INNOVARE JOURNAL OF EDUCATION
Vol 8, Issue 2 , 2020
ISSN: 2347-5528
Research Article

RISK FACTORS ASSOCIATED WITH NEURODEVELOPMENTAL DISORDERS IN HIGH SOCIOECONOMIC STATUS FAMILIES: BRIEF INDIAN ANALYSIS

IYER KAMLAM GOPALKRISHNAN[1*], S. VENKATESAN[2]

[1]Research Scholar, DOS in Psychology, The University of Mysore, Mysuru – 06. [2]Professor & Head, Department of Clinical Psychology, All India Institute of Speech and Hearing (AIISH), Manasagangotri, Mysuru - 06.
***Email: iyerkamlam@gmail.com**

Received: 23 July 2020, Revised and Accepted: 10 August 2020

ABSTRACT

This study seeks to identify parental prenatal, perinatal and postnatal risk factors of Neurodevelopmental Disorders (NDD) in comparison to Typically Developing (TD) children, all from high Socioeconomic Status (SES) families. A unified definition of NDD in terms of delays in development was employed for the purpose of this study. SES was understood as an important variable in the context of NDD. We employed a cross-sectional/comparative two-group survey design. It included parents of 60 children: 32 children with NDD and 28 children with TD. The developmental assessment was conducted for all the children for their classification into NDD and TD groups. Results depicted significant differences in the family history of mental illness or NDD, perinatal factors rather than prenatal and postnatal factors. On measures of association and variance, composite perinatal factors were observed to have a small effect on NDD, while the pre and postnatal showed a negligible impact. The interpretation and its application for improving the prevalence of NDD in high SES families in an Indian urban set-up were discussed.

Keywords: Neurodevelopmental Disorders, Children, Typically developing, Socioeconomic status.

INTRODUCTION

Many mental disorders of childhood and adolescence mark their onset in the early to middle childhood years. Some disorders have their onset in the developmental period of a child. These disorders produce impairments in various domains of development such as personal, social, and school. The impairments, in turn, result in deficits in skills of learning, intelligence, language, causing a delay in attaining developmental milestones. Clinically such a child might present symptoms in excesses or deficits and the resulting varied conditions are collectively called Neurodevelopmental Disorders (NDD). In order to better comprehend the etiology of NDD, documentation of its risk factors, or "specifiers" becomes necessary (Diagnostic and Statistical Manual of Mental Disorders 5th ed.; DSM-5; American Psychiatric Association, 2013).

BACKGROUND OF THE STUDY

The need for an elaborate and comprehensive, epidemiological and risk factor data has been emphasized for a developing and a vastly populated country like India time and again (Sharan & Sagar, 2008) and has been undertaken in the recent past. A brief search of "risk factors of NDD from India", "risk factors of Autism Spectrum Disorder (ASD) from India", "risk factors of Attention Deficit Hyperactivity Disorder (ADHD) from India", "risk factors of Intellectual Disability (ID) from India", "risk factors of Global Developmental Delay (GDD) from India" on Google Scholar, Google & Pubmed yielded 27500 results approximately every time, from which about 15 papers addressed the medical and non-genetic risk factors of NDD. These are presented in table 1 which are pertaining to the current study. A thorough list of reviews is beyond the scope of this study.

As observed in Table 1, many studies have attempted to gather all prenatal, perinatal, and postnatal factors pertaining to NDD. Nevertheless, the number of studies including all conditions of NDD is far and few.

Socioeconomic Status (SES) of individuals with disorders amounting to disability has been well documented in the World report on disability (World Health Organization, 2011). Furthermore, socioeconomic factors are considered to be one of the risk factors in the multifactorial etiology/origin of NDD (De Felice, Ricceri, Venerosi, Chiarotti & Calamandrei, 2015).

Maternal, perinatal, neonatal, and early childhood neurological and developmental outcomes in high socioeconomic disadvantaged groups are observed to be higher than the middle or low disadvantaged families (Chin-Lun Hung et al., 2015). Many groups of SES have been considered in this present review of studies. These studies have classified SES in three or more groups.

