ORIGINAL ARTICLE

# Early Social Experience and Digital-Media Exposure in Children with Autism Spectrum Disorder

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## Abstract

**Objective** To study the early social experience and digital media exposure in children with autism spectrum disorder (ASD) in comparison with typically developed children.

**Methods** Details of digital-media exposure and early social experience in 65 children with ASD were compared with those in a control group of equal number of typically developed children, matched for age and gender. Prenatal and perinatal factors were also studied. The diagnosis of ASD was based on the International Clinical Epidemiology Network (INCLEN) diagnostic tool and Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) diagnostic criteria. Variables which were biologically relevant and has a $P$ value of $< 0.05$ in the univariate analysis were analyzed by logistic regression to obtain the adjusted effect measures.

**Results** Children with ASD were exposed to digital media at an earlier age and spent significantly more time with digital media and less time with their mothers, compared to typically developed children. Exposure to digital media before 21 mo was associated with risk of ASD and the risk increased when mothers spent less than 6.5 h per day with the baby. Family history of epilepsy and developmental delay, maternal stress during the antenatal period, and absence of exclusive breastfeeding during the first 6 mo were significantly more in children with ASD.

**Conclusion** There are significant differences in the early life social experience and digital-media exposure in children with ASD compared to typically developed counterparts. Given the reported rise in prevalence of ASD, these findings stress the need for further prospective studies to explore these potentially modifiable risk factors.

**Keywords** Autism spectrum disorder · Early social experience · Digital-media exposure · Exclusive breastfeeding · Maternal stress

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## Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by persistent deficits in social communication and social interaction associated with restricted, repetitive patterns of behavior, interests, or activities [1]. The prevalence of ASD according to the Center for Disease Control (USA) Surveillance Data for 2016 was 1/64 among children aged 4 y [2]. There is a wide variation in the reported prevalence of ASD in India ranging from 0.1% to 1.4% [3–5].

ASD has a complex and heterogeneous etiology with both genetic and environmental risk factors. Gene-environment interaction leading to heritable epigenetic changes in gene expression is one of the emerging theories on the etiology of ASD [6]. It has been proposed that environmental risk factors may influence in-utero neurodevelopment through epigenetic mechanisms [7].

The environmental risk factors implicated include parental age, natal and prenatal factors, maternal infections and auto-immune disorders, medication use during pregnancy, maternal lifestyle and dietary factors, and environmental toxins [6]. Excessive exposure to visual media and less parent child play in early life has also been reported as risk factor for ASD [8].

Difference in exposure to the environmental risk factors may be one of the reasons for the wide variation in the reported prevalence of ASD in India [3]. These are modifiable risk factors and the knowledge about the region-specific differences is crucial to plan preventive strategies.

Despite the increasing prevalence of ASD [9], very few studies have looked into the role of perinatal and psychosocial risk factors in the etiology of ASD in this part of the country. Health indices of Kerala are comparable to those of the developed world and recently the state has achieved the unique target of single digit infant mortality rate (IMR) [10]. Increased survival of preterm and low birth weight babies is likely to contribute to increased prevalence of neurodevelopmental disorders including ASD. The living environment in Kerala is also unique with significant expatriate population, working mothers, and single mothers [11]. Hence, it is pertinent to look for the perinatal and psychosocial risk factors for ASD in the state.

The present study was conceived in this backdrop with the aim to assess the early social experience and digital-media exposure in children with ASD in comparison with typically developed children. The study also aimed to compare the prenatal and perinatal factors in children with ASD with those in typically developed children.

## Material and Methods

A case control study design was chosen, and the study was conducted at the Child Development Services of the Institute of Mental Health and Neurosciences (IMHANS) and Govt. Medical College, Kozhikode, among the children who attended the out-patient (OP) services. Children with a clinical diagnosis of ASD who attended the OP during the 18 mo from December 2017 to June 2019 were included in the case group. Children in the 3- to 8-y age group were consecutively recruited for the study. Children with progressive neurological disorders were excluded.

The control group included typically developed children with no neurological disorders who attended the general pediatric OP for minor illnesses like upper respiratory Infection. Both the groups were matched for age and gender. Sample size was calculated as 74 in each group to detect an odds ratio (OR) of 3 as statistically significant, assuming that the exposure prevalence of low birth weight was 20% [12] and a power 80% and 95% two-sided confidence interval (CI) using Open Epi[ref] online software [13].

