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Paediatrics Section

Screen-Positive Prevalence and Associated Factors of Neurodevelopmental Disorders among Children Aged 1-12 Years in Southern India: A Community-Based Cross-sectional Study

SUNDAR BHAVANI[1], PRIYA JOSE[2], NISHANTH RAJAN[3], K PETER PRASANTH KUMAR[4], RAMACHANDRAN[5], RAJESH KUMAR KONDURU[6]

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ABSTRACT

Introduction: Neurodevelopmental Disorders (NDDs) are a group of conditions characterised by developmental deficits that impact personal, social, academic or occupational functioning. Early Identification is critical for timely intervention, especially in resource-limited settings.

Aim: To assess the community-based screen-positive prevalence of NDDs among children aged 1-12 years in selected urban and rural areas of South India and to assess the associated factors of Neurodevelopmental disorders.

Materials and Methods: A community based cross sectional study was conducted at Pondicherry Institute of Medical Sciences, Kalapet, Puducherry, India. among 730 children aged 1-12 years using a multi-stage sampling method over a period of 10 months from March to December 2023. Screening was done using the Developmental Psychopathology Checklist (DPCL) for children. Demographic and clinical details were collected. Descriptive statistics were used to calculate prevalence. Bivariate analysis to identify the risk factors was performed. A Chi-square test and logistic regression were used to determine predictors of NDDs. A p-value <0.05 was considered significant.

Results: A total of 730 children, of whom 51.6% were male and 48.4% were female, with a mean age of 6.02 ± 3.22 years, were enrolled. The overall screen-positive prevalence of neurodevelopmental disorders (NDDs) was 8.4% (95% CI: 6.4%-10.4%). In multivariable logistic regression, children aged 5-8 years had higher odds of screen-positive NDDs than the reference age group (adjusted odds ratio [aOR]=3.580, 95% CI: 1.728-7.415; p=0.001), as did children aged 9-12 years (aOR=4.200, 95% CI: 1.981-8.909; p <0.001). Preterm birth was also independently associated with screen-positive NDDs (aOR=2.368, 95% CI: 1.113-5.035; p=0.025).

Conclusion: The overall screen-positive prevalence of neurodevelopmental disorders was 8.4%. Older age groups and preterm birth were independently associated with screen-positive NDDs.

Keywords: Child development, Community health services, Developmental disabilities, Mass screening, Premature birth, Risk factors

INTRODUCTION

Neurodevelopmental disorders (NDDs) are a group of conditions with onset in the developmental period. These disorders typically manifest early in development, often before the child enters grade school, and are characterised by developmental deficits that produce impairments in personal, social, academic, or occupational functioning. Disruption in the dynamic inter-relationship between environmental, genetic, neurologic, cognitive, emotional, and behavioural processes across the developmental lifespan can lead to NDDs [1].

Children from low-income communities and those living in poverty are disproportionately affected by NDDs [2]. Despite this recognised burden, reliable epidemiological data capturing the overall prevalence and associated factors of NDDs in community settings remain limited, particularly in low- and middle-income countries such as India [3]. This lack of data constrains effective public health planning, early identification strategies, and resource allocation.

Previous researchers have examined NDD prevalence in specific regions and age groups. A landmark multicentric Indian study [4] estimated NDD prevalence in children aged 2-9 years across five regions, reporting rates of 9.2% (2-6 years) and 13.6% (6-9 years). Similarly, several international and Indian studies have evaluated individual NDDs such as Attention-Deficit/Hyperactivity Disorder (ADHD), Autism Spectrum Disorder (ASD), and learning disabilities using disorder-specific diagnostic tools, providing valuable but fragmented insights into the burden of these conditions [5-8].

However, important gaps remain in the existing literature. First, most studies focus on single disorders rather than the overall burden of NDDs, limiting understanding of co-occurrence and cumulative impact [5-8]. Second, there is a paucity of community-based studies encompassing a wider developmental age range (1-12 years), particularly from South India [3,4]. Third, urban-rural comparative data are scarce, despite known disparities in healthcare access and reporting patterns [9]. Also, very few studies have utilised a single, culturally adapted, standardised indigenous screening tool to assess multiple domains of neurodevelopment simultaneously [5,10].

The present study addresses these lacunae by providing a comprehensive, community-based estimate of screen-positive NDD prevalence (proportion of children who screened positive for one or more NDDs using DPCL) [11] across a broad age range (1-12 years), incorporating both urban and rural populations in South India. Hence, the present study aimed to assess the community-based screen-positive prevalence of NDDs among children aged 1-12 years in selected urban and rural areas of South India.

The objectives of the study were to estimate the screen-positive prevalence of NDDs using the DPCL tool; To identify demographic and perinatal factors associated with NDDs; To compare urban and rural prevalence patterns.

