

Fundamental Gross Motor Abilities In High-Risk Children At 5-6 Years – A Cross Sectional Study

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Cite this paper as: Harshini SJ, Rajeswari Muthusamy, Sivakumar Ramachandran, N Udayakumar, C. Arockia Pramila, (2025) Fundamental Gross Motor Abilities In High-Risk Children At 5-6 Years – A Cross Sectional Study. *Journal of Neonatal Surgery*, 14 (10s), 971-977.

ABSTRACT

Introduction: High risk new-borns are not only prone to develop apparent developmental disabilities but more subtle deficits might also occur which can be attributed to the outcome of a stormy neonatal period. Mastering of fundamental gross motor skills like jumping, hopping and catching beyond the rudimentary motor skills of sitting upright and walking becomes the precursors to more specialized movement and sport skills. The standard follow-up of many multicentred networks is around 2 years even though motor developmental delay is high and fundamental gross motor skills are ignored in high-risk children. This study intends to find the level of fundamental gross motor abilities and analyse the relationship between high-risk factors at the time of birth with gross motor development at 5-6 years.

Materials and Methods: This cross-sectional study was carried out in Karthikeyan Child Developmental Unit in 30 high-risk children at 5-6 years of age. Birth records of the children were reviewed and the details of high-risk factors were recorded. Peabody Developmental Motor Scale-2 (PDMS 2) was used to evaluate gross motor development in high-risk children at 5-6 years.

Results: Out of 30 high risk-children, 17 children were found to be preterm and 13 were low birth weight. The mean gross motor quotient of fundamental gross motor skills in high-risk children was found to be 81.5 which denotes a below average performance with deficits found in stationary and object manipulation component of PDMS 2. Spearman's correlation between the Gestational age/ Birth weight and gross motor quotient showed a significant positive correlation with a r_s value of 0.73 and 0.76 respectively and p value of ≤ 0.01 conveying that higher gestation age and birth weight showed good gross motor development.

Conclusion: Fundamental gross motor abilities of the high-risk children at 5-6 years shows below average performance and strong association between the gestational age/birth weight and gross motor abilities emphasizes the need for long term neuro-developmental follow up of these children and to address the subtle deficits earlier to attain their fundamental gross motor abilities appropriately.

Keywords: Fundamental Gross motor skills, Preterm, Low birth weight, Peabody Developmental motor scale

1. INTRODUCTION

High-risk infant (HRI) is defined as one who are born with biologic or environmental risk factors that makes them vulnerable for developmental disability (1). The early years of life are a critical period of development where the neural pathways of the brain develop most rapidly and proliferate from conception to two years. Stressors during this period including prematurity, undernutrition and trauma contribute to long-term effects on the brain's structure (2).

High risk new-borns are not only prone to develop apparent developmental disabilities in the form of cerebral palsy, mental retardation and global developmental delay but more subtle deficits might also occur which can be attributed to the outcome of a stormy neonatal period and the prevalence of neurodevelopmental delay was 51.4% in high-risk new-borns at 2-3 years (3). Motor developmental delay was 30% more than in a normal population and the most powerful risk factors were preterm (PT) (25.6%), low birthweight (LBW) (19%), neonatal seizures (7.4%), hyaline membrane disease (6.6%) and neonatal hyperbilirubinemia (4.9%) in specific sequence (4).

High risk children (HRC) without established neural impairment still revealed an increased likelihood of childhood motor skill impairment with inferior motor abilities in future due to prematurity (5, 6). Toddlers with LBW showed significant delay in gross motor, cognitive and communication skills at 2 years of age and preterm children showed 3 distinct motor trajectories of stably normal (55%), deteriorating (32%), and persistently delayed (13%) in the first year of life (7). Infants with transient neonatal hypoglycaemia have 50% higher rates of motor delay even after three years which insists that long-term consequences for motor development should be investigated in follow-up at school age (8, 9).

