Review Article

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20205438

Prevalence and correlates of neurodevelopmental disorders among children in India: a narrative review

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Received: 29 November 2020 Revised: 08 December 2020 Accepted: 09 December 2020

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ABSTRACT

Neurodevelopmental disorders (NDD) are seen disproportionately affecting the low-income communities. Paucity of consistent and large-scale studies in India and variations in assessment and diagnostic tools reduce the scope for generalization of prevalence estimates to national level. This review tried to consolidate the existing community-based evidence of the prevalence of NDDs, risk factors and comorbidities among children in India. We searched studies related to the review objectives on search engines PubMed and Google Scholar. The community or school-based studies in India, published in English language were included. The prevalence of each of these NDDs differed in different locations and age groups. The prevalence appeared to be increasing with increase in age. Non-institutional delivery, perinatal asphyxia or delayed crying, low birth weight or prematurity, neonatal illness or neurological infections were significantly associated with the NDDs. Most of the significant risk factors are modifiable with the help of effective programs to improve maternal and child healthcare and nutrition. Further large-scale, good-quality epidemiological studies in community settings are needed to develop and prioritize the delivery of the prevention and rehabilitation interventions.

Keywords: Neurodevelopmental disorders, Prevalence, Comorbidities, Risk factors, Correlates, India, Review

INTRODUCTION

Disruption in the dynamic inter-relationship between genetic, neurologic, cognitive, emotional and behavioural processes across the developmental lifespan, through environmental and genetic risks can lead to neurodevelopmental disorders (NDD). NDDs affect an individual through the life span, affecting life expectancy and health. The major group that is disproportionately affected by NDDs is low-income communities and children living in poverty. The inadequate data about disease burden and risk factors make it difficult to formulate policy decisions and implement programs to address NDDs in these populations. Inclusion of childhood disability in the agenda of the sustainable development goals (SDGs) necessitates the use of

evidence-based estimates to address national and regional contexts, disaggregated by gender and age.⁴

India has been lauded for significant improvements in both infant and child survival during the last decade.⁵ Yet, the improved survival of infants and children with high risk for neurodevelopmental disorders and disability (NDDs) may result in higher community prevalence, showing the need to concurrently develop the interventions and policies for prevention of the NDDs as well as rehabilitation of affected children.⁶ A critical understanding of the local context and correlates of NDDs is needed in order to develop an effective strategic intervention. Despite the growing concern about neurodevelopmental disorders, the available literature from India is inconsistent.⁷ Most of the studies estimating prevalence have been conducted in hospital settings, or

have recruited children from special schools, while the estimates of prevalence and correlates at community level are patchy.⁸ With this background, this review was conducted to describe published literature on prevalence and correlates of NDDs among children in India.

METHODOLOGY

We conducted a narrative literature review to collate the existing evidence of the prevalence, comorbidities and factors associated with NDDs among children in India. We searched electronic databases 'Google scholar' and 'Pub med' for peer-reviewed studies related to the study objectives. We used combinations of keywords "neurodevelopmental disabilities, developmental disorders, prevalence, factors, comorbidity, children, and India". Studies in English language published between the year 2010 to 2020 and assessing prevalence in school or community settings were included. We excluded studies outside India, or studies assessing treatment or therapies for NDDs, or studies assessing prevalence of NDDs among adult population. In the end, 27 full text articles were included in the review. The data were extracted in an excel sheet, and arranged as per the review objectives. The review was conducted between April 2020 to June 2020.

OBSERVATION

The findings from reviewed studies are presented as: prevalence, comorbidities and correlates with respect to each of the major NDDs- autism spectrum disorder (ASD), neuro-motor impairments-cerebral palsy (CP), attention deficit hyperactivity disorder (ADHD), intellectual disabilities (ID), and learning disabilities.

