Original Article

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Evaluation of Developmental Delay in Term Babies on Ventilator Support: A Cross-sectional Study

Paediatrics Section

R HEMANTH KUMAR[1], JAYESH CHANDRAN[2]

ABSTRACT

Introduction: Developmental limitation in two or more developmental domains that affects children under the age of five is termed as developmental delay. Due to various reasons such as drug-induced toxicity and maternal variables like a history of drinking, smoking, or infections during pregnancy (e.g., rubella), neonates may require admission to the Neonatal Intensive Care Unit (NICU). Although NICU admission improves survival rates, the extended stay and the use of different types of equipment in the NICU may lead to developmental delay.

Aim: To identify the developmental delays in critically ill full-term babies on ventilator support, using the Ages and Stages Questionnaire-3 (ASQ-3) scale.

Materials and Methods: A cross-sectional study was designed to evaluate developmental delays in term babies receiving ventilator support. A total of 35 babies who met the inclusion criteria were included in the study. Once the babies reached 17 to 18 months of age, parents were given ASQ-3 to complete. The data were analysed and expressed as mean, standard deviation, frequency, and percentage.

Results: Out of the 35 full-term babies on ventilator support, 22 babies (62.9%) showed lower values in gross motor function, 12 (34.3%) in fine motor function, and 12 (34.3%) in problem-solving skills compared to communication and other components, according to ASQ-3.

Conclusion: The findings of this research suggest that critically ill full-term infants on ventilator support exhibit significant developmental delays, particularly in gross motor, fine motor, and problem-solving skills.

Keywords: Ages and stages questionnaire-3, Full-term baby, Gross motor, Mechanical ventilator support, Neonatal intensive care unit

INTRODUCTION

Infants with delayed development lag behind their peers in achieving age-appropriate developmental milestones. Global Developmental Delay (GDD) is the term used to describe a developmental limitation in two or more developmental domains that affects children under the age of five [1]. A study conducted in 2016 concluded that 1.15 crore children in India, or 2 percent of all children worldwide, experience developmental delays [2]. Developmental delay has become a significant issue in low and middle-income nations [3-5].

A newborn may be transferred to the NICU for various reasons. For instance, factors such as drug-induced toxicity and maternal variables like a history of drinking, smoking, or infections during pregnancy such as rubella and toxoplasmosis, or early maternal illnesses [6]. Additionally, the child's admission to the NICU for ventilator support may be due to intrauterine growth retardation, perinatal asphyxia, hypoxic-ischaemic encephalopathy, smothering of the newborn, starvation, or umbilical cord knotting [6]. Although NICU admission improves the chances of survival, the extended duration of stay and the use of various technologies may have long-term effects, including an increased risk of cognitive impairments, delays in socialisation and development, and developmental delays [7]. Prolonged artificial ventilation in premature newborns is associated with delayed development and compromised brainstem development. Each additional day of mechanical ventilation is linked to a decline in motor scores [8].

Early intervention programs were established to address the developmental needs of neonatal intensive care survivors and to stimulate and normalise their development [5]. Early intervention programs are multidisciplinary services provided to children from birth to six years of age, aiming to promote their health and well-being [7].

The well-being of infants and children relies on the early identification of developmental delays, as prompt referrals to medical attention reduce the risk of persistent issues in the future. While performance-based evaluation of early childhood development is ideal, there are several disadvantages to this method when determining the best approach for an individual child or when investigating how an intervention or specific risk exposure affects development in resource-constrained environments [9,10]. The ASQ-3 can be employed more extensively in public and research investigations [10]. Existing literature [11] has demonstrated that preterm and underweight babies who remain in the NICU are more prone to developmental delay [7,10]. While a study has examined the effects of invasive ventilators, such as tracheostomy, on preterm babies leading to developmental delay, no studies have been conducted on how non invasive ventilator support affects critically ill full-term babies [1]. Due to the limited available literature, the main objective of this study was to assess developmental delay in critically ill full-term babies who received non invasive ventilator support, using the ASQ-3 scale.

