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Early Detection of Global Developmental Delay in Infants Using Indian Screening Tools: Insights from a Tertiary Care Hospital and Implications for Raising Awareness about Neurodevelopmental Outcomes - A Cross-Sectional Study

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ABSTRACT

Introduction: Developmental delay may have an impact on a child's development in several areas, such as social, linguistic, motor and cognitive. Since GDD encompasses a wide range of developmental domains, as opposed to particular developmental disorders that concentrate on a single area, it is a complex and challenging condition to study and treat. Early diagnosis and treatment of GDD symptoms are essential for maximizing a child's development through the application of specialized strategies and therapies.
Method: This cross-sectional study is focused on screening infants (1-11 months of age) on the basis of Indian Screening Tools for Global Developmental Delay, providing insights from a Tertiary Care Hospital and its implications for Raising Awareness about Neurodevelopmental Outcomes.
Results: Out of 201 eligible infant population (age between 1-11months old), mean (SD) 6.9weeks (3.1) (Male=142, Female=59), Among the total population, mean Item Delay using TDSC in male children was 5, mean item Delay using TDSC in Female children was 4. Mean Item Delay using BDST in Male children was 4; Mean Item Delay using BDST in Female children was 4. Mean Item Delay using LDS in Male children was 4; Mean Item Delay using LDS in Female children was 3.
Conclusion: Our data, which is used to detect term and preterm children at risk of suffering a global developmental delay, shows distinct developmental trajectories in respect to the scores obtained from the Indian screening methods. Additionally, in order to monitor and clarify the neurodevelopmental outcomes of infants at an early stage and provide early remediation for disabilities, it is crucial to establish an awareness drive regarding parent-reported developmental concerns among parents within the tertiary care setup and multidisciplinary team.

Keywords: Global developmental Delay (GDD), developmental screening, neurodevelopment

1. INTRODUCTION

A child is said to have global developmental delay (GDD) if they fail to achieve developmental milestones in several domains of functioning within the anticipated time range such as aged 5 years

or younger[1]. A child's development in a number of domains, including social, communicative, motor, cognitive, and cognitive, may be impacted by developmental delay. GDD is a complex and difficult condition to study and treat since it spans a wide range of developmental domains, unlike specific developmental disorders that focus on a single area[2]. Recognizing the signs of GDD early on is crucial for timely intervention, allowing for the implementation of tailored strategies and therapies to optimize a child's development. Understanding the global dimension of developmental delay emphasizes the importance of a holistic and inclusive approach. GDD is not limited by geographical borders or socio-economic backgrounds; it can affect children worldwide, highlighting the need for collaborative efforts in research, awareness, and accessible interventions.

1.1 Global Developmental Delay as a global concern & its underlying etiologies

Developmental delays may be caused by a number of illnesses, both acquired and congenital in nature.

Common etiology of developmental delay:

Prenatal
→Genetic abnormalities include chromosomal microdeletion or duplication, fragile X syndrome, and Down Syndrome, vascular: occlusion, bleeding, Cerebral dysgenesis: microcephaly, missing corpus callosum, hydrocephalus, neural migration problem; Medications: anti-epileptic, cytotoxic.
→Toxins: smoke and alcohol
→ Early maternal infections: toxoplasmosis, CMV, and rubella HIV, malaria, and varicella late in pregnancy
Natal
→Neonatal Intrauterine growth retardation, periventricular leukomalacia, intraventricular hemorrhage, and preterm ischemic encephalopathy and hypoxia in perinatal asphyxia
→Metabolic: bilirubin-induced neurological impairment, symptomatic hypoglycemia
Post Natal
→Infections: Meningitis and encephalitis
→ Metabolic: dehydration, hypoglycemia, hypernatremia.
Suffocation, almost drowning, seizures: anoxia Trauma: stroke or other vascular injury to the head, whether accidental or not.
Others
→ Social: severe malnourishment (low iron, folate, and vitamin D), severe under-stimulation, abuse, Mental health issues in mothers [5]