THE SIGNIFICANCE OF THE PRESENT STUDY

This study attempts to delineate the risk factors related to the parents, prenatal, perinatal, and postnatal factors from an urban metropolitan city of India--Bangalore. About 10.85% of this city has children as its population between the ages of 0-6 years (Census, 2011a). With the efforts of our government, reduction in infant and neonatal mortality rates has been observed (Census, 2011b). Although this could have increased the cases of NDD indirectly.

We have conceptualized NDD as per the impairments affecting a child with respect to its primary "functioning" of all the developmental domains. Therefore we attempt to explore the parental, prenatal, perinatal, and postnatal factors as constituting risk factors of NDD.

Although large scale epidemiological studies have pointed to socioeconomic disadvantage as an important risk factor determining various conditions of NDD, its occurrence only in the high SES has not been documented from our country. Hence our focus is on families of children with NDD from high SES for delineating such factors.

AIMS AND OBJECTIVES

The main aim was to identify and compare the family, prenatal, perinatal, and postnatal risk factors in children with NDD and their peers with TD.

Operational definitions

1. NDD: It has been defined as any impairment in the developing brain and/or the CNS originating during the developmental period and characterized by delay by three or more months or disturbance in the acquisition of skills in at least two domains such as motor, sensory,

speech, and language, social, cognition, play and academics as measured on valid tools.
2. SES: It has been defined as an index of parental education, immovable assets, annual income, nature of the occupation. It is measured using valid tools.
3. Environmental factors: The child's parental prenatal, perinatal and postnatal factors are considered environmental factor.

Table 1: Summary of studies from India on risk factors in NDD in the last two decades

S. No.	Sample Size	Rural/ Urban India	NDD condition	SES Group	Risk Factors	References
1.	2064	Urban & rural	ADHD, expressive speech disorder, ID & epilepsy	Family income considered	Parental factors and a family history of psychiatric morbidity	Srinath et al., 2004
2.	438	Urban	ID	Mentioned but no detailed groups	Prenatal & postnatal factors and psychosocial factors	Persha et al., 2007
3.	122	Urban	GDD/ID	High, middle & low groups	Perinatal & postnatal factors	Jauhari et al., 2011
4.	471	Urban	ASD	High, middle & low groups	Maternal hormonal interventions	Mamidala et al., 2013a
5.	471	Urban	ASD	High, middle & low groups	Prenatal. perinatal & postnatal factors	Mamidala et al., 2013b
6.	4801	Urban + rural	GDD, epilepsy, visual, hearing & motor disorders	High, middle & lower groups	Parental, prenatal, perinatal & postnatal factors	Kumar, Bhave, Bhargava & Agarwal, 2013
7.	500	Urban	ASD	High, middle & low groups	Consanguinity, prenatal and postnatal factors	Mamidala et al., 2015
8.	1798	Rural & urban	NDD	Middle & lower groups	Place of birth & immunization states	Juneja et al., 2014
9.	11000	Rural, tribal & urban	ASD	High, middle & low groups	Home delivery & birth asphyxia	Raina, Kashyap, Bhardwaj, Kumar & Chander, 2015
10.	427	Semi-Urban	Develop--mental delay	Lower group	Perinatal & postnatal factors	Chattopadhyay & Mitra, 2015
11.	350	Urban	ASD	Lower group	Parental age, perinatal and postnatal factors	Ravi, Chandrasekar, Kattamani & Subramaniam, 2016
12.	55	Urban	ASD	High, middle & low groups	Prenatal, Perinatal & Postnatal factors	Geetha, Sukumar, Dhivyadeepa, Reddy & Balachander, 2018
13.	30	Urban	ASD	High, middle to lower groups	Breastfeeding as a neonatal factor	Manohar, Pravallika, Kandaswamy, Chandrsekar & Rajkumar, 2018
14.	3964	Urban & rural	ASD, ADHD, epilepsy, visual & hearing impairments, ID, cerebral palsy & speech and language disorders	Income classified	Parental, prenatal, perinatal & postnatal factors	Arora et al., 2018
15.	13	Rural	ADHD	Middle to lower group	Parental, prenatal, perinatal & postnatal factors	Sharma et al., 2020

ADHD: Attention Deficit Hyperactivity Disorder; ID: Intellectual Disability; ASD: Autism Spectrum Disorder; GDD: Global Developmental Delay; NDD: Neurodevelopmental Disorders

RESEARCH QUESTIONS

The following research questions were formulated in lieu of the aforementioned points:

1. Is there a difference in the parental age at conception between the NDD and TD groups?
2. Are there differences in factors of consanguinity, family history of mental illness, family type, and the number of family members between the NDD and TD groups?
3. Are there differences in prenatal, perinatal and postnatal factors between the NDD and TD groups?
4. Is there an association between NDD and prenatal, perinatal, and postnatal factors?

