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Original Research Article

Prevalence and determinants of developmental delay among children below two years of age visiting an immunization clinic of a tertiary care centre in South India

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ABSTRACT

Background: Developmental delay in children is a worldwide public health problem. It can lead to significant motor and neurocognitive issues along with social constraints. Early detection and intervention are essential to optimize developmental outcomes for children with delays. This study aims to investigate the prevalence and determinants of developmental delay in children aged from two months to two years visiting the immunization clinic of Sree Avittam Thirunal hospital, Kerala, India, using the Trivandrum Developmental Screening Chart (TDSC).
Methods: A hospital-based cross-sectional study was conducted among 300 children aged two months to two years visiting the immunization clinic. Socio-demographic, maternal obstetric, antenatal and neonatal data were collected from mothers/guardians using a semi-structured interviewer-administered questionnaire. TDSC was used for screening. Results were analyzed using SPSS v.27 and R studio v.2023.09.1+494 software.
Results: Out of 300 children studied, 30(10%) were identified with developmental delay amongst which 43.3% had multiple item delay. On univariate analysis factors such as parents' age and education, father's occupation, antenatal history of decreased fetal movements, gestational age, history of feeding difficulty soon after birth, neonatal infections and birth weight were found to be significant. Multivariable analysis showed maternal education, gestational age at birth and neonatal infections to have a significant association with developmental delay.
Conclusions: The observed prevalence of developmental delay was 10% (95% CI 6.8-14). The significant risk factors identified like maternal education, gestational age and neonatal infections offer insights for intervention. The study highlights the importance of integrating developmental screening into immunization clinics for early detection and intervention.

Keywords: Screening, Developmental delay, TDSC, Risk factors

INTRODUCTION

Child development is a multifaceted process that involves a series of changes, maturation of functions and acquisition of skills.[1] A developing child goes through various physical, cognitive and psychosocial changes in the process of development. These changes occur independently yet simultaneously across different developmental domains like cognitive, social-emotional, language and motor. A delay in the process of development is expected when the child acquires various developmental skills at a pace later than his/her peers. Developmental delay is a global public health problem. Every year approximately 200 million under-five children exhibit significant delay worldwide; 86% of the developmental delay being in developing countries.[2] In India, studies have found that the prevalence of developmental delay in children under 2 years of age ranges between 1.5% to 2.5%.[3,4] Developmental delay

can have an impact not only on the individual child but also on the broader community.[5] Delay in children usually goes unnoticed by parents, especially in children less than two years. When a child rolls over, sits up, crawls, walks, or runs later than his/her older siblings or other children of the same age, it often makes parents and guardians concerned. The importance of early detection of children with developmental delay has been well documented.[5,6] Any delay in reaching the milestones especially during the first few years of life will finally affect how an individual interacts with his/her surrounding society. Hence early identification, intervention and supportive services are essential to optimize the developmental outcomes for children with delay and promote their overall well-being and inclusion within the community.[2,5] Early intervention plays a crucial role in mitigating the long-term sequelae of developmental delay in children. They also help to improve the child's academic performance, enhance social and emotional skills and make them better equipped to perform daily activities.

There is no simple tool that community health workers can use to screen the development of children. Hence children with developmental delay are usually not identified at the community level. According to the American academy of paediatrics (AAP), "good" screening tools are those with sensitivity and specificity in the range of 70-80%. In our study we have used the TDSC: 0-3Y- a simple, convenient and valid Indian tool that has a sensitivity of 66.7% and specificity of 78.8%, for screening the developmental status of children. TDSC was designed and developed by the child development centre, Thiruvananthapuram which can be used to measure the cognitive and motor development of children under 36 months of age.[7] Early detection of developmental delay is necessary for setting up community-based intervention program to halt onward progression to disability. Early stimulation of children will help them to acquire necessary skills and bridge the developmental gaps.

In recent times, there have not been many studies focusing on the development of children under the age of two years in Kerala.[3,8] In this context, the present study was planned to assess the development among children below two years of age and its associated factors. The objectives of this study were to estimate the prevalence of developmental delay in children of two months to two years of age visiting immunization clinic Sree Avittam Thirunal hospital, Thiruvananthapuram, Kerala using TDSC 0-3 years and its associated clinical and socio-demographic determinants.