Concern has grown in recent years on the significance of early diagnosis and treatment of children with developmental delays. As early detection of children with developmental delays has significant effects on their care, reducing the likelihood of future disabilities and secondary issues such family dysfunction, peer issues, and academic failure. Successful detection of developmental delays projects onto the need of skillful screening of children along with awareness of timely routined evaluation and analysis[3]. Screening is the process of looking for potential developmental problems that might go undetected in typical pediatric surveillance care. The purpose of screening is to find developmental problems in children who are at high risk as early as possible so that remediation can begin when it is most beneficial[3].

Physicians and other health care providers encounter several challenges when diagnosing developmental delay in children under six months of age. These include: 1) false positive diagnosis in relation to a normal outcome or other aetiology; 2) difficulty interpreting symptoms of impaired motor control and functioning in a child; 3) lack of precise, clear evidence-based tools for accurate early diagnosis; 4) parents' lack of awareness of normal developmental milestones to identify and report any early markers of developmental delay [4]

1.2 Importance of Early Intervention through early identification of impaired development –

Early developmental delay diagnosis is crucial because it can result in focused early intervention, which maximizes the chances

of providing the right kind of learning and physical assistance. [6] Children's brain plasticity is stronger than that of adults. [7]

1.2.1 Neuroplasticity in children – A child's brain grows rapidly during the first few years of life. Every neuron in the brain develops into a larger number of synaptic connections. At birth, each cerebral cortex neuron has roughly 2,500 synapses. By the time a child is two or three years old, each neuron in their body has about fifteen thousand synapses. Therefore, newborns have higher neuroplasticity. [8][9]

1.2.2 Importance of Early intervention – A large portion of what a kid learns throughout infancy is essential to the development of subsequent abilities, which justifies early intervention. Higher proficiency can be attained by using the fundamental behaviour patterns or schemes that are learned, practiced, integrated, or combined. [9] Using Indian screening instruments in a tertiary care hospital, the aim of this study is to identify early markers of global developmental delay in infants and to explore the implications for awareness regarding neurodevelopmental outcomes. Though the literature for identifying early signs of GDD is sparse, there are very few research on developmental screening. To reduce the high incidence rates, it is therefore imperative that this study detect the indicators as soon as possible.

2. MATERIALS AND METHOD

This cross-sectional single-centre observational study (No. of samples=201) was carried out in the years 2022–2024 at the D.Y Patil Medical Hospital in Pune. The infants included in this study were from Paediatric IPD and high-risk OPD. The assessment of newborns who may experience a global developmental delay was the main objective of this study. Following the institutional ethics committee's clearance, participants were chosen over a two-year period (August 22, – February 24) based on inclusion and exclusion criteria from the high-risk OPD, IPD. The following inclusion criteria were used to choose the infants for this study: (1) Infant population, meaning those between the ages of one and eleven months; (2) Male and female; (3) Preterm and Full Term Infants; (4) High Risk Infants [10]; (5) Infants with Parental Consent in Writing. Infants whose parents refused to participate in the study or whose vital signs were unstable were excluded from the trial. Sample collection was done in a purposeful manner.

An informed and written consent form was given to all the parents of the participants. After the approval from the parents, demographic details of the sample population were noted. Also, Then active participants were screened for delay in different domains using Trivandrum Developmental Screening Tool (TDSC) [10], New Lucknow Developmental Screen (LDS) [11] Baroda Developmental Screening Test (BDST) [12] taken by principal investigator which helped in identifying early signs of global developmental delay in infants.

This study was approved by the Ethics Committee of Dr. D.Y Patil College of Physiotherapy

[Ethical Reference code– DYPCPT/IEC/01/2023] & registered in CTRI (CTRI/2023/08/056805).

Photograph 1: Developmental Evaluation of a 3 months old infant in pediatric IPD.