METHODOLOGY

A cross-sectional exploratory study was designed and the sample was recruited after obtaing the written consent only. The data included in the manuscript is compliant with all the ethical rules as necessary for bio-behavioral research (Venkatesan 2009a). The period of the collection of the data was from April 2019 to February 2020.

Participants

A non-probability purposive technique was used to collect the sample. The sample consisted of mothers and/or fathers of NDD probands (N=32) and their TD peers (N=28) in the age group of 6 to 8 years with both boys and girls included. The families were of Indian origin with no visual-hearing impairment.

Recruitment of families with NDD probands

Families who approached the multi-specialty clinics/hospitals/speech therapy clinics/special education centers were contacted and invited to participate in the study for the recruitment of the families with NDD probands.

Recruitment of families with TD children

Families living in a general community apartment complexes/schools were contacted for the recruitment of mothers with TD children.

The criteria for the final inclusion of the sample were according to table 2. A flow diagram depicting the final sample is given in figure 1.

Table 2: Inclusion criteria

S. No.	$NDD_{Mothers}$ & $TD_{Mothers}$
1.	Probands/Children in the ages of 6 to 8 years and staying with them
2.	Assessment of development of their children using ACPC-DD
3.	Speaking Tamil, English, Kannada or Hindi
5.	Formal education of graduation or above
6.	Belonging to upper socioeconomic status
7.	Biological parents/parent only

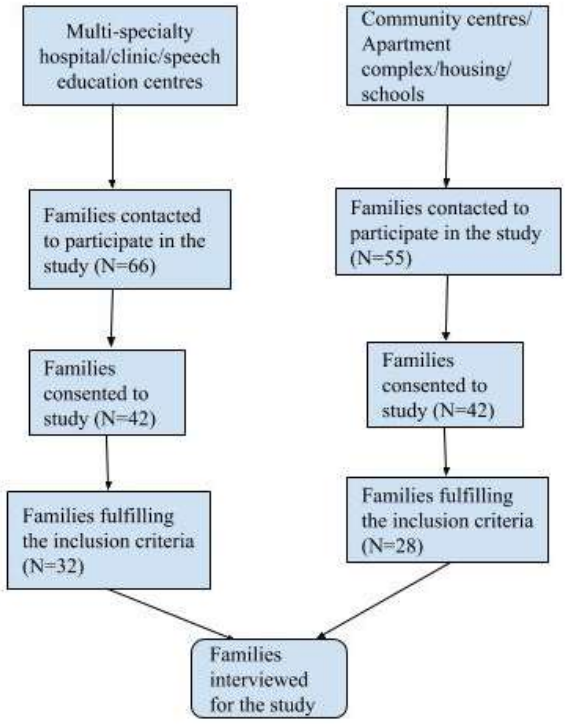

Fig. 1: Flow diagram of the recruitment of sample

Tools

The investigator used a computer coded and amenable data intake and record sheet for every family to facilitate ease of scoring. The details of the intake-interview are presented in the following inter-related sections.

1. **Developmental assessment of the children:** This was done with Activity Checklist Developmental

Disabilities (ACPC-DD) (Venkatesan 2004). The number of items in each of the eight child development domains is fixed at 50 items. On each item, the child receives a score from 0 to 5 depending on the level of assistance required to perform that given item. Children with delays of three or more months and in at least two domains were included in the group of NDD, while children with no delay in any of the domains were included in the group of TD.