METHODS

A hospital-based cross-sectional study was carried out among children aged two months to two years visiting the immunization clinic of a tertiary care centre during the period August 2023 to October 2023.The study setting was the immunization clinic of Sree Avittam Thirunal hospital of the government medical college in Thiruvananthapuram, the first ever established medical college in Kerala which acts as an apex referral centre to the population of several nearby districts. Study participants were children aged two months to two years, and the respondents were their mother/guardian. Informed consent was obtained from the child's mother/guardian and they were interviewed using a pretested, semi-structured questionnaire.

To determine the sample size, we used the formula $n=(Z_{1-\alpha/2})^2pq/d^2$, where n is the sample size, $Z\alpha=1.96$, p is the expected prevalence=6.6% as per a study by Gupta et al and d is the absolute precision of error=3.[5] By inputting these values into the formula, an estimated sample size of 300 participants was obtained.

The universe of the study population was children aged two months to two years visiting the immunization clinic at the time of data collection. Using a systematic random sampling technique; every third mother/guardian waiting in the queue, with their child to be immunized at the immunization clinic was taken for study.

The tentative diagnosis of developmental delay was our main outcome of interest, which was evaluated using the TDSC. As per TDSC, if a child fails to acquire any of the items mentioned within the age limit specified in the TDSC he/she is said to have developmental delay. The potential associations between the following factors and developmental delay were examined: age in months and sex of the child, socio-economic status of the family, parents' age in years at time of child delivery, educational and occupational status of parents, place of residence and family type. In study, we also investigated the relationship between developmental delay and maternal obstetrics history, antenatal risk factors, gestational duration of pregnancy, natal and neonatal factors.

Ethical clearance was obtained from the human ethics committee of government medical college, Thiruvananthapuram HEC NO: 12/20/2023/MCT, and informed written consent was obtained from the parents or guardians. No financial burden was incurred on study participants. Confidentiality and data safety was ensured.

Data were analyzed using SPSS v.27 and R studio v.2023.09.1+494. Quantitative variables were expressed in terms of mean and standard deviation, while qualitative variables expressed in terms of frequency and percentage. Univariate analysis included chi-square test. We utilized binary logistic regression as multivariable analysis to predict factors associated with developmental delay. $P<0.05$ considered statically significant.

RESULTS

Developmental delay has a multifactorial causation. Various factors contribute to developmental delay such as

premature birth, low birth weight, infections during pregnancy, genetic disorders, environmental factors like poverty, neurological disorders like cerebral palsy, autism, etc. These factors impact developmental trajectories. Understanding the underlying causes is crucial for early identification, intervention and support.

In the study, a total of 300 study participants were studied. Majority i.e., 125 (41.7%) of them were aged between two and six months of age with a mean age of 9.7 (6.6) months and the median age of 9 months (Figure 1). The study included 151 girls (50.33%) and 149 boys (49.67%), nearly equal in number (Figure 2).

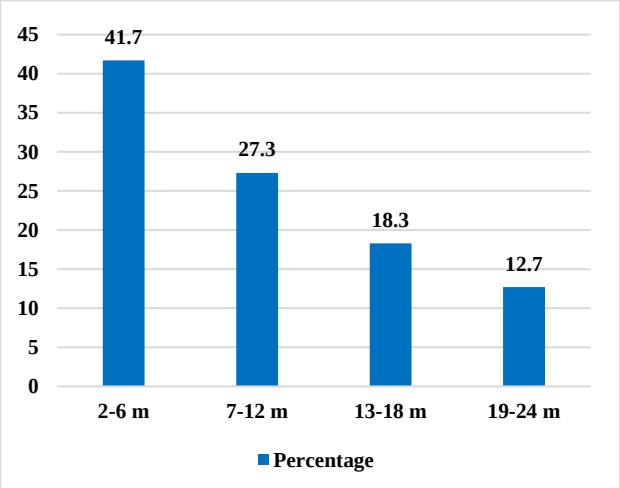

Figure 1: Age distribution of study participants.