Photograph 2: Creating awareness regarding routined developmental screening associated with better neurodevelopmental outcomes.

Tools	Age	Developmental domain	Sensitivity	Specificity	No. of Items	validated against
New Lucknow Development Screen (India)	0-24 months	motor, mental, language, social	95%	73.1%	27 items	DASII, Vineland Social maturity scale
Trivandrum Development Screening Chart (India)	0-2 years	mental, motor, vision, hearing	86%	100%	17 items	DDST (Denver developmental screening test)
Baroda Screening Tool (India)	1-11 months	Motor and mental	65-95%	65-95%	54 items	BSID, DDST

2.1 Outcome measures

2.1.1 Trivandrum Developmental Screening Tool: For the new tool to apply, the chronological age of the child is assessed, firstly. Then a line is to be drawn vertically through the chronological age of the child (given in bottom horizontally) marked in the tool. The items with upper limit ending to the left of the line are expected to be attained by the child normally. If any item is not attained by the child by that age, that item delay is assumed for the child. Thus, the tool is designed to be simple and no expertise is required. It the child fails to achieve any item that falls short on the left side the vertical line, the child is considered to have developmental delay. [10]

2.1.2 New Lucknow Developmental Screen: For the new tool to apply, the chronological age of the child is assessed, firstly. Then a line is to be drawn vertically through the chronological age of the child (given in bottom horizontally) marked in the tool. The items with upper limit ending to the left of the line are expected to be attained by the child normally. If any item is not attained by the child by that age, that item delay is assumed for the child. Thus, the tool is designed to be simple and no expertise is required. If the child fails to achieve any item that falls short on the left side the vertical line, the child is considered to have developmental delay. [11]

2.1.3 Baroda Developmental Screening Test: Performance of the child is known by plotting the total number of items passed by

an infant(score) against the chronological age. Any child below the 97% pass level is screened out for further study for developmental delay. [12]

3. STATISTICAL ANALYSIS

Sample size (n=201) was calculated according to the study done by Disha Agarwal et al. in Agra[16] by the formula SAMPLE SIZE = (Z-Score)^2 x Standard Deviation x (1-Standard Deviation)/Confidence Interval^2 ; prevalence rate of GDD for 0-11m of 6% with confidence level 95%, acceptable difference of 3%. So, the sample size calculated is 200. Confidence interval of 95% CI and acceptable difference of 2-8%. Software used was WINPEPI VERSION 11.38. Data was analyzed using the tool "Jupyter notebook" (version 7.1), the language used to draw the conclusion was Python. Excel's (6.2.14 Excel 2019, Excel 2021) was used for compilation and storing the data. Descriptive statistics was performed to assess the mean and standard deviation of the whole population.

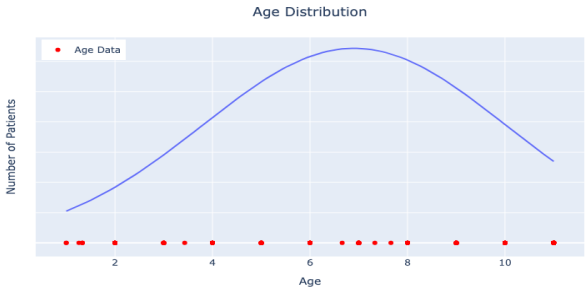

Fig1: Line Graph representing mean age distribution (in months) of children

(INTERPRETATION: A total of 201(Male=142, Female=59) infants fulfills inclusion criteria, X Axis = Age (in months); Y Axis = Number of Patients; Mean Age = 6.9 weeks & Standard Deviation = 3.1)

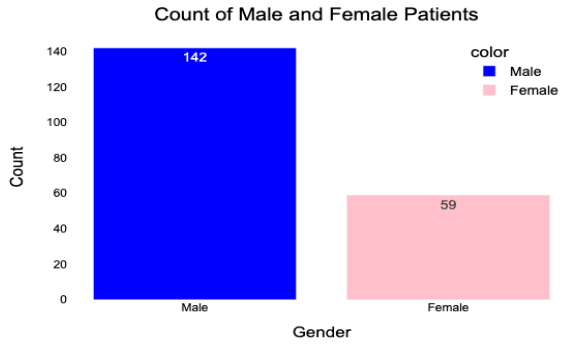

Fig2: Bar graph representing distribution of Male and Female children who underwent developmental evaluation.