MATERIALS AND METHODS

This community-based cross-sectional study was conducted at Pondicherry Institute of Medical Sciences (PIMS), Puducherry, India, after approval from the Institutional Ethics Committee (IEC No: RC/2022/170). The study was conducted over a period of 10 months from March 2023 to December 2023. Four areas were included: two rural villages in Tamil Nadu (Chunampet, Anichamkuppam), one rural area (Kalapet), and one urban area (Muthialpet) in Puducherry. A parent or legal guardian of each child provided written informed consent in either English or Tamil prior to participation. Children aged seven years and above additionally provided written assent before enrolment.

Inclusion criteria: All children aged 1-12 years who had been residing in the selected study areas for at least six months were included in the study, provided that a parent or legal guardian capable of giving a reliable history was available at the time of data collection.

Exclusion criteria: Children with severe acute illness at the time of assessment and those from households that were not contactable even after two visits were excluded from the study.

Sample size: Sample size was calculated using the formula for estimation of a single proportion, $n= Z^2pq/d^2$, where Z is the standard normal deviate at 95% confidence level (1.96), p is the assumed prevalence (9%), q= 1-p, and d is the absolute precision (2%); based on this, the calculated sample size was 730 [4].

A multistage sampling technique was adopted to obtain a representative sample of the study population. In the first stage, study areas were selected purposively based on predefined criteria such as population density, feasibility of data collection, and accessibility. In the second stage, each selected study area was subdivided into smaller, well-defined clusters (e.g., wards/blocks). A list of all clusters within each area was prepared, and clusters were either selected randomly or included based on the required sample size and distribution. In the third stage, households within each selected cluster were chosen using systematic random sampling. In cases where an eligible participant was not available in the selected household, the next immediate household was approached.

Study Procedure

Data collection: Demographic details comprised age, gender, place of residence and Socioeconomic Status (SES) of the participants was recorded. Perinatal history like: Gestational age, Number of siblings etc., social and cultural practises like primary care taker, and birth order were also collected. The total sample of 730 children was proportionately allocated across the four areas based on their respective population sizes: Muthialpet (urban, n=385), Kalapet (rural, n=180), Chunampet (rural, n=85), and Anichamkuppam (rural, n=80). Within each area, the population was divided into three geographic clusters, and an equal number of participants were recruited from each cluster to ensure balanced representation.

DPCL tool: The DPCL, developed by the Department of Child and Adolescent Psychiatry, National Institute of Mental Health and Neurosciences, was used in the present study [11]. The kit was procured through the Clinical Psychology Department for research use. The DPCL is a standardised indigenous screening instrument designed to identify developmental and behavioural problems among children in the Indian setting. It consists of a total of 124 items distributed across six broad domains: (i) developmental history; (ii) developmental problems/disorders; (iii) psychopathology; (iv) psychosocial factors; (v) temperament; and (vi) social supports and assets.

The psychopathology section further includes subdomains assessing ADHD, conduct problems, learning problems, emotional problems, obsessive-compulsive symptoms, somatic symptoms, and psychotic symptoms. Although these psychopathology subdomains are scored separately, they collectively belong to the single broad "psychopathology" domain. Therefore, the DPCL essentially contains six major domains, while the individual psychopathology components are interpreted as subcategories within one domain.

Of the total 124 items, developmental history contains 10 items, developmental problems/disorders 18 items, ADHD four items, conduct problems eight items, learning problems six items, emotional problems nine items, obsessive-compulsive symptoms one item, somatic symptoms nine items, psychotic symptoms 13 items, family history seven items, stressors 16 items, and temperament-related characteristics assessing sociability, rhythmicity, tolerance, negativity, and adaptability. Most items are scored dichotomously as "present" or "absent," with scores generally assigned as one and zero, respectively, as specified in the DPCL manual. Hence, higher scores indicate a greater burden of developmental or behavioural concerns.

A child was considered screen-positive for a particular NDD category when the score in the respective domain exceeded the predefined cut-off specified in the DPCL manual. The cut-off scores used in the present study were as follows: developmental history ≥3 out of 10, developmental problems/disorders ≥5 out of 18, ADHD ≥2 out of four, conduct problems ≥4 out of eight, learning problems ≥3 out of six, emotional problems ≥3 out of nine, obsessive-compulsive symptoms one out of one, somatic symptoms ≥3 out of nine, and psychotic symptoms ≥3 out of 13. Family history, psychosocial stressors, temperament, and social support domains are primarily descriptive domains and do not have fixed screening cut-offs in the DPCL manual.

The DPCL does not recommend a single overall total cut-off score for diagnosing or screening NDDs. Instead, interpretation is based on domain-specific cut-offs, as the checklist follows a dimensional approach that identifies difficulties across multiple developmental and psychopathological domains rather than generating one composite diagnostic score. The minimum possible score is zero, while the maximum possible score depends on the cumulative endorsed items across domains.

The DPCL has demonstrated strong psychometric properties, including high inter-rater reliability Intraclass Correlation Coefficient (ICC=0.968) and internal consistency (ICC=0.965). It has been culturally adapted for the Indian population and validated against the Child Behaviour Checklist (CBCL). However, sensitivity and specificity vary across domains, with relatively lower sensitivity for ASD and intellectual disability; therefore, confirmatory diagnostic assessment is recommended for screen-positive children. The methodology and scoring approach used in the present study were discussed with faculty from the Department of Child and Adolescent Psychiatry, NIMHANS.