MATERIALS AND METHODS

A cross-sectional study was conducted at Justice KS Hegde Charitable Hospital, Deralakatte, Mangalore, Karnataka, India from March 2022 to February 2023. Two time periods were considered: the first period was when the term infants were placed on a ventilator immediately after delivery, and the second period was when the babies reached 17 and 18 months of age. The proposed study was approved by the Institutional Ethical Committee (IEC) of Nitte Institute of Physiotherapy in Mangalore, Karnataka, with reference no NIPT/IEC/Min/10/2021-2022, dated 12-02-2022.

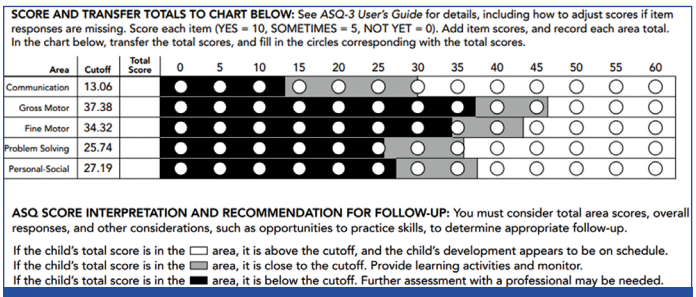
Inclusion criteria: Low moderate risk full-term babies who received ventilator support in the NICU (risk classification based on APGAR

score greater than 4 at 1 and 5 minutes) [10], babies aged between 17 and 18 months (as ASQ-3 is more reliable and valid for older children beyond 18 months) [9], babies who received more than 48 hours of ventilator support, and parents who were proficient in English were included in the study.

Exclusion criteria: Preterm babies with spinal and brain anomalies, babies who underwent tracheostomy, babies with genetic disorders, babies with peripheral nerve injuries, and babies with congenital anomalies were excluded from the study.

Sample size: The estimated sample size for this study was 35, based on a previous study, with a 90% confidence level and a 10% margin of error [2]. Samples were screened based on the inclusion and exclusion criteria. The parents were provided with an assent form containing explanatory information and were encouraged to participate in the research. Parents had the option to withdraw their baby from the study at any time. Full-term babies admitted to the NICU for ventilator support after birth were enrolled from the register. The address and contact information were obtained from the medical record department of Justice K.S. Hegde Hospital between November 2020 and July 2021.

A total of 89 babies were initially identified, out of which 44 were recognised as full-term babies. After considering factors such as distance, language, and willingness to participate in the study, 35 babies were included in the final study sample. The caregivers were provided with the ASQ-3 questionnaire to complete when the babies reached 18 months of age [6,10,12,13]. The ASQ-3 is a widely used series of developmental questionnaires that serves as one of the most commonly used caregiver report outcome measures worldwide. It is designed to identify developmental delays in children between the ages of two and sixty-six months, with different cut-off scores for each month. The questionnaire assesses five key areas of development: communication, gross motor skills, fine motor skills, problem-solving, and personal-social skills. Each area consists of six items, resulting in a total of 30 items. The questionnaire can be completed quickly and easily, taking only 15 minutes [9,11]. The rating system for the ASQ-3 is based on a scale of three points: a score of 0 indicates that the task has not yet been accomplished, a score of 10 indicates that the activity can be performed, and a score of 5 suggests that it may be completed at some point. The ASQ-3 has demonstrated an 86% sensitivity and 85% specificity, with intra- and inter-reliability of 93%. The interpretation and cut-off scores for the ASQ-3 are provided in [Table/Fig-1] [13].



[Table/Fig-1]: Scoring criteria and interpretation of scores of ASQ-3 questionnaires.

STATISTICAL ANALYSIS

All data analyses were conducted using Statistical Package for Social Sciences (SPSS) for Windows (version 20.0, SPSS). The data were analysed and presented as mean, standard deviation, frequency, and percentage.