GENDER	MALE	FEMALE
FREQUENCY	142	59
PERCENTAGE	70.6%	29.3%

(INTERPRETATION: Gender Distribution of children screened in this study was non homogenous, 142 males and 59 females were recruited with a percentage of 70.6% and 29.3% respectively.)

DISTRIBUTION OF TOTAL SCREENED POPULATION	N (%)
ARDS	13 (6.4)
CHD	3(1.4)
Cancer	1(0.4)
Cerebral Palsy	8(3.9)
Fever	67(33.3)
Genetic Disorder	2(0.9)

Global Developmental Delay	10(4.9)
Infection	16(7.9)
Kidney Disease	3(1.4)
Low Birth Weight	3(1.4)
Normal	24(11.9)
Pneumonia	20(9.9)
Seizures	19(9.4)
Spina Bifida	3(1.4)
Stroke	7(3.4)
Umblical Hernia	2(0.9)

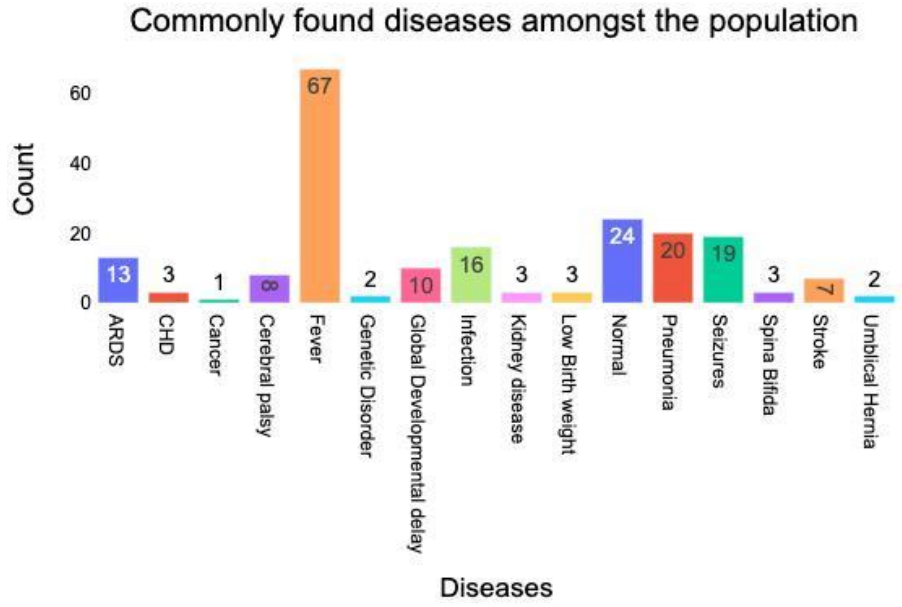

Fig 3: Bar Graph representing the total screened population of children (Both Normal and Diseased)

(**INTERPRETATION:** 6.4% of the children had ARDS, 1.4% of the children had CHD, 0.4% of the children had Cancer, 3.9% of the children had cerebral palsy, 33.3% of the children had fever, 0.9% had genetic disorder, 4.9% of children had global developmental delay, 7.9% of the children had infection, 1.4 of the children had kidney disease, 1.4% of the children had low birth weight, 11.9% children were normal, 9.9% children had pneumonia , 9.4% children had seizures, 1.4% children had Spina bifida, 3.4% children had stroke , 0.9% children had Umblical hernia.)