Include in study procedure Training of research assistants: Research assistants underwent structured training under supervision of a paediatrician and clinical psychologist, including mock interviews and pilot testing to ensure uniform data collection.

STATISTICAL ANALYSIS

Data were analysed to address the primary and secondary objectives. Descriptive statistics were used to estimate the community-level screen-positive prevalence of NDDs among children aged 1-12 years. Bivariate analysis was performed using the Chi-square test for categorical variables and independent t-tests or Mann-Whitney U tests for continuous variables to identify factors associated with NDDs. Variables with p <0.2 on bivariate analysis were entered into a multivariate binary logistic regression model to determine independent predictors of screen-positive NDD status. Adjusted Odds Ratios (aOR) with 95% Confidence Intervals (CI) are reported. Gestational age had 12 missing values (1.6%), which was below the pre-specified 5% threshold; complete-case analysis was therefore applied. No other variable exceeded the 5% threshold. A p-value of <0.05 was considered statistically significant. Missing data were minimal (gestational age missing in 1.6% cases) and handled using complete-case analysis as it was below the 5% threshold. No imputation was required.

RESULTS

A total of 730 children were enrolled in the study (mean age 6.02±3.22 years; 51.6% males, 48.4% females). The overall screen-positive prevalence of NDDs was 8.4% (95% CI: 6.4-10.4%).

Geographical Anichankuppam distribution varied from lowest screen positive prevalence of 4 (5%) in Village (Rural) of Tamil Nadu to highest prevalence of 9 (10.6%) in Chunampet village (rural) of Tamil Nadu, followed by Muthialpet Town (Urban) in Union territory of Puducherry (36, 9.3%) and Kalapet town (Rural) in UT of Puducherry (12, 6.6%). Screen positive NDD Prevalence in Urban area (36, 9.35%) was found to be higher than in rural areas (25, 7.24%) [Table/Fig-1].

Area	NDD Present n (%)	95% Confidence Interval (CI)
Muthialpet (Urban)	36 (9.3%)	6.4-12.2
Kalapet (Rural)	12 (6.6%)	3.0-10.2
Anichankuppam (Rural)	4 (5.0%)	0.6-9.4
Chunampet (Rural)	9 (10.6%)	4.7-16.5
Overall	61 (8.4%)	6.4-10.4

[Table/Fig-1]: Site-wise screen-positive prevalence of NDDs (N=730).

A higher screen positive prevalence was noted among males (38, 10.1%) compared to females (23, 6.5%). Age category wise, highest screen positive prevalence was noted in the age group of 9-12 years (23, 13%) followed by 5-8 years (27, 11.20%) and the least was seen in 0-4 years age group (11, 3.52%).

Among the 730 children, 42.7% were aged 1-4 years, 33.0% were aged 5-8 years, and 24.2% were aged 9-12 years. Males comprised 51.6% of the study population, 52.7% resided in urban areas, and 59.7% belonged to the upper middle socioeconomic class. Most children were first-born (56.6%) and had one sibling (61.2%). Most mothers were aged 25-29 years. Mothers were the primary caregivers for most children (88.8%), followed by grandparents (6.9%) and fathers (4.2%) [Table/Fig-2].

Characteristic	n (%)
Age group	
1-4 years	312 (42.7%)
5-8 years	241 (33.0%)
9-12 years	177 (24.2%)
Gender	
Male	377 (51.6%)
Female	353 (48.4%)
Place of residence	
Urban	385 (52.7%)
Rural	345 (47.3%)
Socioeconomic Status (SES)	
Upper	121 (16.6%)
Upper middle	436 (59.7%)
Lower middle	150 (20.5%)
Upper lower	22 (3.0%)
Lower	1 (0.1%)
Birth order	
1st	413 (56.6%)
2nd	282 (38.6%)
3rd	31 (4.2%)
4th	3 (0.4%)
6th	1 (0.1%)
Number of siblings	
0	124 (16.9%)
1	447 (61.2%)
2	125 (17.1%)
3	29 (3.9%)
4	1 (0.1%)
5	2 (0.3%)
6	2 (0.3%)
Primary caregiver	
Mother	648 (88.8%)
Father	31 (4.2%)
Grandparents	50 (6.9%)
Others	1 (0.1%)
Mother's education status	
Illiterate	7 (1%)
Primary school	36 (5.3%)
Middle school	145 (19.8%)
High school	175 (23.9%)
Higher secondary/diploma	52 (7.1%)
Graduate degree	240 (32.8%)
Postgraduate and above	75 (10.2%)
Father's education status	
Illiterate	25 (3.4%)
Primary school	40 (5.4%)
Middle school	140 (19.4%)
High school	166 (22.7%)
Higher secondary/ Diploma	82 (11.2%)
Graduate degree	201 (27.5%)
Postgraduate and above	76 (10.4%)
Gestational age	
Term	665 (91.1%)