Multiple NDDs

A multicentric study, conducted in 4 states in India by Arora et al. assessed the prevalence of NDDs in 2-9 years old children.⁷ The study reported the prevalence of any of

the 7 NDDs in children ages 2-<6 years to be 9.2%, whereas the prevalence of any of the 9 NDDs in 6-9 years old children as 13.6%. The all site pooled-prevalence was 1.3 for NMI-CP, 1.4 for ASD, 5.2 for ID, 1.0 for ADHD, and 1.6 for LD. The factors significantly associated with NDDs were non-institutional delivery, history of perinatal asphyxia, neonatal illness, postnatal neurological/brain infections, stunting, LBW/prematurity, and older age category (6–9 year).

Prevalence of NDD was significantly higher in low birth weight (LBW), preterm infants and twins. There was a significant association between neonatal sepsis, birth asphyxia, convulsions and NDD. 9-11 Studies also reported that the children with severe acute malnutrition, and lower head circumference were significantly associated with developmental delays. 12,13

Autism spectrum disorder

As shown in Table 1, the prevalence of ASD ranged between 0.9 per 1000 in 1-10 years old children in Himachal Pradesh to 12 per 1000 in 2-9 years old children in four states in India. We observed increased prevalence with increase in age, and higher prevalence in males compared to females. 7,14,15 Table 1 summarizes the studies in this review that reported prevalence of ASD. 7,14,15,20,21

The study by Sharda et al showed that 25% of children with ASD also had epilepsy. ¹⁶ A study by Manohar et al also added that ADHD was present in 40% of children with ASD in the study. ¹⁷

Additionally, the studies that assessed the risk factors or correlates of ASD in children showed that infantile spasms (15%), family history of ASD (38%) or epilepsy (15%), high parental age (37%), environmental exposure to toxic substances or air pollution during pregnancy (31%), rural area (50% of diagnosed cases) and lower middle class (60% of diagnosed cases) were significantly associated with ASD in children. ^{18,19,14}

Table 1: Prevalence of ASD and CP.

Author, year	Location	Sample size	Findings*			
Autism spectrum disorder						
Arora et al, 2018 ⁷	Kangra, Himachal Pradesh; Palwal, Haryana; Dhenkanal, Odisha; Hyderabad, Telangana; North goa	3,964 children, Age 2-9 years	Total:12 2—<6 years: 10, 6-9 years: 14 Himachal Pradesh: 7.5, Haryana: 18, Odisha: 8, Telangana: 17, Goa: 3			
Raina et al, 2017 ¹⁴	Bharmour, Una &Kangra districts, Himachal Pradesh	11,000 children, Age 1–10 years	Total: 0.9 Rural: 1.05 Urban:0.7 Tribal: 0.97			
Poovathinal et al, 2016 ¹⁵	Palakkad, Kerala	5331 children, Age 1-10 years	Total: 2.33, males- 3.18, females- 1.5 1-5 years:1.7, males- 3.39, females: 0 6-10 years: 5.0, males- 5.49, females: 4.49			
Nair et al, 2014 ²¹	Thiruvananthapuram, Kerala	101,438 children, Age 0-6 years	Total: 12.8			

Continued.

Author, year	Location	Sample size	Findings*
Cerebral palsy			
Chauhan et al, 2019 ²⁰	India	1545- 101,438 children and adolescents, age 6 months-15 years	2.95
Arora et al, 2018 ⁷	Kangra-Himachal Pradesh, Palwal-Haryana, Dhenkanal- Odisha, Hyderabad- Telangana, North goa	3,964 children aged 2-9 years	2-<6 years: 21,6-9 years: 13
Nair et al, 2014 ²¹	Thiruvananthapuram, Kerala	101,438 children Age 0-6 years	84.3

^{**}The prevalence is presented as children with ASD/CP per 1000 children.

Table 2: Prevalence of ADHD.