2. **Socio-economic status assessment:** The sample was assessed for SES using the National Institute of Mental Health (NIMH)-SES (Venkatesan 2009a). All the families with a score of 16 and above were considered for this study.
3. **Prenatal, perinatal and postnatal assessment:** An assessment intake sheet containing open and closed-ended questions on the parental/family, prenatal, perinatal, and postnatal factors were prepared using the National Institute for Empowerment of Persons with Disabilities NIEPID (Formerly NIMH) Manovikas, Secunderabad, India. This provides a comprehensive assessment of all the medical and non-genetic factors of a child with developmental disabilities (Venkatesan & Rao, 1996). The factors are enlisted in the categories below.
    a. Family/parental factors included maternal and paternal age at conception, consanguinity in marriages, the family history of mental illness/NDD, family types such as nuclear or joint set-up, and the number of members in the family along with the child.
    b. Prenatal factors included subjective feelings on health, gestational diabetes, regular prenatal check-ups, nutritional disorder, hypertension, thyroid dysfunction, psychological trauma, any significant accidents/injury, jaundice, convulsions, any other infections/illness during this period.
    c. Perinatal factors included birth term and labor duration, place of birth, type of delivery, cord around the baby's neck, birth cry and weight, and feeding immediately after birth.
    d. Postnatal factors included the child's condition during the first 28 days of birth, duration of stay at the hospital, respiratory disorders, jaundice, convulsions, significant accidents/injury, infections, nutritional disorder, and thyroid dysfunctions.
4. Additionally, the obtained data were corroborated with secondary sources such as antenatal and neonatal medical birth records.

Procedure

From the final sample, 3% of both mothers and fathers participated in the interview and mothers alone in the rest of 97% of the families. The investigator interviewed them in one or two sessions of 50 minutes. The investigator was not blind to the diagnosis of the children while interviewing their parents.

Data analysis and statistics

Random selection of four (12.5%) of the parent/s from the NDD group and five (17.86%) from the TD group was done for data quality control. This sub-sample was requested to undergo the interview again and a 98% concordance rate was computed. Further analysis proper was conducted using the Statistical Package for Social Sciences (SPSS version 23.0) (IBM Corp 2014). The nominal variables between the groups were compared using Pearson's Chi-square statistics. Quantitative variables were compared using Student's t statistic. Association between nominal by interval scale variables were measured using Eta and their variance using Eta square.

RESULTS

The study's findings are presented in the following distinct but interrelated headings: (a) Demographic characteristics of the families & clinical profile of the children (b) Distribution of family factors (c) Distribution of prenatal, perinatal and postnatal factors in the groups and (d) Correlational analysis

a. **Demographic characteristics of the families & clinical profile of the children:** Table 3 denotes a mean age of 6.72 years of the NDD group and mean age of 6.70 years of the TD group at the time when their parents were interviewed for the study. The children were from the same chronological ages (p>.05). The boys in the NDD group were 78.1% (N=25) and girls were 21.9% (N=7). The TD group had 64.3% (N=18) boys and 35.7% (N=10) girls. The developmental score of the children for the two groups was found to be significantly different (p<.001). Non-significant differences were found on the family SES of all the children, suggesting them coming from the same SES backgrounds (p>.05). The maternal and paternal age at conception was observed to be below 35 years for all the parents and were non-significant in the two groups (p>.05). This supports our first research question negatively.

Table 3: Demographic characteristics of the families & clinical profile of the children

Demographic factors	**NDD (N=32)**		**TD (N=28)**		**p-value***
	Mean	**SD**	**Mean**	**SD**	
Age of the children	6.72	0.83	6.70	0.51	.94
Developmental level	1314.05	273.21	1967.55	25.89	.000**
SES scores	19.65	1.40	19.91	0.47	.20
Maternal age at conception	27.67	3.87	28.59	3.06	.31
Paternal age at conception	31.89	3.62	30.95	3.63	.32