Late preterm	64 (8.8%)
Moderate preterm	0
Extreme preterm	1 (0.1%)
Singleton/Multiple pregnancy	
Singleton	705 (96.58%)
Multiple	25 (3.42%)
Cried immediately after birth	
Yes	702 (96.1%)
No	28 (3.9%)
NICU admission	
Yes	101 (13.8%)
No	629 (86.2%)
Obstetric complications	
Yes	33 (4.5%)
No	697 (95.5%)
Hospital admission >1 week	
Yes	37 (5%)
No	693 (95%)
Chronic medical illness	
Yes	10 (1.4%)
No	720 (98.6%)
Chronic drug intake	
Yes	7 (1%)
No	723 (99%)
Immunised completely for age	
Yes	720 (98.6%)
No	10 (1.4%)
Exclusive breastfeeding	
Yes	703
No	27

[Table/Fig-2]: Demographic characteristics of study population (N=730). Neonatal intensive care unit (NICU)

[Table/Fig-3] shows the screen positive prevalence of specific NDD categories which was found to be highest for ADHD (28, 3.8%), followed by developmental delay (22, 3.0%), emotional problems (7, 1.0%), learning problems (6, 0.8%), conduct problems (5, 0.7%), psychotic symptoms (5, 0.7%), and somatic problems (1, 0.1%). Among children with screen positive NDD, 15 children (24.59%) of them had more than one NDD.

NDD category (DPCL)	n (%)	95% Confidence interval (CI)
Developmental delays	22 (3.0%)	1.8-4.5
Developmental problems	12 (1.6%)	0.8-2.9
ADHD	28 (3.8%)	2.4-5.5
Conduct disorder	5 (0.7%)	0.2-1.6
Learning disorder	6 (0.8%)	0.3-1.8
Emotional disorder	7 (1.0%)	0.4-2.1
Somatisation	1 (0.1%)	0-0.7
Childhood psychoses	5 (0.7%)	0.2-1.6
Total NDD prevalence	61 (8.4%)	6.4-10.4

[Table/Fig-3]: Prevalence of screen-positive NDDs by category (N=730).

Age showed a significant association with NDD prevalence (χ^2=17.03, p <0.001), with the highest prevalence observed in the 9-12 years age group, followed by 5-8 years and 1-4 years. However, SES was not significantly associated with NDD prevalence (χ^2=8.16, p=0.086). Geographical distribution analysis revealed no significant differences in NDD prevalence across Tamil Nadu rural, Pondicherry rural, and Pondicherry urban regions (χ^2=1.05, p=0.30). Among associated factors, along with age group, preterm birth demonstrated a significant association with NDD prevalence (p=0.003), Fisher Exact test was used for smaller sizes. While other factors, including gender, maternal and paternal education levels, exclusive breastfeeding, chronic medical illnesses, and birth order, showed no significant relationships [Table/Fig-4].

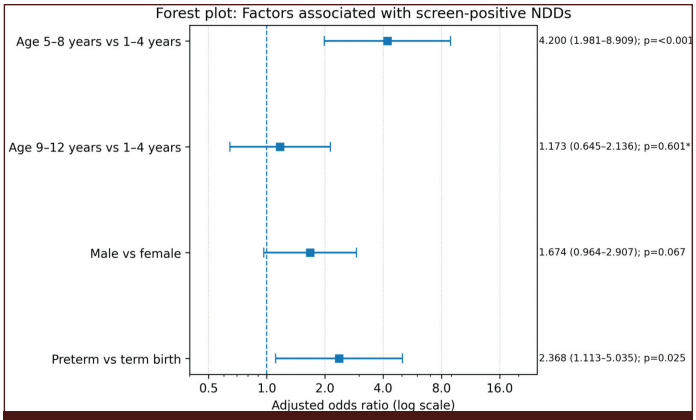
In the multivariable binary logistic regression analysis, children aged 5-8 years had significantly higher adjusted odds of screen-positive neurodevelopmental disorders (NDDs) than children aged 1-4 years (aOR=3.580, 95% CI: 1.728-7.415; p=0.001). Similarly, children aged 9-12 years had significantly higher adjusted odds compared with the 1-4-year reference group (aOR=4.200, 95% CI: 1.981-8.909; p <0.001). Preterm birth was also independently associated with screen-positive NDDs compared with term birth (aOR=2.368, 95% CI: 1.113-5.035; p=0.025). Although males had higher estimated adjusted odds than females, the association was not statistically significant (aOR=1.674, 95% CI: 0.964-2.907; p=0.067) [Table/Fig-5].