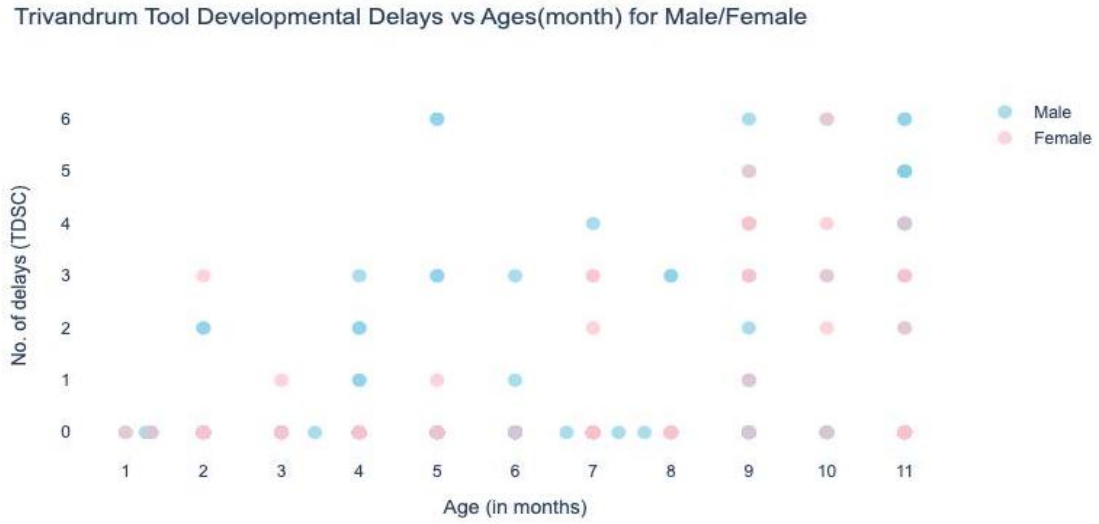

Fig 4: Mean Delay in children (using TDSC)

INTERPRETATION: Mean Item Delay using TDSC in Male children = 5; Mean Item Delay using TDSC in Female children=4.

GENDER	AGE (in Months) for both Male and Female	ITEM DELAY COUNT (for both Male and Female respectively)
Male, Female	1	0, 0
Male, Female	2	2, 4
Male, Female	3	0, 1
Male, Female	4	4, 5
Male, Female	5	6, 4
Male, Female	6	4, 0
Male, Female	7	6, 5
Male, Female	8	7, 0
Male, Female	9	9, 7
Male, Female	10	6, 8
Male, Female	11	8, 7
Mean Item Delay		4.7 (5) , 3.7(4)

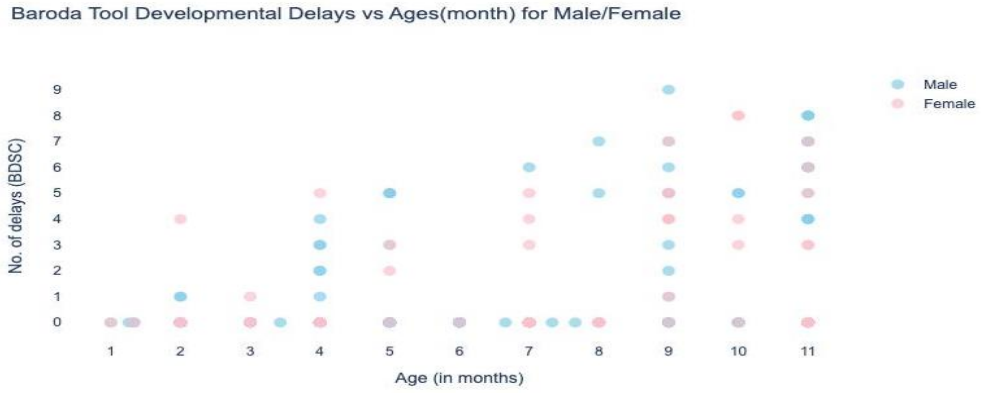

Fig 5: Mean Delay in children (using BDST)

INTERPRETATION: Mean Item Delay using BDST in Male children=4; Mean Item Delay using BDST in Female children=4.