A questionnaire was prepared to document the perinatal and psychosocial factors and the data collection was done by interviewing either one of the parents and verifying the available records. Parents were asked to report at what age the child was exposed intentionally to digital media like TV, mobile, video games, etc. and also how many hours the child spends watching digital media during the previous 2-wk period to document the details of digital-media exposure. The average time spent by the mother or the primary caretaker with the child per day during the first two years of life was obtained by appropriate questions in the questionnaire. Personal perception on stress experienced by the mothers during pregnancy was obtained by two questions incorporated in the main proforma on the presence or absence of stress and the type of stress. The diagnosis of ASD was made using the INCLEN diagnostic tool [14] and satisfying DSM-5 diagnostic criteria for ASD. The diagnosis was confirmed by an expert in child psychiatry (PK) and neurosciences (SB). Co-morbid disorders were diagnosed based on DSM-5 diagnostic criteria. Socioeconomic status was assessed based on modified Kuppuswami scale [15]. Informed consent from the parents was obtained and the study was approved by the institutional ethics committee.

The data were entered in to the excel data sheet and analyzed with SPSS V.16 (SPSS, Chicago, Illinois, USA) statistical package. The results were expressed in terms of frequency and percentage for qualitative variables and in terms of mean and standard deviation for quantitative variables. OR with 95% CI was used to assess the strength of association. Quantitative variables like duration of media exposure, age of starting the media exposure and average time spent with mother were compared between the two group using Mann-Whitney U-test as the data was skewed. A multivariable logistic regression was used to find the adjusted OR and 95% CI. Variables which were biologically relevant and had $P$ value of $< 0.05$ in the univariate analysis were put in the logistic regression to obtain the adjusted effect measures. $P$ value of $< 0.05$ was taken as level of significance for association between exposure variables and ASD.

Receiver operating characteristics (ROC) curve is extensively used in clinical epidemiology to quantify how accurately a test can discriminate between diseased state and nondiseased state. The area under the ROC curve (AUC) is a measure of separability and if the AUC is nearer to 1, it indicates that the model is better in distinguishing cases and controls. The authors applied ROC curve to assess the probability of developing autism spectrum disorder in the settings of early digital media exposure and also for the time spent with the mother.

## Results

The study group consisted of 65 children with ASD and included 53 (81.5%) boys and 12 (18.5%) girls. The mean

age of children with ASD was 4.77 y (SD ± 1.57). They belonged to lower, middle, and upper socioeconomic classes in 26 (40%), 11 (17%), and 28 (43%) cases, respectively and 38 (58.5%) were from joint families and 27 (41.5%) from nuclear families. The age- and sex-matched control group included 65 typically developed children with 47 (72.2%) boys and 18 (27.8%) girls with a mean age of 4.40 y (SD ± 1.52).

All children with ASD had delayed language development and only 10 (15%) children were able to communicate meaningfully. The majority of them (51; 78.4%) had impaired intellectual functioning and 5 (7.7%) had co-morbid ADHD. Hearing impairment was present in 2 (3%) children.

Prenatal and perinatal factors with statistically significant difference between the study group and the control group on univariate analysis are described in Table 1.

Children with ASD were exposed to digital media at an earlier age and they spent significantly more time with digital media compared to the children in the control group (Table 2). The ROC curve showed an AUC of 0.756 implying association with younger age of onset of audio-visual media exposure and autism spectrum disorders. Onset of exposure less than 21 mo was associated with a risk of developing ASD with sensitivity of 71% and specificity of 72% (Fig. 1).

On the other hand, children with ASD spent significantly less time with the mother/primary caretaker compared to the children in the control group (Table 2). The area under the ROC curve was 0.830 and the risk of ASD was found to decrease with the mother spending 6.5 hour per day on average with the baby, with a sensitivity of 89% and specificity of 72% (Fig. 2).

Multivariable logistic regression was done with the risk factors that reached statistical significance in univariate analysis. Neonatal seizure and family history of ASD were not included in regression as there were zero subjects among controls. On multivariate analysis it was found that family history of epilepsy and developmental delay, maternal stress during the antenatal period, absence of exclusive breastfeeding during the first 6 mo, early exposure to digital media and increased screen-time, and mother spending less quality time with the child had significant association with ASD (Table 3).