*p-value using t-test; **significant at p<0.001 level

Table 4: Distribution of family factors for the NDD and TD groups

Family factors		NDD (N=32)		TD (N=28)		p-value	O. R	C. I
		N	%	N	%			
Consanguinity	Present	1	3.13	0	0	.346	.969	.910-1.031
	Absent	31	96.88	28	100			
Family history of mental illness/NDD	Present	12	37.5	3	10.71	.017*	.200	.050-.807
	Absent	20	62.5	25	89.29			
Family type	Nuclear	25	78.13	25	89.29	.247	.429	.099-1.849
	Joint	7	21.88	3	10.71			
The number of members in the family	0-4 members	30	93.75	26	92.86	.890	1.154	.152-8.778
	more than 4 members	2	6.25	2	7.14			

p-value using Chi-square test; n = the frequency count of the cases, * significant at p<.05

b. Distribution of the family factors

Table 4 denotes family factors such as consanguinity in marriage, family history of any mental illness/NDD in first or second degree relatives, family type, and the number of members in the family of the child. Consanguinity was considered if there was a marriage reported between paternal father and sister's daughter/to paternal aunt's daughter/maternal uncle's daughter/paternal uncle's daughter/maternal aunt's daughter/any other relations. A pedigree chart upto three generations was noted to assess family reports on a history of mental illness/NDD. Family type of these urban high SES families is mostly nuclear [$X^2(1)=1.339$, p>.05] with only less than four members in a household [$X^2(1)=.019$, p>.05]. Both groups are similar with respect to the prevalence of consanguinity in marriages [$X^2(1)=.890$, p>.05]. Nevertheless, the prevalence of both paternal and maternal family history was noted to be significantly different [$X^2(1)=5.714$, p<.05]. This supports our second research question partly.

c. Distribution of prenatal, perinatal, and postnatal factors in the two groups

Table 5 displays the distribution of NDD and TD groups in the obstetric aspects. The assignment of numerals to each of the nominal categories for all the obstetric factors depicts lower scores being equivalent to typical development and higher scores of NDD in children. In the prenatal factors, the mother's opinion on her state of health as being affected was higher in the NDD group as compared to the TD group [$X^2(1)=8.077$, p<.01]. No other significant differences were observed between the two groups. The perinatal aspects portrayed a different picture.

Premature birth of the children [$X^2(1)=10.500$, p<.001] with prolonged labor duration [$X^2(2)=10.364$, p<.01] and C section type of delivery [$X^2(2)=11.213$, p<.01] was noted to be significantly higher in the NDD group. Additionally, cord around the child's neck [$X^2(1)=10.129$, p<.01], delayed birth cry [$X^2(2)=11.483$, p<.01], lower birth weight [$X^2(2)=20.649$, p<.001] and, the inclusion of bottle and breastfeeding the first one month of the child's birth [$X^2(1)=14.320$, p<.001], were observed in the NDD group than the TD group.

Postnatal factors of maternal opinion on the general child's health being affected [$X^2(1)=3.750$, p>.05] and significant accidents/injury [$X^2(1)=1.162$, p>.05], duration of stay at the hospital greater than 3 days [$X^2(1)=5.801$, p>.05], respiratory [$X^2(1)=2.763$, p>.05] or the presence of jaundice [$X^2(1)=.805$, p>.05] convulsions [$X^2(1)=2.763$, p>.05] were not significantly different between the two groups. Only neonatal infections were significantly noted in the NDD group [$X^2(1)=4.773$, p<.05].

A bar graph depicting the mean of the composite scores obtained for all the factors for each of the groups is given in Figure 2. TD group shows lower mean composite scores equivalent to normal obstetric factors and higher scores indicative of NDD in children. Therefore with a few perinatal and postnatal factors significantly different, our third research question has been supported partly.

d. Correlational analysis

Table 6 depicts the measure of association between the prenatal, perinatal and postnatal (obstetric) factors and the developmental scores of the children with NDD. A sum was considered as a composite in each of the obstetric factors by creating meaningful grouping (Song, Lin, Ward & Fine, 2013). The Eta test variable was used as a measure of association. Perinatal and postnatal factors showed nil impact on the development of the children with NDD. Although a very small impact was observed due to prenatal factors ($\eta^2 = .09$).