GENDER	AGE (in Months) for both Male and Female	ITEM DELAY COUNT (for both Male and Female respectively)
Male, Female	1	0, 0
Male, Female	2	1, 4
Male, Female	3	0, 1
Male, Female	4	4, 5
Male, Female	5	5, 3
Male, Female	6	0, 0
Male, Female	7	6, 5
Male, Female	8	7, 0
Male, Female	9	9, 7
Male, Female	10	5, 8
Male, Female	11	8, 7
Mean Item Delay		4.0, 3.6 (4)

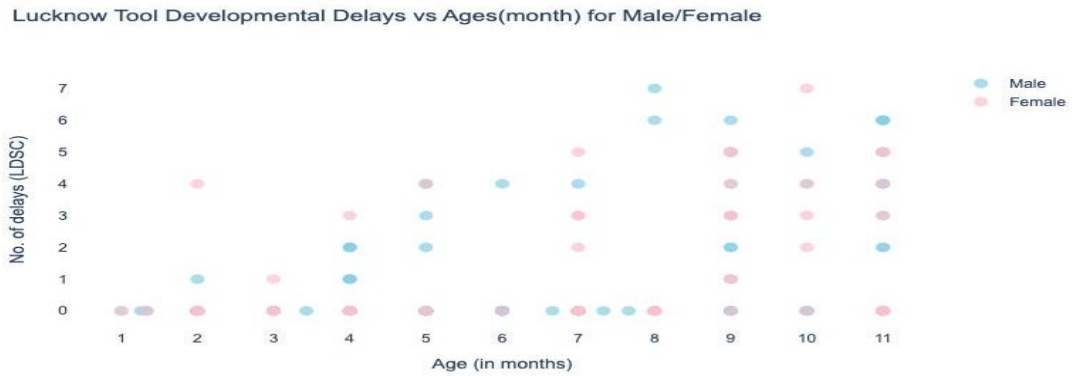

Fig 6: Mean Delay in children (using LDS)

INTERPRETATION: Mean Item Delay using LDS in Male children=4; Mean Item Delay using LDS in Female children=3

GENDER	AGE (in Months) for both Male and Female	ITEM DELAY COUNT (for both Male and Female respectively)
Male, Female	1	0, 0
Male, Female	2	1, 4
Male, Female	3	0, 1
Male, Female	4	2, 3
Male, Female	5	4, 4
Male, Female	6	4, 0
Male, Female	7	4, 5
Male, Female	8	7, 0
Male, Female	9	6, 5
Male, Female	10	5, 7
Male, Female	11	6, 5
Mean Item Delay		3.5(4) , 3.0

4. DISCUSSION

The aim of the present study is "Early Detection of Global Developmental Delay in Infants Using Indian Screening Tools: Insights from a Tertiary Care Hospital and Implications for Raising Awareness about Neurodevelopmental Outcomes – A Cross-Sectional Study".