## Discussion

The authors have studied the early life social experience and digital-media exposure in children with ASD in comparison with those in typically developed children and also compared the prenatal and perinatal factors. They found that children with ASD spent significantly more time with digital media and the latter were exposed to digital media at an earlier age, compared to typically developed children. On the other hand, the authors found an inverse relationship between quality time spent with mother during the first 2 y and the risk for ASD.

Over-exposure to digital media may lead to neurochemical and neuroanatomical changes in the brain and influence learning and cognition [16]. But whether excessive screen time during early childhood has any direct effect on increasing the risk for ASD is still inconclusive, with some studies reporting an association [8, 17, 18] and others finding none [19]. It is likely that children with ASD preferred to be left alone and spend time with visual media rather than with

**Table 1** Prenatal and perinatal factors with significant association with ASD on univariate analysis

| Risk factors | Cases No. (%) | Controls No. (%) | P value | Odds ratio | 95% Confidence interval | |
|---|---|---|---|---|---|---|
| Family history of epilepsy | 15 (23.1%) | 6 (9.2%) | 0.032 | 2.95 | 1.06 | 8.17 |
| Family history of autism | 10 (15.4%) | 0 | 0.001 | 0.458 | 0.337 | 0.557 |
| Family history of developmental delay | 7 (10.8%) | 1 (1.5%) | 0.029 | 7.72 | 0.922 | 64.68 |
| Family history of psychiatric illness | 10 (15.4%) | 1 (1.5%) | 0.015 | 5.72 | 1.2 | 27.2 |
| Treatment for infertility | 8, 12.3% | 1, 1.5% | 0.016 | 8.98 | 1.09 | 74.03 |
| Maternal stress during the antenatal period | 32, 49.2% | 4, 6.1% | 0.000 | 14.7 | 4.8 | 45.4 |
| Cesarean birth | 36, 55.4% | 24, 36.9% | 0.035 | 2.12 | 1.05 | 4.27 |
| Prematurity | 8 (12.3%) | 1 (1.5%) | 0.016 | 8.98 | 1.09 | 74 |
| Fetal distress | 8 (12.3%) | 1 (1.5%) | 0.016 | 8.98 | 1.09 | 74 |
| Delayed birth cry | 12 (18.5%) | 1 (1.5%) | 0.001 | 14.5 | 1.8 | 115 |
| Neonatal seizures | 7, 10.8% | 0 | 0.007 | 0.472 | 0.39 | 0.56 |
| Neonatal jaundice | 17, 26.2% | 7, 10.8% | 0.024 | 2.93 | 1.12 | 7.66 |
| Lack of exclusive breastfeeding in first 6 mo | 29, 44.6% | 51, 78.5% | 0.001 | 0.221 | 0.103 | 0.476 |

**Table 2** Association of digital-media exposure and time spent with mother with ASD risk

| Risk factors | Cases (mean/SD) N = 65 | Controls (mean/SD) N=65 | P value |
|---|---|---|---|
| Background media exposure (h) | 3.4 (2.7) | 1.8 (1.7) | < 0.001 |
| Intentional media exposure (h) | 2.8 (2.2) | 1.5 (1.2) | 0.001 |
| Age of onset of exposure to audiovisual media (in mo) | 17.3 (8.3) | 29.8 (16.2) | < 0.001 |
| Average time spent with the mother in the first 2 y (h) | 4.5 (2.3) | 7.2 (1.5) | < 0.001 |

*ASD* Autism spectrum disorder

parents due to the inherent characteristics of the autistic symptomatology. The finding that children with ASD spent more time with digital media and less time with mothers warrants more attention in the Indian context, in view of a study from south India which had reported that around one third of children with ASD had social experiential deprivation and focused interventions resulted in better short-term outcomes. They chose the working definition of social experiential deprivation as mothers spending less than 2 h per day with the child, screen time more than 4 h a day or excessive solitary time of the child [20]. Similar findings had been reported in studies from abroad also [17]. Another recent study from south India reported that families of children with ASD spent significantly more time in front of digital media and less time interacting with the child [21].