Rudimentary motor phase occurs till 2 years of age where integration of perceptual and motor information begins followed by which the child eventually develops greater precision and control to their movements like sitting upright and walking. Fundamental movement phase occurs till 5-6 years of age where the synchronization of the temporal and spatial elements of movement is improved and coordinated followed by which the child performs locomotor activities (running and jumping), manipulative activities (throwing and catching) and stability activities (beam walk and one-foot balance) which are termed as Fundamental motor skills (FMS) (10).

The school stage is a key moment for the child's development because it requires skills that have not been previously demanded and FMS act as the foundation for many sports and physical activities in the early childhood (11). Rudimentary motor skills are essential in childhood beyond which the mastery of FMS should begin in early childhood and if delayed it can be identified only when there is a long term follow up of HRI which is found to be insufficient.

Significant impairments in motor development were found at 2 to 3 years of age among infants born PT and LBW (12). Follow-up rates for HRI are high during infancy at 18-24 months corrected age and steadily fall during the preschool years as parents are satisfied when their child attains standing and walking but motor problems are evident in later years also when these children fail to attend preterm specific follow-up programs (13). Major clinical problems which were not identified till one year of age would develop some deficits in the later ages and the resulting neuro-motor delay can be addressed only when there is a long term follow up of HRI which is found to be scanty in the literature. This study intends to assess the development of FMS in HRC at the age group of 5-6 years, and its association with the high-risk factors at the time of birth.

2. METHODOLOGY

The study was approved by Research Advisory Committee of Sri Ramachandra Faculty of Physiotherapy, Sri Ramachandra Institute of Higher Education and Research. The study was conducted over a period of one year and subjects were recruited from Karthikeyan Child Developmental Unit where contact was made through phone call and on return of HRC at 5-6 years, informed consent was obtained. 30 HRC at 5-6 years of both genders with normal cranial ultrasonography findings at the time of birth were included in the study. HRC with any neurological impairments, congenital abnormalities, hearing and vision loss were excluded from the study. Birth records of the children were reviewed and the details of high-risk factors (GA, BW, Neonatal hyperbilirubinemia, hypoglycaemia, sepsis, Apnoea of prematurity) were collected. The PDMS-2 was used to evaluate gross motor development in HRC at 5-6 years.

Instrumentation:

The Peabody Developmental Motor Scales – Second Edition (PDMS-2): It is a paediatric tool to assess motor development in children from 0-72 months. It consists of 6 subscales (reflex/stationary/locomotion/object manipulation/grasping/visual motor integration) based on Harrow's taxonomy of psychomotor domain. The test was conducted based on the instructions provided in the manual. The summation of scores from 4 subscales gives a gross motor quotient (GMQ). The standard scores, age equivalent, quotient scores were obtained from raw scores. The standard scores which were converted in to GMQ, indicates gross motor development of children (14,15).

Gross motor components of PDMS -2:

1. Reflexes - This subtest measures aspects of a child's ability to automatically react to environmental events. Because reflexes typically become integrated by the time a child is 12 months old, this subtest is given only to children ages

2 weeks through 11 months.

2. Stationary - This subtest measures a child's ability to sustain control of the body within its centre of gravity and retain equilibrium.
3. Locomotion - This subtest measures behaviours that children use to transport themselves from one place to another, such as crawling, walking, running, hopping, and jumping forward.
4. Object manipulation - This subtest measures a child's movements needed to catch and throw objects. Because these skills do not become apparent until a child reaches 11 months of age, this subtest is only given to children ages 12 months and older.