Table 5: Distribution of prenatal, perinatal and postnatal factors for the NDD and TD groups

Obstetric factors		**NDD (n=32)**		**TD (n=28)**		**p-value#**	**O. R**	**C. I**
		N	**%**	**n**	**%**			
(a) Prenatal factors								
Maternal opinion on subjective state of health as:	Normal	24	75	28	100	.004**	.750	.614-.916
	Affected	8	25	0	0			
Prenatal check-ups	Yes	24	75	27	96.43	.212	.259	.027-2.470
	No	8	25	1	3.57			
Nutrition	Adequate	32	100	27	96.43	.346	.969	.910-1.031
	Inadequate	0	0	1	3.57			
	Not known	0	0	0	0			
Hypertension	Present	10	31.25	3	10.71	.054	.264	.064-1.083
	Absent	22	68.75	25	89.29			
Gestational diabetes	Present	6	18.75	2	7.14	.187	.333	.061-1.807
	Absent	26	81.25	26	92.86			
Thyroid dysfunction	Present	2	6.25	3	10.71	.533	1.800	.278-11.635
	Absent	30	93.75	25	89.29			
Psychological-trauma	Present	2	6.25	3	10.71	.533	1.800	.278-11.635
	Absent	30	93.75	25	89.29			
Significant accidents/Injury	Present	0	0	1	3. 57	.281	1.037	.966-1.114
	Absent	32	100	27	96.43			
Jaundice	Present	0	0	1	3.57	.281	1.037	.966-1.114
	Absent	32	100	27	96.43			
Convulsions	Present	0	0	1	3.57	.281	1.037	.966-1.114
	Absent	32	100	27	96.43			
Any infection	Present	2	6.25	1	3.57	.635	.556	.048-6.477
	Absent	30	93.75	27	96.43			
Any other illness	Present	2	6.25	0	0	.178	.938	.857-1.025
	Absent	30	93.75	28	100			
(b) Perinatal factors								
Birth term	Full	22	68.75	28	100	.001**	.688	.544-.868
	Premature	10	31.25	0	0			
	Post-term	0	0	0	0			
Place of birth	Home	0	0	0	0	**a**		
	Hospital	32	100	28	100			

Labour duration	Normal	20	62.5	23	82.14	.006**	**a**	
	Prolonged	12	6.25	4	14.29			
	Not known	0	0	1	3.57			
Delivery type	Spontaneous	4	12.5	11	39.29	.004**	**a**	
	Forceps	3	9.37	6	21.43			
	C-section	25	78.13	11	39.29			
Cord around neck	Present	20	62.5	1	3.57	.001**	**a**	
	Absent	12	37.5	27	96.43			
	Not known	0	0	0	0			
Birth cry and/or asphyxia	Immediate	17	53.12	27	96.43	.003**	**a**	
	Delayed	14	43.75	1	3.57			
	Not known/Not obtained by hospital records	1	3.13	0	0			
Birth weight	Less than 2.5kg	2	6.25	0	0	.000***	**a**	
	2.5 to 3.2 kg	21	65.63	13	46.43			
	Above 3.2 kg	9	28.13	15	53.57			
	Not known	0	0	0	0			
Feeding	Breast	17	53.13	27	96.43	.000***	.042	.005-.347
	Bottle	15	46.88	1	3.57			
(c) Postnatal factors								
Maternal concerns on child's condition in the first 28 days as:	Normal	28	87.5	28	100	.053	.875	.768-.997
	Affected	4	12.5	0	0			
Duration of stay at the hospital	0-3 days	15	46.88	21	75	.055	**a**	
	4-6 days	11	34.38	6	21.43			
	7 days above	6	18.75	1	3.57			
Respiratory disorders	Present	3	9.38	0	0	.096	.906	.811-1.013
	Absent	29	90.63	28	100			
Jaundice	Present	7	21.88	9	32.14	.370	1.692	.534-5.364
	Absent	25	78.13	19	67.86			
Convulsions	Present	3	9.38	0	0	.096	.906	.811-1.013
	Absent	29	90.63	28	100			
Significant accidents/Injury	Present	0	0	1	3.57	.281	1.037	.966-1.114
	Absent	32	100	27	96.43			
Any infection	Present	5	15.63	0	0			

	Absent	27	84.38	28	100	.029*	.844	.727-.979
Nutritional disorder	Present	0	0	0	0	**a**		
	Absent	32	100	28	100			
Thyroid dysfunction	Present	0	0	0	0	**a**		
	Absent	32	100	28	100			

p-value using Chi-square test; n = frequency count of the cases; **a** = no computation possible due to constants in both the groups;
* p<.05; ** p<.01; ***p<.001