Risk factor	NDD* present n (%)	NDD absent n (%)	Chi-square (χ^2)	P
Age group				
1-4 years	11 (3.5%)	301 (96.5%)	17.030	<0.001
5-8 years	27 (11.2%)	214 (88.8%)		
9-12 years	23 (13.0%)	154 (87.0%)		
Gender				
Female	23 (6.5%)	330 (93.5%)	3.024	0.082
Male	38 (10.1%)	339 (89.9%)		
Socioeconomic Status (SES)				
Class-I	9 (7.4%)	112 (92.6%)	8.145	0.086
Class-II	39 (8.9%)	397 (91.1%)		
Class-III	8 (5.3%)	142 (94.7%)		
Class IV & V	5 (18.5%)	18 (81.5%)		
Urban/rural				
Urban	36 (9.3%)	349 (90.7%)	1.052	0.305
Rural	25 (7.2%)	320 (92.8%)		
Birth order				
Firstborn	34 (8.2%)	379 (91.8%)	1.225	0.874
Second-born	23 (8.2%)	259 (91.8%)		
Third or higher	4 (10.8%)	33 (89.2%)		
No. of siblings				
No siblings	8 (6.5%)	116 (93.5%)	2.691	0.912
One	40 (8.9%)	406 (91.1%)		
Two	9 (7.2%)	116 (92.8%)		
Three and higher	4 (11.4%)	31 (88.6%)		
Mother's education status				
Illiterate	0	7 (100%)	5.463	0.523
Primary school	4 (11.1%)	32 (88.9%)		
Middle school	9 (6.2%)	136 (93.8%)		
High school	18 (10.2%)	157(89.8%)		
Higher secondary/ diploma	2 (3.8%)	50 (96.2%)		
Graduate degree	19 (7.9%)	221 (92.1%)		
Postgraduate and above	9 (12%)	66 (88%)		

Father's education status				
Illiterate	0	17 (100%)	10.631	0.100
Primary school	3 (7.5%)	37 (92.5%)		
Middle school	9 (6.9%)	121 (93.1%)		
High school	23 (13.6%)	143 (86.1%)		
Higher secondary/ Diploma	4 (4.9%)	78 (95.1%)		
Graduate degree	18 (8.5%)	193 (91.5%)		
Postgraduate and above	4 (5.3%)	72 (94.7%)		
Primary caregiver				
Mother	50 (7.7%)	597 (92.3%)	5.655	0.160
Father	6 (19.4%)	25 (80.6%)		
Grandparents	4 (8%)	46 (92%)		
Others	0	1 (100%)		
Gestational age				
Term	51 (7.9%)	596 (92.1%)	14.192	0.003$
Late preterm	9 (14.1%)	55 (85.9%)		
Moderate preterm	0	6 (100%)		
Extreme preterm	1 (100%)	0		
Singleton/Multiple pregnancy				
Singleton	59 (8.4%)	646 (91.6%)	0.004	0.948
Multiple	2 (8%)	23 (92%)		
Cried immediately after birth				
Yes	59 (8.4%)	643 (91.6%)	0.056	0.813
No	2 (7.1%)	26 (92.9%)		
NICU admission				
Yes	12 (11.9%)	89 (88.1%)	1.803	0.179
No	49 (7.9%)	573 (92.1%)		
Obstetric complications				
Yes	4 (12.1%)	29 (87.9%)	0.640	0.347
No	57 (8.2%)	640 (91.8%)		
Hospital admission >1 week				
Yes	3 (8.1%)	34 (91.9%)	0.003	0.955
No	58 (8.4%)	635 (91.7%)		
Chronic medical illness				
Yes	2 (20%)	8 (80%)	1.795	0.200
No	59 (8.2%)	661(91.8%)		
Chronic drug intake				
Yes	1 (14.3%)	6 (85.7%)	0.325	0.459
No	60 (8.3%)	663 (91.7%)		
Immunised completely for age				
Yes	61 (8.5%)	659 (91.5%)	0.924	0.336
No	0 (0.0%)	10 (100%)		
Exclusive breastfeeding				
Yes	61 (8.7%)	642 (91.3%)	2.556	0.157
No	0	27 (100%)		

[Table/Fig-4]: Association of age group and gestational age with NDDs (Univariate Analysis).
*NDD: Neurodevelopmental disorders; <0.05 significant (two tailed)

Although males showed a numerically higher odds of screen-positive NDD compared to females, this did not reach statistical significance in the adjusted model (aOR=1.674, 95% CI: 0.964-2.907, p=0.067). Exclusive breastfeeding, SES, and paternal education did not show significant independent predictive value in the model. Children aged 5-8 years had significantly higher odds of screen-positive NDD compared to the reference group (0-4 years) aOR=4.200 (95% CI: 1.981-8.909, p<0.001). Children aged 9-12 years showed a slight increase in odds (aOR≈1.18), which was not statistically significant (p=0.593). Male children had higher odds of screen-positive NDD compared to females (aOR≈1.89), though this association is borderline/significant depending on model adjustment [Table/Fig-5].



[Table/Fig-5]: Forest plot of adjusted Odds Ratios (aOR) for association of age group and gender with screen-positive NDD.
Y-axis: Predictor variables (Age group categories and Gender); X-axis: Adjusted Odds Ratio (aOR) with 95% Confidence Interval (CI); NDD: Neurodevelopmental disorders

Preterm birth was a significant independent predictor of screen-positive NDD status (aOR=2.368, 95% CI: 1.113-5.035, p=0.025), with preterm children having approximately 2.4 times higher odds of screening positive for NDD compared to term-born children.