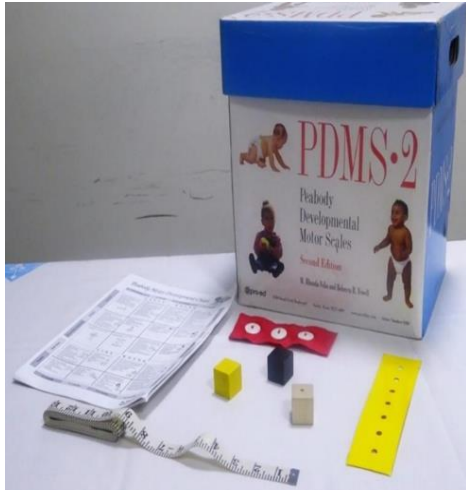


FIG: 1: PEA BODY DEVELOPMENTAL MOTOR SCALE - 2



FIG:3: LOCOMOTION JUMPING FORWARD (53-54 months)



FIG:4: OBJECT MANIPULATION HITTING TARGET UNDERHAND (39-40 months)



FIG:2: STATIONARY SKILL STANDING ON TIP TOES (< 3 sec - 43-44 months)

3. RESULTS

The study was performed with 30 HRC at 5-6 years out of which 17 children were found to be PT and 13 were LBW. The mean GMQ of FMS in HRC at 5-6 years was found to be 81.5 which denotes a below average performance in their FMS.

Spearman's correlation coefficient between the high-risk factor (PT and LBW) and GMQ of PDMS-2 showed a positive correlation with a r_s value of 0.73 and 0.76 respectively and a significant p value of ≤ 0.01 conveying that children with higher gestational age and birth weight showed good gross motor development.

TABLE1: DEMOGRAPHIC CHARACTERISTICS

VARIABLES	MEAN (SD)
Age	68.2 months (4.30)
Gender	Male-21, Female- 9
Preterm	30weeks (0.98)
Low birth weight	1992grams (159.1)
GMQ	81.5 (3.71)

TABLE 2: GMQ AND STANDARD SCORES OF SUBTEST COMPONENTS IN PDMS 2.

HIGH RISK FACTOR	MEAN GA (months) / BW (grams)	N	MEAN AGE (SD)	MEAN GMQ (SD)	MEAN STANDARD SCORES (SD)		
					STAT	LOC	OBJ.MAN
Preterm	30	17	67.5 (4.13)	81.8 (3.3)	6.9 (0.72)	7.7 (0.80)	6.8 (0.92)
Low birth weight	1992	13	68.1 (4.50)	81 (3.3)	6.8 (0.76)	7.4 (1.0)	6.7 (0.69)

GA- gestational age; BW- birth weight; m- months; g- grams; GMQ- gross motor quotient; SS- standard scores; STAT- Stationary; LOC- Locomotion; OBJ.MAN- Object manipulation

TABLE 3: CORRELATION OF GA/BW AND GMQ

HIGH RISK FACTOR	N	MEAN GA/LBW (weeks/grams)	MEAN GMQ (SD)	r_s	p
Preterm	17	30	81.8 (3.3)	0.73	0.000
Low birth weight	13	1992	81 (3.3)	0.76	0.002

Spearman's correlation coefficient $p \leq 0.05$, significant

TABLE 4: AGE- APPROPRIATE GMS AND AVERAGE GMS PERFORMED

COMPONENTS OF PDMS-2	APPROPRIATE GMS TO BE PERFORMED AT 5-6 YEARS	AVERAGE GMS PERFORMED (PTC)	MONTHS	AVERAGE GMS PERFORMED (LBWC)	MONTHS
STATIONARY	(61-70 M)	(N=17)		(N=13)	
	Standing on 1 foot without sway, 10 seconds	NP		NP	NP

	Sit-ups(5 times in 30 seconds)	Standing on tip toes (3 seconds)	43-44	Standing on tiptoes (3 seconds)	43-44
	Push-ups (8 in 20 seconds)	NP		NP	NP
LOCOMOTION	Skipping (10ft)	galloping	51-52	Running	45-46
	Hopping speed (20ft)	NP		NP	NP
	Kicking the ball with opposing limb movements	Throwing ball underhand	29-30	Throwing ball overhand	39-40
OBJECT MANIPULATION	Catching the bounced ball	Catching the ball	33-34	Hitting target underhand	39-40
				Catching ball to chest (5ft)	41-42

GMS – gross motor skills, PTC – preterm children, LBWC – low-birth weight children,

NP– not performed

4. DISCUSSION

Motor skills are considered important for children's physical, social and psychological development and early childhood is the age where practicing FMS is necessary to create a foundation for more complex movement activities of daily living, recreation, and sports in later childhood (16). Infants with PT and LBW may experience a disruption of important processes involved in early brain development and are at increased risk for a variety of developmental problems related to health, psychological adjustment, intellectual functioning and motor abilities (17).