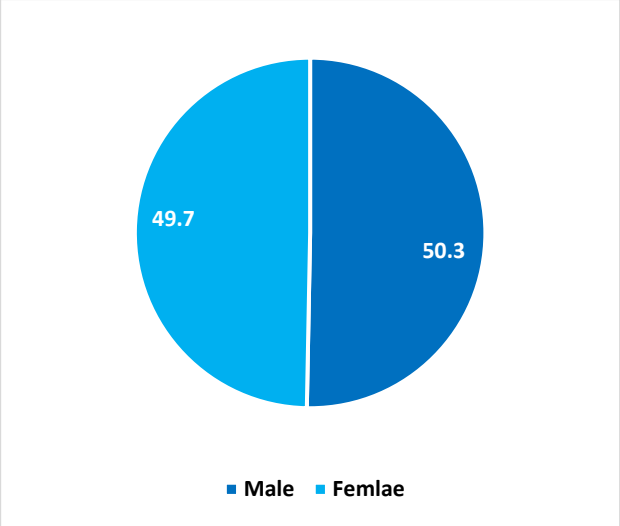

Figure 2: Sex distribution of study participants.

Majority of the study participants came from rural areas with 181(60.3%) belonging to below poverty line (BPL) category. The mean and the median ages of the fathers and mothers of the children were 33.52 (5.3) and 33 and 28.06 (5.01) and 27 years respectively. Among the fathers of study participants, 86 (28.7%) were educated up to higher secondary, 85(28.3%) were educated up to high school and 74 (24.7%) were degree holders. Out of all the mothers, 135 (45%) had a degree, 76 (25.3%) had completed higher secondary education, and 40 (13.3%) had a postgraduate degree. Only 4 (1.3%) mothers had a primary level education, and 1 (0.33%) had no formal education. Of the fathers, 250 (83.3%) were skilled workers, and only 50 (16.7%) engaged themselves in unskilled activity. However, the majority, i.e., 213 (71%) mothers, were unemployed, and only 87 (29%) mothers were employed. Of the study's participants, 186 (62%) came from three-generation families, 111 (37%) were from nuclear families, and three (1%) were from joint families.

Interviewing the mothers of the study participants, 41 (13.67%) gave a history of treatment for infertility and 64 (21.33%) had a history of previous abortion. In the background of their antenatal history, 62 (20.7%) had hyperemesis, 93 (31%) had diabetes mellitus, 56 (18.67%) had hypertension, 10 (3.33%) had at least one event of trauma, 7 (2.33%) had seizures, 9 (3%) had radiation exposure and 19 (6.33%) gave a history of reduced fetal movements during their third trimesters of gestation. There were no mothers with home as place of delivery.

Of the study participants, 197 (65.66%) were born after completing 36 weeks of gestation in the mother's womb (full-term) and 103 (34.33%) were born pre-term i.e. before completion of 36 weeks of gestation. Majority of the study participants [175 (58.3%)] were delivered via caesarean section and 125 (41.7%) were delivered via normal vaginal delivery.

Considering the postnatal history of the study participants, it was found that 89 (29.67%) of them had respiratory distress soon after birth, 55 (18.33%) had feeding problems shortly after birth, 23 (7.67%) had convulsions, 6 (2%) had meningitis, 2 (0.7%) had chromosomal anomalies, 132 (44%) had history of neonatal intensive care unit (NICU) admission, 12 (4%) had history of head injury, 41 (13.67%) had history of infections during neonatal period, 22 (7.3%) of them were not immunized up to age, and 24 (8%) of them had delayed cry. Further, 92 (30.7%) were not exclusively breastfed for age, 116 (38.7%) had low birth weight, and 15 (5%) had a family history of developmental delay.

Out of the 300 study participants studied, 30 study participants showed a delay in achieving the age-appropriate milestones according to the TDSC 0-3 years thereby giving an estimated prevalence of developmental delay of 10% (95% CI 6.8% to 14%) (Figure 3). Among the 30 study participants with developmental delay, five children (1.7%) showed a two-item delay, three children (1%) showed a three-item delay, three children (1%) showed a four-item delay, and two children (0.7%) showed a five-item delay as per TDSC, underscoring the relevance of periodic screening for a child's development (Figure 4).

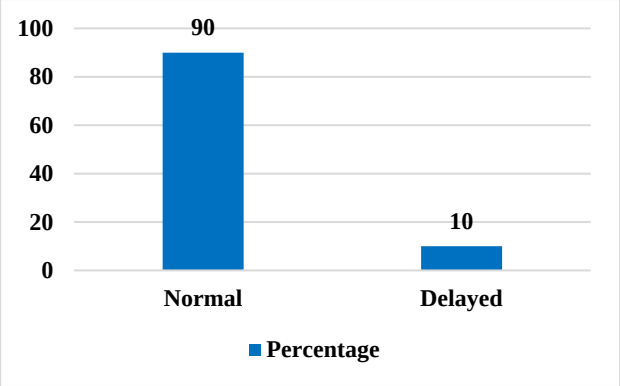

Figure 3: Distribution of developmental delay among study participants.