DISCUSSION

The present study found a screen-positive NDD prevalence of 8.4% (95% CI: 6.4-10.4%) among children aged 1-12 years in community-based settings of South India. This is comparable to Arora NK et al., who reported NDD prevalence of 9.2% in children aged 2-6 years and 13.6% in those aged 6-9 years across five Indian regions [4]. Direct comparison is limited however, as Arora NK et al., conducted a more extensive multicentric study using disorder-specific diagnostic tools for each NDD category, whereas the present study used the DPCL as a single screening instrument covering multiple NDD domains, which may have underestimated certain NDD categories. The wide variation in NDD prevalence reported across studies globally reflects differences in screening tools used, variability in parental reporting across populations, and the NDD categories included in each study. NDDs constitute a significant public health concern in childhood, with a multicentric Indian study reporting prevalence rates of 9.2% among children aged 2-6 years and 13.6% among those aged 6-9 years [4].

A global systematic review reported prevalence estimates ranging from 0.63% for intellectual disability, 5-11% for ADHD, and 0.70-3% for ASD, highlighting the substantial burden of these conditions worldwide [12]. Global meta-analyses have consistently estimated the prevalence of ADHD among children and adolescents to range between 3.4% and 7.2% [5,6,13]. Similarly, a school-based study from Uttar Pradesh reported an ADHD prevalence of 6.34% among school children [14]. In the United States, ASD prevalence among eight-year-old children was reported as 27.6 per 1,000 children, equivalent to approximately one in 36 children [7]. Studies examining a single NDD category using a disorder-specific tool tend to report more consistent estimates compared to studies assessing

overall NDD burden [12]. Zablotsky B and Black LI reported that developmental delay was more common in rural areas, with ADHD and cerebral palsy being the most frequently identified NDDs, and highlighted that many children in rural settings had not undergone formal assessment or therapy [9].

Jacob P et al., using a comprehensive battery of neurodevelopmental assessment tools, found that specific learning disability was the most common co-existing NDD, while oppositional defiant disorder was the most frequent psychiatric comorbidity [15]. Jaisoorya TS et al., reported ADHD prevalence rates of 4.3% for the combined type, 1.8% for the hyperactive-impulsive type, and 1.4% for the inattentive type, with a predominance among males [16]. In a cross-sectional study among school children in Kancheepuram, Catherine TG et al., found an overall ADHD prevalence of 8.8%, with inattentive ADHD being the most common subtype, followed by the hyperactive and combined types [17].

Another school-based cross-sectional study from Mysore reported an overall ADHD prevalence of 14.4% using DSM-V diagnostic criteria, indicating a substantial burden of ADHD among school-aged children [18].

Studies evaluating neurodevelopmental outcomes in children have demonstrated a strong association between prematurity and long-term disability. The overall crude prevalence of cerebral palsy has been reported as 2.4 per 1,000 children [19]. Although advances in neonatal care have reduced the severity of disease among moderate and late preterm infants compared with very preterm infants, neurodevelopmental morbidity remains a significant concern [20]. Children born with extreme prematurity have the highest rates of disability and adverse developmental outcomes [21]. Furthermore, late and moderate preterm infants have been reported to have nearly twice the risk of developing NDDs compared with term-born children, emphasising the need for continued developmental surveillance and early intervention [22].

Among NDD categories, ADHD was most prevalent (3.8%), consistent with Indian estimates ranging from 1%-12.5% [9,13-18], followed by developmental delay (3.0%), which is consistent with previously reported rates [20]. The lower rates of emotional (1.0%), learning (0.8%), and conduct problems (0.7%) likely reflect the parent-report nature of the DPCL, which may not adequately capture internalising conditions such as anxiety or subtle learning difficulties. The low somatic problem prevalence (0.1%) similarly suggests underreporting through parent-administered screening. Among screen-positive children, 24.59% had more than one NDD category, highlighting the frequent co-occurrence of neurodevelopmental conditions in this population.

In the multivariable logistic regression analysis, both older age groups were significantly associated with higher odds of screen-positive neurodevelopmental disorders (NDDs) compared with children aged 1-4 years. Children aged 5-8 years had 3.58 times higher adjusted odds of screening positive for NDDs (aOR=3.580, 95% CI: 1.728-7.415; p=0.001), while children aged 9-12 years had 4.20 times higher adjusted odds (aOR=4.200, 95% CI: 1.981-8.909; $p < 0.001$). The higher adjusted odds in the 9-12-year age group suggest that developmental and behavioural difficulties may become more apparent as children progress through school and encounter increasing academic and social demands. [20]. Preterm birth was also independently associated with screen-positive NDDs. Children born preterm had approximately 2.37 times higher adjusted odds of screening positive than those born at term (aOR=2.368, 95% CI: 1.113-5.035; p=0.025). This finding is consistent with existing evidence linking preterm birth with an increased likelihood of adverse neurodevelopmental outcomes. These findings highlight the importance of developmental surveillance and timely assessment of children born preterm, including those who may not have obvious developmental difficulties during early childhood [9,21,22]. Although the crude prevalence of screen-positive NDDs was higher among males than females (10.1% versus 6.5%), male sex was not significantly associated with the outcome after adjustment for other variables (aOR=1.674, 95% CI: 0.964-2.907; p=0.067). Although the adjusted estimate suggested higher odds among males, the confidence interval included 1 and the p-value exceeded 0.05. Therefore, male sex cannot be considered a statistically significant independent predictor in this study. The urban-rural difference in prevalence (9.35% vs 7.24%) was not statistically significant (χ^2=1.052, p=0.305), which may partly reflect under-reporting in rural areas due to stigma and reduced healthcare-seeking behaviour [4,9].