Many studies in the past had reported that breast feeding has a protective effect on ASD [22–24]. In the present sample, children who received exclusive breast feeding during the first 6 m of life were significantly less in the ASD group compared to the control group. The present data are insufficient to conclude that exclusive breastfeeding has a protective effect against ASD since feeding problems are common in these children and mothers may be compelled to give artificial feeds. It has been observed that even when initiated at the recommended age, mothers could not sustain breastfeeding due to practical problems [25]. The protective effect of breastfeeding need not be due to the nutritional aspects alone. Breastfeeding helps to promote mother-child bonding and better mother-child interaction and provides the crucial stimulation for brain development. Difficulties in sustaining breastfeeding may be contributing to social experiential derivation in children with ASD.

The finding that maternal stress during pregnancy is a risk factor for ASD emphasizes the importance of psychological wellbeing of pregnant mothers which often does not get due attention. This is an area which needs further exploration. Stress during the antenatal period can adversely affect neurodevelopment and predisposes to neurodevelopmental disorders including ASD [26].

**Fig. 1** Age of first exposure to visual media — ROC curve
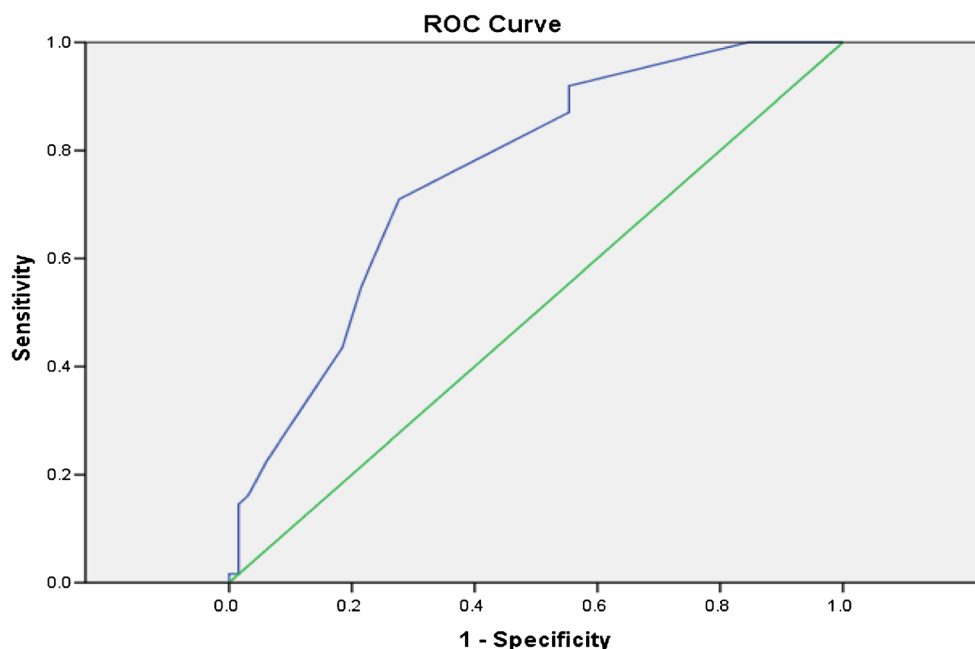


Diagonal segments are produced by ties.