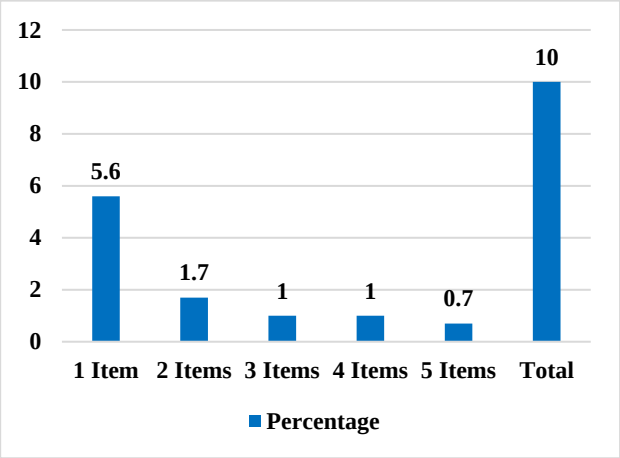

Figure 4: Distribution of number of items delayed according to TDSC among children with developmental delay.

On univariate analysis, the following variables were found to be significant: fathers aged more than 40 years, mothers aged more than 35 years, fathers educated up to high school, mothers educated up to high school, fathers engaged in unskilled occupation, antenatal history of decreased fetal movements, babies born preterm, neonatal history of feeding difficulty, children with chromosomal anomalies, history of NICU admission, and neonatal history of infections (Table 1).

A binary logistic regression was performed to build a prediction model for developmental delay. Those variables that were found to be significant in univariate analysis ($p<0.05$) and those variables with a $p<0.30$ were used in model building. The enter method was used and those variables with higher p values were removed to reach a better model fit.

The final model for prediction of developmental delay was statistically significant ($p<0.05$) with the Nagelkerke R^2 value of 0.138. The model summary was able to explain 13.8% of the variability in developmental delay.

The significant variables in the model were mother's education with odds ratio 4.510 (95% CI 1.795- 11.328, p=0.001), gestational age of the child at the time of delivery with odds ratio 2.849 (95% CI 1.287-6.310, p=0.010) and history of infections during neonatal period with odds ratio 3.089 (95% CI 1.213-7.868, p=0.018). Mothers who have studied up to high school or below had 4.51 times the odds of having children with developmental delay. Preterm babies had 2.849 times the odds of having delayed development than full term babies. Children with history of infections during neonatal period had 3.089 times odds of developmental delay when adjusted for other risk factors (Table 2).

Table 1: Results of univariate analysis.

Variables	With developmental delay, N (%)	Without developmental delay, N (%)	P value	Odds ratio
Socio-demographic determinants				
Age (2-12 months)	189 (70)	18 (60)	0.261	1.556
Male sex	19 (63.3)	130 (48.1)	0.115	1.86
Rural place of residence	21 (70)	164 (60.7)	0.322	1.508
BPL category	18 (60)	163 (60.4)	0.969	0.985
Father's age >40 years	8 (26.7)	19 (7)	0.002	4.804
Mother's age > 35 years	7 (23.3)	19 (7)	0.008	0.249
Father's education (upto 10^{th} std)	15 (50)	74 (27.4)	0.01	2.649
Mother's education (upto 10^{th} std)	9 (30)	24 (8.9)	0.002	4.393
Father's occupation (unskilled)	10 (33.3)	40 (14.8)	0.01	2.875
Mother's occupation (unskilled)	21 (70)	195 (72.2)	0.797	0.897
Nuclear type of family	14 (46.7)	97 (35.9)	0.248	1.561
Maternal obstetric history				
Infertility treatment	5 (16.7)	36 (13.3)	0.579	1.3
Previous abortion	9 (30)	55 (20.4)	0.222	1.675
Still-birth	0	5 (1.9)	1	NA
Neonatal death	0	5 (1.9)	1	NA
Post-neonatal death	1 (3.3)	0	0.1	NA

Continued.