Data for this study was gathered from tertiary health care Center where 201 infants were recruited in this study out of which 142(70.6%) were males, 59(29.3%) were females. Out of the total screened population, 6.4% of the children had ARDS, 1.4% of the children had CHD, 0.4% of the children had Cancer, 3.9% of the children had cerebral palsy, 33.3% of the children had fever, 0.9% had genetic disorder, 4.9% of children had global developmental delay, 7.9% of the children had infection, 1.4 of the children had kidney disease, 1.4% of the children had low birth weight, 11.9% children were normal, 9.9% children had pneumonia , 9.4% children had seizures, 1.4% children had spina bifida, 3.4% children had stroke , 0.9% children had umblical hernia. Among the total population, mean Item Delay using TDSC in male children was 5, mean item Delay using TDSC in Female children was 4. Mean Item Delay using BDST in Male children was 4; Mean Item Delay using BDST in Female children was 4. Mean Item Delay using LDS in Male children was 4; Mean Item Delay using LDS in Female children was 3. In this regard, this study emphasizes early detection of Global Developmental Delay in infants using screening tools of Indian origin which projects onto the needful parental awareness for optimizing neurodevelopmental outcomes due to any underlying cause. In a study conducted by Serra Acara et.al: An overview of developmental screening instruments and their applicability to early intervention and special education for young children is given in this article. This study demonstrates how early identification of children in need of care might result from rigorous screening. For young children who are at risk of experiencing a developmental delay or disorder, early identification and intervention result in improved results. The use of appropriate screening instruments by families and classroom teachers is valid, dependable, and useful. Parental input is particularly crucial when evaluating screening results. Following a screening, more screenings, focused evaluations, or started service coordination are examples of follow-up measures. Planning programs and lessons can benefit further from screening. In order to enable the adoption of screening procedures in nations that do not yet have systematic screening, more research is required [13].MMarie-Victorine Dumuids-Vernet1, Joëlle Provasi, David Ian Anderson, et al. conducted a systematic study in France to investigate the effects of early motor interventions on gross motor and locomotor development for infants at-risk of motor delay. More excellent research is desperately needed to determine how early motor therapies affect infants with a variety of disorders or delays in development when it comes to their gross

motor and locomotor development. [14] Developmental screenings and surveillance is crucial because it helps identify developmental delays or concerns early in a child's life, allowing for timely intervention and support. Screening tools provide a structured way to assess various developmental domains, such as motor skills, language, cognition, and social-emotional development, helping healthcare providers detect potential issues and refer children for further evaluation if needed. Early remediation to a disease can significantly improves outcomes and reduce the long-term impact of developmental delays on a child's functioning and well-being. By equipping parents with the necessary knowledge regarding developmental screening methods, they may take charge of their child's development and get help when issues do arise.[15] This can be accomplished in a number of ways: E - campaigns: Setting up webinars, seminars, or workshops to educate parents about the value of developmental screening and the operation of screening instruments. Parenting classes: Providing parenting workshops or support groups where parents may learn about the developmental milestones of their kid and how to use screening instruments to keep an eye on their progress. Educational resources: Distributing leaflets, booklets, or web materials that outline developmental milestones and the process of identifying possible concerns using screening methods. Advice for healthcare providers: During routine check-ups, encourage medical professionals to talk to parents about developmental screening and offer advice on how to use the screening instruments.

5. CONCLUSION

Thus, we conclude that our data show different developmental trajectories in relation to the Indian screening tools scores and it is used to identify term and preterm infants at risk of developing a global developmental delay. Also, it is important to establish an awareness drive regarding parent reported developmental concerns amongst parents within the tertiary care setup and multidisciplinary team to clarify and monitor the neurodevelopmental outcomes of infants at early stage to provide early remediation to disabilities.

6. Limitations

Study population was bound to a particular geographical area.

7. Future Scope

There's a possibility of undertaking this research study on a larger sample size. The study can be done on a different geographical location. Various interventional studies, comparative studies can be done based on this data. To ensure generalizability, more studies can be conducted. Parents can be empowered with developmental screening knowledge through e-campaigns, parenting classes, educational resources, advice from healthcare providers, online tools, and community collaborations.

Authors' Contribution

Supervision – Dr. Shilpa Khandare
Methodology, Data collection, original draft writing and editing – Aanchal Goyal

Ethical consideration: This research was approved by the ethical committee of Dr. D.Y Patil College of Physiotherapy, Pimpri, Pune
[Ethical code – **DYPCPT/IEC/01/2023]**

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