This study was conducted to analyse the gross motor development at 5-6 years of age in HRC. The mean GMQ of FMS was found to be 81.5 denoting a below average performance in their FMS, which reveals that gross motor delay is carried to the later years similar to higher rates of delay found in infants born PT / LBW in younger age at 2–3 years of age (18). The long-term neuro-motor delay at 5-6 years could be attributed to the immaturred neuronal and synaptic formations which takes place in the first three years of life where in HRC, the development of preoligodendrocytes, microglia, axons, thalamus, cortex and cerebellum are affected resulting in an immature brain which can result in subtle deficits (19).

Correlation between the GA / BW and the GMQ in the HRC showed a positive correlation with a r_s value of 0.73 and 0.76 respectively which is consistent with the study done by Hediger et al., (2002) where the motor development showed significant delay and strong association with level of PT/LBW in these children (20).

The standard scores of the subtest component of PDMS-2 in stationary, locomotion and object manipulation was found to be 6.9, 7.7 and 6.8 in PT children and 6.8,7.4 and 6.7 in LBW respectively, which shows that both groups have average performance in locomotion but a below average performance is evident in stationary and object manipulation component. The postural control and balance becomes the important pre-requisite to competently perform skilled and complex movements like sit-ups and push-ups but such stationary skills are found to be delayed in children with PT and LBW which might be attributed to the diminished neurodevelopmental events that results due to impaired white matter development and a decrease in total brain volumes which persists through childhood and into adolescence thus affecting the cognitive, motor and perceptual tasks at later ages (21).

Gross object manipulatory skills like catching a bouncing ball or kicking a ball with opposing limb movements to the target requires more of visuo-spatial skills which might be reduced as these activities are found to demand increased visual cues which plays a prominent role on stability, locomotor and manipulatory skills of children at 5 to 15 years. Functional neuroimaging studies have shown visuo-spatial working memory is related to brain activity in frontal, parietal, occipital, premotor cortex, cerebellum and thalamus (22). This seems to be facilitated by a complex network of brain activity which is important for planning, execution and control of movements, thereby explaining the relationship with gross motor skills.

The average age equivalence in PT and LBW was found to be 49.5 and 49 in stationary and 45 and 44 in object manipulation subtest component of PDMS-2. The activities at which the blocking of development started was standing on tip-toes, standing on onefoot, imitating movements in stationary components and bouncing a ball, underhand and overhand throw in object

manipulatory components. This denotes that these children had a significant delay in performing activities which would be demanded at school level that act as an integral part of sporting activities. This is consistent with the meta-analysis done by de Kieviet, J. F et al (2009) which showed PT and LBW were associated with significant motor impairments throughout childhood (23).

Physical activity and FMS are clearly interrelated and stand to give researchers and practitioners an important overview of key behaviours and skill development in young children. Motor Delay has a negative impact on child's psychiatric problems where inattention, symptoms of anxiety and depression will have an adverse effect on quality of life, academic achievement and involvement with the environment. According to WHO children at 3-6 years should be encouraged to perform moderate to vigorous physical activity to help develop these FMS and higher levels of motor competence (25). The result of the study implies that long-term neurodevelopmental follow up of HRC should be done to monitor the level of fundamental motor functioning to create adequate skill practice opportunities and to address the subtle deficits earlier and thus allowing these children to achieve overall better FMS and explore the association between locomotor, object control and balance skills.

5. CONCLUSION

The fundamental gross motor abilities of the high-risk children at 5-6 years were below average and showed a strong association between the gestational weeks/ birthweight which emphasizes the need for long term neuro-developmental follow up of these children and to address the subtle deficits earlier and to attain their FMS appropriately.

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