Variables	With developmental delay, N (%)	Without developmental delay, N (%)	P value	Odds ratio
Antenatal history				
Hyperemesis	10 (33.3)	52 (19.3)	0.071	2.096
Diabetes mellitus	11 (36.7)	82 (30.4)	0.479	1.327
Hypertension	6 (20)	50 (18.5)	0.843	1.1
Trauma	2 (6.7)	8 (3)	0.263	2.339
Fever with rashes	0	4 (1.5)	1	NA
Epilepsy	0	7 (2.6)	1	NA
Radiation	2 (6.7)	7 (2.6)	0.224	2.684
Decreased fetal movements	5 (16.7)	14 (5.2)	0.03	3.657
Neonatal history				
Preterm	17 (56.7)	86 (31.9)	0.007	2.798
Delivery by caesarean section	17 (56.7)	158 (58.5)		0.927
Delayed cry at birth	5 (16.7)	19 (7)	0.077	2.642
Respiratory distress at birth	12 (40)	77 (28.5)	0.192	1.671
Feeding difficulty at birth	11 (36.7)	44 (16.3)	0.006	2.974
Convulsion	4 (13.3)	19 (7)	0.266	2.032
Meningitis	2 (6.7)	4 (1.5)	0.113	4.75
Jaundice	10 (33.3)	72 (26.7)	0.437	1.375
Chromosomal anomalies	2 (6.7)	0	0.01	NA
NICU admission	22 (73.3)	110 (40.7)	0.001	4
Head injury	2 (6.7)	10 (3.7)	0.342	1.857
Infections	8 (26.7)	33 (12.2)	0.045	2.612
Not immunized upto age	4 (13.3)	18 (6.7)	0.255	0.464
Not exclusively breastfed for age	9 (30)	83 (30.7)	0.933	0.966
Low birth weight	19 (63.3)	97(35.5)	0.003	3.081
Family history of developmental delay				
Family history present	3 (10)	12 (4.4)	0.18	2.389

Table 2: Results of multivariable logistic regression.

Variables	Crude odds ratio	Adjusted odds ratio (95% CI)	P value
Mother's education	4.393	4.510 (1.795- 11.328)	0.001
Gestational age of child at birth	2.798	2.849 (1.287-6.310)	0.01
History of infections during neonatal period	2.612	3.089 (1.213-7.868)	0.018

DISCUSSION

A child's development is a complex process that follows an orderly pattern and involves the acquisition of various skills for enhanced survival. Developmental delay refers to a lag in reaching developmental milestones typically expected at a particular age compared to his/her peers. The study was conducted on 300 children aged two months to two years visiting the immunization clinic of Sree Avittam Thirunal hospital of government medical college, Thiruvananthapuram, a major tertiary care centre in Kerala, South India. Their development was assessed using the TDSC, a simplified version of the Bayley scale of infant development. It is a tool that has been validated both at the hospital and community level against the standard Denver developmental screening test as a reference, making it a reliable and easy-to-use tool to screen for developmental delay.[7,9]

Our study found a 10% hospital-based prevalence of developmental delay among children under two years of age, similar to some community-based studies.[2,5] Global estimates by UNICEF in 2022 reported a prevalence of 4.3% among children under four years old.[10] In a study conducted by trained ASHA workers in Kerala among children below 6 years showed a community prevalence of 3.08% delay according to TDSC.[8] Additionally, research conducted in West Bengal and Gujarat, states of India, found rates of 7.9% and 9.5% respectively among children under two years old.[2,11] The high prevalence in this study may be attributed to the study setting being a tertiary care centre.

We also analysed the prevalence of multi-item delay in the 30 children with developmental delay and found that 13 (43.3%) of them had multi-item delay according to TDSC. Considering the overall study population of 300 children, five (1.7%) children showed two item delay,

three (1%) children showed three item delay, three (1%) children showed four item delay and two (0.7%) children showed five item delay, giving a total prevalence of 4.33%. In the study by Metwally et al among Egyptian children, 2.8% was the proportion of multiple delays.[12] The study undertaken by Nair et al to build a district model for establishing developmental screening showed a prevalence of 2.45% of children under the age of 6 years with two or more TDSC item delay which is congruent with our study findings.[13]