RESULTS

This study included a total of 35 samples. The gender distribution of the samples was 18 (51.4%) females and 17 (48.6%) males [Table/Fig-2]. The mean±SD age of the babies was 17.69 ±0.4710 months. Among the 35 term babies, 19 had respiratory distress syndrome, five had transient tachypnoea, four had meconium aspiration syndrome, four had grade-1 hypoxic-ischaemic encephalopathy, two had congenital pneumonia, and one had pulmonary hypoplasia.

The mean values of male and female communication, gross motor skills, fine motor skills, problem-solving, and personal-social skills are shown in [Table/Fig-3].

Gender	n (%)
Female	18 (51.4)
Male	17 (48.6)
Total	35 (100)

[Table/Fig-2]: Distribution of participants based on gender.

Domains	Mean score	
	Male (n=17)	Female (n=18)
Communication	36.7647±10.29884	31.6667±11.63160
Gross-motor	24.7059±12.06850	27.5000±17.34172
Fine-motor	42.3529±16.21319	35.5556±16.96787
Problem-solving	39.4118±16.38238	33.8889±16.13870
Personal-social	41.1765±13.86649	35.2778±15.28862

[Table/Fig-3]: Gender wise mean scores in different domains of ASQ-3 scores.

In the communication domain, 24 (68.6%) were considered to be normal, and 11 (31.4%) were categorised as monitoring. Results for fine motor abilities revealed that 12 (34.3%) of the babies exhibited developmental delays, 1 (2.9%) fell into the monitoring category, whereas 22 (62.9%) were classified as normal. In problem-solving, 8 (44.4%) of the girls had developmental delays, while 10 (55.6%) were classified as normal. In the personal-social domain of the ASQ-3, the majority of babies 22 (62.9%) were classified as normal, 7 (20%) fell into the monitoring category, and 6 (17.1%) exhibited developmental delay [Table/Fig-4].

Domains	Affected		Monitor		Normal	
	Male	Female	Male	Female	Male	Female
Communication	0	0	5 (29.4)	6 (33.3)	12 (70.6)	12 (66.7)
Gross-motor	11 (64.7)	11 (61.1)	3 (17.6)	7 (38.9)	3 (17.6)	0
Fine-motor	4 (23.5)	8 (44.4)	1 (5.9)	0	12 (70.6)	10 (55.6)
Problem-solving	4 (23.5)	8 (44.4)	1 (5.9)	0	12 (70.6)	10 (55.6)
Personal-social	1 (5.9)	5 (27.8)	3 (17.6)	4 (22.2)	13 (76.5)	9 (50.0)

[Table/Fig-4]: Distribution of study participants in different domains of ASQ-3 scores based on follow-up required.

DISCUSSION

Infants who received ventilator support experienced a significant delay in gross motor function, and to a lesser extent, in fine motor function and problem-solving skills. These results suggest that, despite the improved survival rate associated with NICU admission, term babies may still face difficulties in later life due to their prolonged stay in the NICU and the various equipment used, such as oxygen hoods, ventilators, and nasal cannulas. This finding was consistent with a previous case study conducted by Sant N et al., which involved a seven-month-old infant boy with a history of preterm birth, poor APGAR score, and a three-month NICU stay [4]. The patient later presented to the physiotherapy outpatient department with complaints of delayed motor milestones, including difficulties in head holding, rolling, and hand movements.

The objective of the ASQ-3 questionnaire was to assess a child's development in five domains over time: problem-solving, fine motor

skills, gross motor skills, communication, and personal-social skills, within the age range of 2-60 months. This questionnaire provides valuable information about the infant's development and helps therapists identify areas that require focused attention [5,6,9,10]. In a comparison of the validity between the Bayley III NL and ASQ-3, it was found that ASQ-3 performed better in identifying older children (18-24 months) with developmental delays [5]. As a stand-alone measure for identifying developmental delays in children, the ASQ-3 is widely used by caregivers globally. It has demonstrated adequate psychometric properties, especially when used with high-risk children or those with severe neurodevelopmental delays, in high-income settings [9].