The strength of this study is its community-based design covering both urban and rural populations across two administrative regions of South India using a single standardised and indigenously developed screening tool. Existing literature largely focuses on individual NDDs using disorder-specific tools, whereas this study uniquely evaluates overall NDD burden using a single indigenous screening instrument across a wider age range and diverse settings. A comparison of the present study with previously published studies [4-7,9,12-22] is presented in [Table/Fig-6].

Author (Year)	Study setting	Age group	Study design	Tool used	Key findings
Arora NK et al., (2018) [4]	Multicentric (India- Delhi, Kerala, Gujarat, Odisha and Assam)	2-9 years	Community-based cross-sectional	Disorder-specific diagnostic tools	NDD prevalence: 9.2% (2-6 y), 13.6% (6-9 y)
Francés L et al., (2022) [12]	Global	Variable	Systematic review	DSM-5 based studies and PRISMA criteria	Intellectual disability - 0.63%; Attention-Deficit/ Hyperactivity Disorder (ADHD)- 5-11%; Autism Spectrum Disorder (ASD) - 0.70-3%; specific learning disorder - 3-10%; communication disorders - 1-3.42%; and motor disorders- 0.76-17%.
Polanczyk GV et al., (2015) [5]	Global	Children and adolescents	Meta-analysis	-	The worldwide prevalence of attention-deficit hyperactivity disorder was 3.4% and any disruptive disorder was 5.7%
Ayano G et al., (2023) [13]	Global	Children & adolescents	Umbrella review	Meta-analysis	ADHD prevalence globally ~5-7%
Sharma P et al., (2020) [14]	Uttar Pradesh	School children	Cross-sectional	Vanderbilt ADHD rating scale	Prevalence - 6.34%

Author (Year)	Study setting	Age group	Study design	Tool used	Key findings
Thomas R et al., (2015) [6]	Global	Children and	Meta analyses and systematic review	DSM-III, DSM-III-R and DSM-IV criteria	Pooled estimate of 7.2%
Maenner MJ et al., (2020) [7]	11 states of US	8 years	Cross sectional survey	DSM criteria	Overall ASD prevalence was 27.6 per 1,000 (one in 36) children aged 8 years
Zablotsky B and Black LI (2020) [9]	US	3-17 years	Survey	Screening questionnaire	Developmental delay is more in rural areas. ADHD and Cerebral palsy were the commonest. Children in rural area haven't gone for assessment or therapy
Jacob P et al., (2016) [15]	India	Children	Clinical study	Mini-International Neuropsychiatric Interview for Children and Adolescents, Attention Deficit Hyperactivity Disorder Rating Scale IV (ADHD-RS), Children's Global Assessment Scale, Clinical Global Impression Scale, Vineland Social Maturity Scale, and Childhood Autism Rating Scale.	Specific learning disability was the most common co-existing Neurodevelopmental Disorder (NDD) and oppositional defiant disorder was the most common psychiatric co-morbidity.
Jaisoorya TS et al., (2020) [16]	Kerala, India (school-based)	School children	Cross-sectional	Questionnaire	4.3% - ADHD combined type,1.8% for ADHD hyperactive-impulsive type, and 1.4% for ADHD inattentive type with a male predominance
Catherine TG et al., (2019) [17]	Kanjeepuram, South India	School children	Cross-sectional	Conners' Teacher-Parent Rating Scale and DSM V criteria	the overall prevalence of ADHD to be 8.8%. 43.3% for inattentive type, 43.3% for hyperactive type, and 13.2% for combined type
Manjunath R et al., (2016) [18]	Mysuru, India	School children	Cross-sectional	DSM V criteria	The overall prevalence of ADHD was 14.4%. The prevalence of ADHD Inattentive, Hyperactive and Combined type was 4.1, 3.4 and 6.9% respectively
Boyle CA et al., (1996) [19]	USA	3-10 years	Surveillance	Diagnostic screening	The overall crude rate of cerebral palsy was 2.4 per 1,000 children
Song IG (2023) [20]	Global	Preterm infants	Review	Clinical studies	Moderate and late preterm infants have less severe disease than very preterm infants
Marlow N et al., (2005) [21]	UK	Preterm children	Cohort study	Neurodevelopmental assessment	High disability in extreme prematurity
Johnson et al., (2015) [22]		Recruited at birth and follow up till 2 years	Cohort study	Questionnaire	Late and moderate preterm babies were having twice the risk for NDD
Present study	Pondicherry and Tamil Nadu	1-12 years	Cross sectional study	Questionnaire	The overall screen-positive prevalence of NDDs was 8.4% (95% CI: 6.4%-10.4%). In multivariable logistic regression, children aged 5-8 years had higher odds of screen-positive NDDs than the reference age group (adjusted odds ratio [aOR]=3.580, 95% CI: 1.728-7.415; p=0.001). Children aged 9-12 years also had higher odds (aOR=4.200, 95% CI: 1.981-8.909; p <0.001). Preterm birth was independently associated with screen-positive NDDs (aOR=2.368, 95% CI: 1.113-5.035; p=0.025).