On univariate analysis, paternal age (OR=4.804 (95% CI 1.888 and 12.224)), education (OR=2.649 (95% CI 1.234 and 5.686)) and occupation (OR=2.649 (95% CI 1.234 and 5.686)), and maternal age (OR=4.021 (95% CI 1.524 and 10.523) and education (OR=4.393 (95% CI 1.811 and 10.657)) were the significant socio-demographic determinants of developmental delay. History of decreased fetal movements in antenatal period (OR=3.657 (95% CI 1.217 and 10.993)), gestational age at the time of delivery of child (OR=2.798. (95% CI 1.300 and 6.020), history of feeding difficulties shortly after birth (OR=2.974 (95% CI 1.323 and 6.683)), history of infections in the neonatal period (OR=2.612 (95% CI 1.075 and 6.343)), history of NICU admission (OR=4.000 (95% CI 1.719 and 9.310)), chromosomal anomalies and birth weight (OR=3.081 (95% CI 1.408 and 6.741)) were statistically significant clinical factors.

Though comorbidities in mother like diabetes, hypertension, epilepsy during antenatal period were considered as risk factors according to Huang et al study, no such relation was obtained in this study.[14] Study by Cabanas Vela et al showed a significant association between hyperbilirubinemia and delay in visual development.[15] Head trauma and developmental delay were considered to have a strong link as per Eismann et al study but no such association was observed in the study.[16]

We performed a multivariable analysis using binary logistic regression. Maternal education (aOR 4.510 (95% CI 1.795-11.328)), gestational age at the time of delivery of child (aOR 2.849 (95% CI 1.287-6.310)) and history of infections in the neonatal period (aOR 3.089 (95% CI 1.213-7.868)) showed significant association with developmental delay. Maternal education and gestational age at the time of delivery of child were also found to be significant in studies by Bhattacharya et al and Vora et al.[2,11] Studies by Bishwokarma et al in slums of Nepal and Westgard et al in rural communities of Peru also demonstrated that lower the level of education of the mother, higher the chance of developing neurocognitive delay in the child.[17,18] A similar finding was observed in a study conducted in Turkey by Ozkan et al.[19] Maternal education is an important antecedent factor in determining a child's health as it will help them to identify their child's delay in development at an early age and appropriate interventions can be given to correct them.

The observed significance of gestational age at the time of delivery of child shows the role it plays in the development of child. Preterm babies are more prone for developmental delay than full term babies. A similar study conducted in Gujarat by Vora et al also showed that prematurity was a significant factor in influencing the development of a child.[11] The first 1000 days, i.e. from the time of conception to two years of age is considered as the golden period for brain development. Maximum brain development occurs in the last 3 months of gestation. Thus, children born before completing 36 weeks, their brain may not be as mature as that of a full-term baby leading to a lag in the neurocognitive maturation. The study by Kerstjens and colleagues showed that early preterm babies had a greater prevalence of developmental delay than moderate preterm babies.[20] Thus the risk of developmental delay increases with decrease in gestational age at the time of delivery. Vogel et al have found that advanced maternal age, low socioeconomic status, poor obstetric history in the past and antenatal insults can lead to preterm labour.[21]

Our data showed that history of infections during the neonatal period (aOR 3.089 (95% CI 1.213-7.868)) can affect a child's development and lead to considerable delay in acquiring developmental milestones apt for that age. The findings are consistent with that of a population-based cohort study by Mitha et al.[22] This has also been supported by a study conducted in urban slums of Nepal where children who had a history of infection in the past exhibited developmental delay.[16]

Many studies have indicated that breastfeeding promote the development of child.[23–25] Children who were never breastfed were more likely to develop gross motor delay but we did not get any significant association between these two. Children delivered by cesarean section was also considered as a danger element for developmental delay.[26,27] However, we did not uncover any such relations. The socioeconomic status of parents did not show any influence on developmental delay in this study which is incongruent with the findings of study by Conger et al.[28] The lack of significance for some variable like socioeconomic status, breastfeeding, mode of delivery, head trauma, meningitis may be because the sample size was not adequately powered for testing the significance of these potential risk factors. The higher prevalence of developmental delay in this study can be attributed to the study being conducted in a tertiary care centre.

CONCLUSION

In conclusion, addressing developmental delay is of paramount importance for ensuring the optimal wellbeing of children. Therefore, screening for developmental delay is necessary for giving early intervention as it has the potential to improve the development of children. Collaboration among caregivers, educators, and healthcare professionals is pivotal in creating

environments conducive to supporting children with developmental delays in reaching their full potential. Ongoing research and increased awareness are vital to cultivate a compassionate and knowledgeable society that embraces diversities in developmental trajectories.

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