Author, year	Location	Sample size	Findings*
Sharma et al, 2020 ²⁵	Jammu, Jammu & Kashmir	205 children, age 6-12 years	63.4
Catherine et al, 2019 ²⁸	Kancheepuram, Tamil Nadu	3253 school children, Age 8-11 years	Total: 88 Inattentive:44% Hyperactive:43% Combined type:13%
Jacob et al, 2016 ²⁶	Bangalore, Karnataka	63 children and adolescents, Age 4-16 years	Total: 105 Combined: 92.1% Inattentive: 4.8% Hyperactive-impulsive: 3.2%
Jaisoorya et al, 2016 ²⁷	Ernakulam, Kerala	7560 children, age 12-19 years	Total: 75 ADHD-Combined: 4.3%, ADHD-Hyperactivity: 1.8%, ADHD-Inattentive: 1.4%
Manjunath et al, 2016 ²⁹	India	1145 children, age 6-10 years	144

^{*}The prevalence is presented as children with ADHD per 1000 children.

Table 3: Prevalence of ADHD.

Author, year	Location	Sample size	Findings
Intellectual disability			
Arora et al, 2018 ⁷	Kangra-Himachal Pradesh, Palwal- Haryana, Dhenkanal-Odisha, Hyderabad- Telangana, North goa	3,964 children Age 2-9 years	2-<6 years: 31, 6-9 years: 52
Nair et al, 2014 ²¹	Thiruvananthapuram, Kerala	101,438 children Age 0-6 years	168.5
Learning disabilities			
Chordia et al, 2020 ³³	Puducherry	480 children Age 5-7 years	Total: 7.5%, Males: 9.6%, Females: 4.9%
Sridevi et al, 2020 ³⁴	Warangal, Kerala.	327 children Age 6-14 years	19%

^{*}The prevalence is presented as children with ID per 1000 children.

Cerebral palsy

The prevalence of CP among children in India ranged from 2.95 to 84.3 per 1000 children, as shown in Table $1.^{7,20,21}$ The prevalence was higher in male children compared to female children.²²

The commonest type of CP was spastic diplegia, followed by spastic quadriplegia and hemiplegia. The common comorbidities reported in the studies were intellectual disability, epilepsy, Hearing or speech impairment, optic atrophy, chewing, swallowing, and drooling problems.^{23,24} Another study reported seizures (47.36%), acute gastroenteritis (5%), aspiration

pneumonia (4.03%) and bronchopneumonia (4.03%) as the commonest comorbidities.²²

Most common risk factors for cerebral palsy were prematurity and perinatal asphyxia (31.8-45%), pregnancy induced hypertension (PIH) in mothers (29.41%), multiple gestations (29.41%), neonatal meningitis (18.18%), and hypothyroidism in mothers (17.64%).^{22,24}

Preterm birth asphyxia and term birth asphyxia were reported as a risk factor for spastic diplegic cerebral palsy and spastic quadriplegic cerebral palsy respectively.²⁰

Attention deficit hyperactivity disorder

The prevalence of ADHD among children in India ranged from 63-144 per 1000 across India (Table 2). 8,25-29 A review by Kuppili et al reported that the prevalence increases with increase in age, ranging from 5% in 3-4 years old children to 29% in 11-12 years old children. 8 Studies reported higher prevalence of ADHD symptoms as well as ADHD diagnosis in males compared to females. 25

A study by Jacob et al reported presence of medical comorbidities in 22% children with ADHD (seizure disorder 80%, CP 7%, hypothyroidism 7% and bronchial asthma 7%). Whereas 83% children had psychiatric comorbidities such as specific learning disability (21%), anxiety disorder (10%), disruptive behaviour (38%), and both anxiety disorder and disruptive behaviour (35%).26 Comorbidities reported in other studies were neurological soft signs (84%), oppositional defiant disorder (20%), anxiety disorders (16%), specific learning disability (16%), hypothyroidism (18%), language disorders (37%), Seizure disorder (18%).^{8,26,30}

The factors commonly associated with ADHD in the children were joint families and lower middle-class families, having 2 or more siblings, and parental stress. ^{25,31}

Intellectual disability

The prevalence of ID (Table 3) in a multicentric study by Arora et al. ranged from 31-52 per 1000 children across study sites. Whereas a study by Nair et al. reported the prevalence as high as 168.5 per 1000. The prevalence increased with age, and differed in different research sites. 32