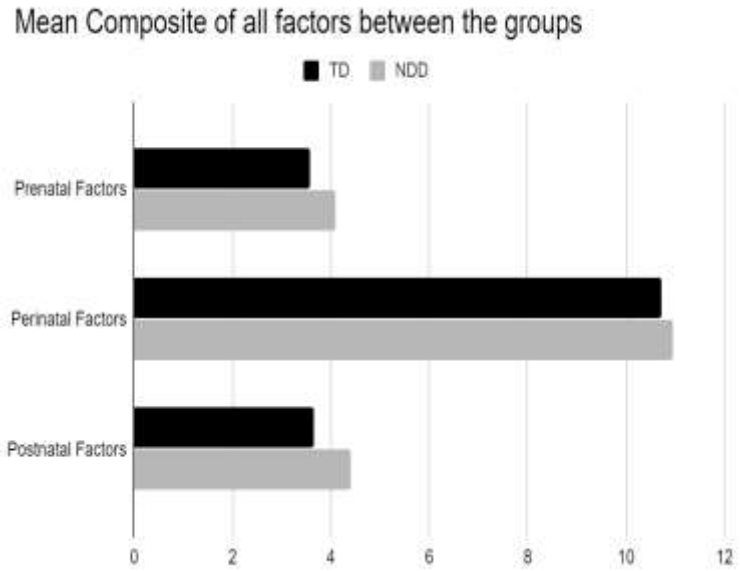

Fig. 2: Bar graph with the mean composite of prenatal, perinatal and postnatal factors between the groups

Table 6: Correlation between the obstetric factors and NDD children

Composite scores of the obstetric factors & developmental scores of NDD	**H**	**η^2**
Prenatal factors & NDD scores	0.303	.09
Perinatal factors & NDD scores	0.025	.00
Postnatal factors & NDD scores	0.112	.02

This denotes partial support to our fourth research question.

DISCUSSION

The present study discusses parental, prenatal, perinatal, and postnatal factors as predisposing NDD. A unified manner of defining NDD was considered for the study. A focus on high SES families has been attempted through "the prevalence of general mental disability" is considered "lowest in this group" (Kumar et al., 2008). Furthermore, a combination of many factors pointing to potential predisposition has been reported to be more important rather than a single factor (Hadj Kacem et al., 2016). Hence parental, prenatal, perinatal, and postnatal factors have been grouped for this study.

Family/parental factors

Of all the family factors, only a family history of mental illness/NDD has emerged as a potential risk to NDD in this study. Delay in speech, ASD, and ADHD along with bipolar disorder were reported in first and second degree relatives of children with NDD in our study. Similar results from India were provided by Kumar, Bhave, Bhargava & Agarwal (2013) where family history of NDD or neurological disorders, while contrarily Jauhari et al. (2010) in their study on ID/GDD from northern India reported a family history of ID emerging as one of the predisposing factors in their study.

The maternal and paternal age at conception was observed to be around 28 years and 31-32 years respectively for both the groups. Parental age at conception is important as advanced maternal age of 35 years and above has been indicative of affecting fetal brain development (Anello et al., 2009). But similar to our findings, Persha et al (2007) reported the younger age of mothers at conception at 24 years in their study on risk factors for ID and deficits in adaptive behavior from eastern India.

Small, nuclear family types from non-consanguineous marriage have been observed as non-significant factors in

the present study. The factor of consanguinity has been associated with rural and slum areas rather than urban areas (Srinath et al., 2004), such as Bangalore. Concordant to our study, nuclear or joint family type was not correlated in a recent study on ADHD children from northern India in varying SES (Sharma et al., 2020; Geetha, Sukumar, Dhivyadeepa, Reddy & Balachandar, 2019).

Prenatal factors

Our findings report of only the mother's opinion on her subjective health to be considered affected by the NDD group vis-a-vis TD group. This is consistent with many studies where no prenatal factors have emerged (Sharma et al., 2020; Chattopadhyay & Mitra, 2015). Some research points to increased duration of labor, psychological stress, exposure to toxic substances, and poor nutrition as risk factors to ASD (Geetha, Sukumar, Dhivyadeepa, Reddy & Balachandar, 2019). One meta-analytic review on various conditions of NDD from low-middle income nations such as ours, have pointed to parental smoking and a history of febrile illness to be a risk factor (Bitta, Kariuki, Abubakar & Newton, 2018).