Previous research conducted by Shin HI and Shin HI, revealed that infants with tracheostomy experienced a significant delay in head control in the supine position and rolling from prone to supine [1]. One possible reason for this difference is that these infants may not have spent enough time in the prone position. The study hypothesised that a higher supine-to-prone score, compared to a prone-to-supine score, indicated a gross motor developmental delay [2]. In the current research, it was found that the samples may have spent more time in the supine position than in the prone position, which contributed to a decline in gross motor development.

Another study by Guillot M et al., found that preschool-aged children with severe respiratory illnesses and preterm births had poor motor scores for each additional day they required ventilator support [14]. This suggests that extended usage of mechanical ventilators, as seen in the target group of the study, is associated with lower motor scores due to complications such as respiratory distress. A longitudinal study by de Mendonça KT et al., also found a relationship between poor gross motor development and the use of oxygen therapy and non invasive ventilator assistance during the hospital stay in the NICU [8]. Considering that the samples in this study also had prolonged periods of mechanical ventilator use, this finding further supports the link between mechanical ventilation and poor gross motor development.

While extended use of mechanical ventilators is associated with various morbidities and mortality, it is still necessary in cases of severe medical conditions. According to Hunt KA et al., babies who required ventilator care for more than 72 hours were more likely to experience serious bronchopulmonary problems [15]. Bose CL et al., also confirmed that prolonged ventilator use in preterm infants can cause organ damage, increase systemic inflammation, and have detrimental effects such as cerebral palsy and cognitive impairment [16]. Prolonged ventilator use can harm the corticospinal tract, increasing the risk of significant neurodevelopmental impairments like cerebral palsy and damaging white matter, thereby affecting both motor and cognitive function [16,17]. Since the target population of the current research also had an extended period of non invasive mechanical ventilator use, it is understandable that decreased scores in motor functions were observed.

A history of prolonged labour during birth contributes to low or poor APGAR scores in the first and fifth minutes of life in most children with early motor deficits. According to Ibrahim SA and Zangana KO these are primary manifestations of moderate and severe hypoxic-ischaemic encephalopathy, which significantly increase the need for ventilator support in the NICU [18]. The samples from the current study displayed developmental delays and required ventilator support due to hypoxic-ischaemic encephalopathy, similar to the findings of the previous study.

Limitation(s)

As the study questionnaire was in English, some participants who were uneducated were unable to answer the questionnaire. Consequently, they had to be excluded from the study. This limitation prevents the study from providing insights into potential measures that could be taken to mitigate the effects observed and provide support for these children. Additionally, due to the limited sample size, the results cannot be generalised to the wider population. Conducting a similar study with a larger sample size in the future would be beneficial.

CONCLUSION(S)

According to this study, babies who received non invasive ventilator support experienced delays in their development. Full-term babies who were placed on non invasive ventilator support shortly after birth exhibited a significant delay in early motor development, specifically in gross and fine motor movements, as assessed by the ASQ-3 questionnaire.

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PARTICULARS OF CONTRIBUTORS:
1. Postgraduate, Nitte Institute of Physiotherapy, NITTE (Deemed to be University), Deralakatte, Mangaluru, Karnataka, India.
2. Assistant Professor (Grade II), Department of Physiotherapy, Nitte Institute of Physiotherapy, NITTE (Deemed to be University), Mangaluru, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Jayesh Chandran,
Assistant Professor (Grade II), Department of Physiotherapy,
Nitte Institute of Physiotherapy, NITTE (Deemed to be University),
Mangaluru-575018, Karnataka, India.
E-mail: jayeshnairpt@gmail.com; rhk3027@gmail.com

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