[Table/Fig-6]: Comparison of the Present Study Findings with Previous Literature.

Limitation(s)

Screen-positive cases rather than confirmed diagnoses, which may include false positives; the DPCL's inability to reliably identify intellectual disability and ASD- both of which require disorder-specific assessment tools beyond the scope of this screening study; accessibility-based area selection which may limit generalisability to other regions of South India; and the expertise, training, and cost required for comprehensive NDD assessment, which may limit replication of such studies in primary care settings.

CONCLUSION(S)

This study highlights that NDDs constitute a significant public health concern in South India, with a screen-positive prevalence of 8.4%. The findings underscore the importance of early identification through community-based screening programs using culturally adapted tools such as the DPCL. However, while such screening instruments are valuable for initial detection, confirmatory diagnostic evaluation remains essential before making clinical decisions or initiating interventions. Future studies should focus on longitudinal follow-up to determine the progression and outcomes of screen-positive children, as well as validation of screening tools against standardised diagnostic assessments in diverse populations. Additionally, exploring region-specific risk factors and strengthening early intervention strategies would further enhance the effectiveness of public health programs targeting NDDs.

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PARTICULARS OF CONTRIBUTORS:
1. Assistant Professor, Department of Paediatrics, Pondicherry Institute of Medical Sciences, Pondicherry, India.
2. Professor, Department of Paediatrics, Pondicherry Institute of Medical Sciences, Pondicherry, India.
3. Professor, Department of Paediatrics, Pondicherry Institute of Medical Sciences, Pondicherry, India.
4. Professor, Department of Paediatrics, Pondicherry Institute of Medical Sciences, Pondicherry, India.
5. Assistant Professor, Department of Biochemistry, Pondicherry Institute of Medical Sciences, Pondicherry, India.
6. Professor, Department of Community Medicine, Pondicherry Institute of Medical Sciences, Pondicherry, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Nishanth Rajan,
Professor, Department of Paediatrics, Pondicherry Institute of Medical Sciences,
Kalapet, Puducherry-605014, India.
E-mail: nishanthwolverine@gmail.com

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Developmental psychopathology checklist for children

English Questionnaire

A	Developmental History	No	Yes/Present
1.	Was there any problems that you (mother) suffered during the pregnancy and post natal period?	0	1
2.	Was there any significant problem in your child when he /she was born? Eg – did not cry after birth, required ICU admission, Jaundice etc.	0	1
3.	Did your child suffer from Epilepsy, head injury or any serious infections till now?	0	1
4.	Do you feel that your child has difficulty seeing?	0	1
5.	Do you feel that your child has difficulty in hearing?	0	1
6	**Gross motor**	1	0
6.1	Did your child hold head and neck steady by self before 5 months of age		0
6.2	Did your child roll from back to tummy and tummy to back by 7 months of age		0
6.3	Did your child crawl/creep and sit by self before 10 months of age		0
6.4	Did your child stand/ walk a few steps with support before 12 months of age		0
6.5	Did your child stand or walk without support by before 18 months of age		0
6.6	Did your child climb up and down staircase without support by 24 months of age		0
6.7	Did your child jump, run, kick ball by 30 months of age		0
7	**Fine Motor**	1	0
7.1	Did your child takes his/ her hand to mouth; hold a toy by 5m;		0
7.2	Did your child reach for toys when on tummy by 7m		0
7.3	Did your child transfer toys/objects from one hand to another by 10m		0
7.4	Did your child drink from a cup by 15m		0
7.5	Did your child scribble by 18m		0
7.6	Did your child eat with a spoon by 24m		0
7.7	Did your child Unsrew lids/ turn pages in a book/ draws standing/ sleeping line by 30m		0
7.8	Removes/ puts on loose dress by himself/herself by 36m		0
8	**Speech/language**	1	0
8.1	Turns head to sounds/ makes sounds like 'ooo' 'aaa' when talk to him/her before 5m		0
8.2	Makes'babababa' 'mamamama' sounds, lifts arm to be picked up before 10m		0
8.3	Speak One or two meaningful words like 'amma' 'appa' 'athai' before 15m		0