infants during the first year of life. *Dev Med Child Neurol* 50: 254-266.
  17. Anderson PJ (2014) Neuropsychological outcomes of children born very preterm. *Semin Fetal Neonatal Med* 19: 90-96.
  18. Treyvaud K, Anderson VA, Lee KJ, et al. (2010) Parental mental health and early social-emotional development of children born very preterm. *J Pediatr Psychol* 35: 768-777.
  19. Guralnick MJ (1998) Effectiveness of early intervention for vulnerable children. *Pediatrics* 102: 1253-1261.
  20. Fuentefria RN, Silveira RC, Procianoy RS (2017) Motor development of preterm infants assessed by the Alberta Infant Motor Scale. *J Pediatr* 93: 328-334.