Perinatal factors

All the children have been in hospital-births in our study. Apart from this, all the rest of the perinatal factors have emerged significantly differently for the two groups in our study. Many studies concur with our findings, both Indian and western. In a study of children with ASD, Mamidala et al. (2013b) obtained significant differences between their control and ASD groups on birth cry, preterm birth, birth jaundice. They conclude that complications during this stage affect fetal neurodevelopment contributing to becoming a risk factor later with the development of the infant. Similar conclusions have been documented by Jauhari et al. (2010) and Chattopadhay and Mitra (2015) on adverse perinatal events pointing to GDD, ID, and developmental delays in children.

Asian studies also indicate a low birth weight of less than 1.25 kg with lower than 33 gestational weeks become a risk factor to ASD in a hospital-based study from Saudi Arabia (Mohammed, Wahass & Mahmoud, 2016).

Postnatal factors

The number of males being affected with NDD is more in our study, being in line with the prevalence rates from previous studies (Juneja et al., 2013; Sharma et al., 2020). Many studies both from India and abroad concur on neonatal events as a major risk factor. Though our study only points to the presence of neonatal illness such as pneumonia/common cold/meningitis in children with NDD, many studies have enumerated numerous postnatal factors. In a study on 350 children with risk for ASD from south India, factors such as resuscitation at birth, 12 hours, and more in neonatal intensive care unit (NICU), seizures at infancy, radiation, not immediately breastfed have been found to be significantly different from the non-risk children. Later in their development, increased crying, banging and breath-holding spells were noted (Ravi et al., 2016). Chattopadhay and Mitra (2015) found jaundice, convulsions apart from other neonatal infections in 134 children with developmental delay in comparison with 293 children of TD from a north Indian city. Moreover, Geetha, Sukumar, Dhivyadeepa, Reddy & Balachandar (2019) found parents having mood changes, sleeping disorders, gastrointestinal upset postnatally in parents of children with ASD.

Golmirzaei et al. (2013) concur with postnatal factors such as seizures and childhood head trauma emerging significantly in ADHD children of 4 to 11 years than the control group of TD children.

All these studies are consistent with their results suggesting the importance of parental, prenatal, perinatal, and postnatal factors in the neurodevelopment of a child. Many factors that have been significant in the previous studies from our sub-continent have not emerged in this study. This could be due to the major role of SES gradient and health outcomes (King & Bearman, 2011), though the severity of the cases has not been classified in this study. Furthermore, similar SES indicators as considered for this study, such as parental education and income have been reported to be modifiers to many outcomes of NDD diagnosis in western studies (DeFelice, Ricceri, Venerosi, Chiarotti & Calamandrei, 2015).

Strengths and limitations

The strength of the present study is its evaluation of NDD as per the International Classification Functioning, Disability, and Health model (World Health Organization, 2001) and not as per the
diagnostic categories or the clinical model. This study relied on the availability of appropriate medical records on prenatal and perinatal conditions for corroboration. Further, high SES families have been explored to understand the risk factors. Due to the availability and awareness of the resources for this group, higher monitoring would enhance a timely and accurate diagnosis of NDD (Schiariti, Mahdi & Bolte, 2018). Thereby, it would assist in initiating early intervention to the children enhancing the outcome of the diagnosis positively (Juneja et al., 2013; DeFelice, Ricceri, Venerosi, Chiarotti & Calamandrei, 2015). A limitation of the study is the small sample size.

CONCLUSION

A few significant perinatal factors have emerged as potential risk factors in the diathesis of NDD from the high SES families of urban India. These factors could be emphasized by the medical professionals for optimal care of expectant mothers.

ACKNOWLEDGEMENT

We are indebted to the Chairperson of the DOS in psychology, University of Mysore, Mysore and Director, AIISH, Mysore, for providing us the permission to conduct this study. We also express our sincerest gratitude to all the parents who have participated in this study.

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