Learning disability

The prevalence of learning disabilities ranged from 75 per 1000 in Puducherry to 190 per 1000 (6-14 years old) in Kerala, as seen in Table 3. The prevalence was higher in males, and in students of government schools (12.1%) than private schools (2.2%).^{33,34}

Some of the major comorbidities were ADHD (22-39%), ASD (31.8%), social anxiety and phobia (2.4-60%), generalized anxiety disorder (7-19.2%), behaviour problems such as aggression, anti-social behaviour, day dreaming and personality problems. Additionally, the male children showed significant aggression and hyperactivity compared to female children.³⁴⁻³⁶

DISCUSSION

This review tried to consolidate an existing evidence on prevalence and context of neurodevelopmental disorders among children in India. We observed that the prevalence of each of the major NDD varies between studies. Non-institutional delivery, history of perinatal asphyxia or delayed crying, low birth weight, prematurity, neonatal illness, postnatal neurological infections, stunting, and older age category (6–9 years) were significantly associated with the NDDs.

Prevalence of NDDs varied between sites. Globally, studies have shown that the estimates of NDD prevalence and their profiles substantially differ between regions due to variability in study methods, diagnostic tools and reporting.³⁷ Boyle et al reported prevalence of ASD in the United States of America to be 0.7% based on parent-reported diagnosis.³⁸ Whereas, Christensen et al showed overall prevalence of ASD 1.5% at 11 sites in the United States of America, by using a pre-systematic community-based assessment.³⁹ Prevalence of NDDs may also vary across different regions in a large country such as India, due to uneven distribution of risk factors and biological factors.⁷

We observed that the prevalence of NDDs increased with increase in age of children. Existing evidence suggests that the higher prevalence of NDDs with increase in age may be attributed to the increased exposure to the childhood-onset causes and exposures such as infections, injuries, and nutritional deficiencies; and increased recognition and diagnosis conditions such as CP, ID, and behavioral disorders in higher age group.⁴⁰

Most of the significant risk factors identified in this review can be modified with the help of effective programs and investment in public health to improve maternal and child health services.41 To develop and programs. effective prevention understanding of the spectrum of NDDs among children is essential. The scarceness of high-quality prevalence studies in India is a hindrance in drawing the inferences for national estimates. This has made health policymakers to rely on national census disability data, which are usually limited to the recognition of visible disabilities and utilize non-specialized assessment tools. Thus, this approach might lead to under-reporting of disorder prevalence in children. 42,43

This review tries to bridge the gaps in inconsistent evidence regarding the NDDs among children in India, in

terms of prevalence and correlates, and could be highly informative in developing effective interventions. However, the limitation of this review is that the generalization of the findings is questionable due to the inconsistencies in sampling, participant age group and the tools used to measure the outcomes. We were not able to perform the time-trend analysis due to the limited number of community-based studies for each of the NDD included in the review. The studies have majorly deployed cross-sectional study designs. Prospective/panel studies are needed to elucidate the important issues such as prevalence, comorbidities and associated factors. Furthermore, valid and practical screening methodologies based on globally accepted disease definitions need to be utilized.⁴⁴

The findings from this review are important in regards to the national child health program ("Rashtriya Bal Swasthya Karyakram") and the universal health care (UHC) agenda of the Government of India. 45 This review will aid in prioritizing the need-based delivery of programs for the prevention of NDDs as well as rehabilitation of affected children and their families. Additionally, it might also inform the policies of other countries with similar socioeconomic and healthcare settings. 46

CONCLUSION

This review tried to consolidate the inconsistent evidence about the prevalence and correlates of the NDDs among children in India. Large-scale, good-quality studies in community settings are needed to explore risk factors and types of NDDs at different demographic groups and geographic regions. The research collated in the present study would be useful to revisit the implementation of the existing policies and reallocate resources for the prevention and management of NDDs.

Funding: No funding sources Conflict of interest: None declared Ethical approval: Not required

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Cite this article as: Gaikwad L, Lagala S. Prevalence and correlates of neurodevelopmental disorders among children in India: a narrative review. Int J Contemp Pediatr 2021;8:200-6.