**Fig. 2** Average time spent with the mother in 1st 2 y of life (ROC curve)
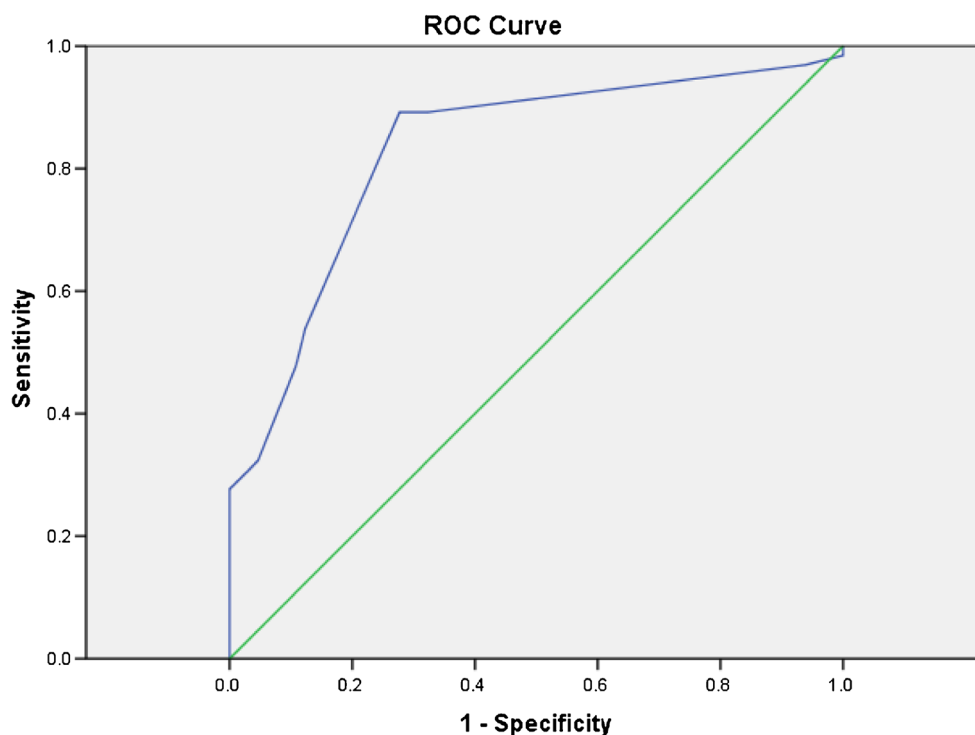
Among the many prenatal and perinatal factors, increased parental age and preterm birth are now considered to be proven risk factors for ASD [6]. It has been postulated that multiple prenatal and perinatal factors, rather than any single one, are involved in the etiology of ASD [27]. In the present sample, prematurity and increased maternal age had a significant association with ASD in univariate analysis, but the association was not found to be significant in multivariate analysis. Even though the risk of ASD increases with both paternal and maternal age, the relationship with maternal age was found to be stronger [28]. Possible biological mechanisms for the age-related risk for ASD include

increased chance for de novo mutations and genetic aberrations in older parents; more chance of unfavorable in-utero environment; and increased chance of obstetric complications in older mothers [29].

Increased presence of neurodevelopmental problems like autism, developmental delay, epilepsy, and psychiatric illnesses in the families of children with ASD, which were also reported in previous studies [30–32] may be indicative of the genetic etiology of autism. Many psychiatric and neurodevelopmental disorders share common risk factors and probably the vulnerability to develop psychiatric disorders is inherited and not individual disorders [31].

**Table 3** Factors associated with risk for ASD (as per logistic regression analysis)

| Risk factor | P value | Adjusted odd's ratio | 95% CI | |
| --- | --- | --- | --- | --- |
| | | | Lower | Upper |
| Family history of epilepsy | 0.013 | 33.985 | 2.130 | 542.354 |
| Family history of developmental delay | 0.045 | 53.792 | 1.097 | 2638.452 |
| Maternal stress during antenatal period | 0.001 | 30.907 | 3.765 | 253.690 |
| Absence of exclusive breastfeeding during the first 6 mo | 0.018 | 0.123 | 0.022 | 0.696 |
| Early onset of exposure to digital media | 0.009 | 14.185 | 1.964 | 102.435 |
| Decreased quality time with the mother | 0.001 | 251.823 | 13.941 | 4548.766 |
| Excessive screen-time | 0.024 | 1.802 | 1.079 | 3.010 |

*ASD* Autism spectrum disorder; *CI* Confidence interval

## Conclusion

The prevalence of ASD is increasing the world over, including India. Being a neurodevelopmental disorder with no specific treatment, early identification of the modifiable risk factors and appropriate intervention is crucial for prevention. Even though there are case- control studies on the perinatal and prenatal risk factors, Indian data on digital-media exposure and quality time being spent with mothers in children with ASD is scant. The authors found that there is an association between early childhood exposure to digital media and risk for developing ASD.

Despite the inherent limitations of a hospital-based study with small sample size and the recall bias, the present study gives preliminary evidence to the potentially modifiable risk factors of ASD relevant to the Indian context. Further, prospective studies to identify the region-specific risk factors and randomized blinded interventional studies are needed in this area to provide robust scientific evidence for the effective management of children with ASD.

## Compliance with Ethical Standards

**Ethical Clearance** Institutional Ethics Committee, Govt. Medical College, Kozhikode. GMCKKD/RP2017/1EC/210 dated 22-11-2017.

**Conflict of Interest** None.

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