



ORIGINAL ARTICLE

Risk of Autism Spectrum Disorder in Children with a History of Neonatal Jaundice: A Case-Control Study

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ABSTRACT

Background: Autism spectrum disorder (ASD) is a complex neurodevelopmental condition influenced by a range of genetic, prenatal, and socioeconomic factors. This study aimed to examine the association of neonatal jaundice and other potential factors with ASD.

Methods: A frequency-matched case-control study was conducted from 1 January to 30 June 2024 at Al-Batool Teaching Hospital in Diyala Province, Iraq. The sample included 113 children with confirmed ASD and 113 age-frequency-matched controls. Sociodemographic and clinical data were collected through structured parent interviews and review of medical records. Bivariate analyses and binary logistic regression were performed to assess associations and identify factors independently associated with ASD.

Results: Data from 226 children aged 24–60 months were included in the final analysis. The proportion of males was significantly higher among children with ASD than among controls (67.3% vs. 52.2%, $p = 0.026$). Children with ASD were also more likely to reside in urban areas and to have a family history of ASD ($p = 0.005$ and $p < 0.001$, respectively). A history of neonatal jaundice was more common in the ASD group than in the control group (72.6% vs. 46.9%, $p < 0.001$). In multivariable logistic regression analysis, family history of ASD (OR = 5.37, 95% CI: 1.99–14.46), neonatal jaundice (OR = 2.85, 95% CI: 1.54–5.29), male sex (OR = 2.16, 95% CI: 1.17–3.98), and urban residence (OR = 1.91, 95% CI: 1.06–3.44) were significantly independently associated with ASD.

Conclusion: Family history of ASD, neonatal jaundice, male sex, and urban residence were independently associated with ASD in children. These findings support a possible role for familial and early-life environmental factors in ASD.

Key words: Autism spectrum disorder; Neonatal jaundice; Phototherapy



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INTRODUCTION

Autism spectrum disorder (ASD) is a heterogeneous group of neurodevelopmental conditions characterized by persistent deficits in social communication and social interaction, along with restricted interests and repetitive behaviors that typically emerge in childhood and may persist into adulthood [1]. Zeidan et al. [2] reported a global ASD prevalence of 0.76 per 100 children, with substantial variation across geographic regions and diagnostic criteria. Although previous research has suggested a complex basis involving both genetic and environmental factors, the exact etiology of ASD remains unclear [3]. Perinatal and obstetric complications, including neonatal jaundice, have been proposed as environmental factors that may be associated with ASD because of their potential effects on early brain development [4].

Neonatal jaundice, a common and usually self-limiting clinical condition during the first week after birth, has been identified as a possible perinatal factor associated with ASD. A large proportion of both term and preterm neonates develop jaundice during the early postnatal period [5].

Neonatal hyperbilirubinemia refers to elevated blood bilirubin levels and may be physiological or pathological in origin. Moderate increases in bilirubin may exert antioxidant effects that could be neuroprotective; however, severe elevations may allow unconjugated bilirubin to cross the blood–brain barrier, leading to bilirubin-induced neurologic dysfunction (BIND) [6].

In recent years, numerous studies worldwide have examined the association between neonatal jaundice and ASD. Several epidemiological studies have reported that infants with serum hyperbilirubinemia requiring hospitalization or phototherapy had higher odds of ASD later in life [7, 8]. In contrast, other studies found no statistically significant association after adjustment for potential confounding factors, such as preterm birth and maternal health conditions [9, 10]. These inconsistent findings highlight the complexity of the relationship and the need for further investigation. Given the potential impact of elevated bilirubin levels during a critical period of brain development, neonatal jaundice may be associated with ASD in a subset of children; however, the available evidence remains inconclusive. Therefore, the present study aimed to examine the association between neonatal jaundice and ASD in early childhood and to identify other social, demographic, and clinical factors associated with ASD among Iraqi children.

PATIENTS AND METHODS

Study design

An age–frequency–matched hospital-based case–control study was conducted at Al-Batool Teaching Hospital in

Diyala Province, Iraq, from 1 January to 30 June 2024. Frequency matching was performed according to predefined age categories (24–35 months, 36–47 months, and 48–60 months). Sex was not used as a matching variable and was therefore considered a potential confounder in the analysis.

Sample size consideration

A formal *a priori* sample size or power calculation was not performed. The final sample size was determined by the total number of eligible autism spectrum disorder (ASD) cases identified during the study period and the availability of age–frequency–matched control children from the same source population.

Data collection

Data were collected through structured interviews with parents and by reviewing medical records. Cases of autism spectrum disorder (ASD) were identified among children who attended the neurological outpatient clinic at Al-Batool Teaching Hospital during the study period. The diagnosis of ASD was confirmed according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria [11].

For each ASD case, one control child without ASD was selected from the same hospital. Controls were randomly selected from children attending the general pediatric outpatient clinics during the same study period to ensure that they originated from the same source population as the cases. Controls were frequency matched by age group only and not by individual age or sex. The distribution of cases and controls across the predefined age bands is presented in Table 1 and reflects the intended frequency–matching approach. Sex was recorded for all participants and was considered in the adjusted analysis. To reduce the likelihood of outcome misclassification, all control children underwent clinical evaluation by a pediatrician. Medical records were reviewed to exclude any documented neurodevelopmental diagnosis, and parents were interviewed to confirm normal developmental milestones and the absence of behavioral or communication concerns suggestive of ASD. The variables collected included maternal and child-related characteristics such as sex, age, neonatal jaundice, prematurity, birth weight, mode of delivery, residence (urban/rural), and family history of ASD.

Inclusion and exclusion criteria

The inclusion criteria for the ASD group were children with a confirmed diagnosis of ASD as the primary reason for attendance at the neurological outpatient clinic of Al-Batool Teaching Hospital in Diyala. The control group consisted of typically developing children without ASD, randomly selected from the hospital's general pediatric outpatient clinics, with no clinical or documented history of ASD or other develop-

mental disorders.

The exclusion criteria were a history of syndromic disorders, known chromosomal or congenital abnormalities, developmental delays or disorders unrelated to ASD, and lack of information regarding neonatal jaundice history.

Definition of variables

Neonatal jaundice was considered present if it was clinically diagnosed after delivery or during any hospital stay within the first month of life, or if the infant underwent phototherapy or exchange transfusion during the first month of life. Because exact total serum bilirubin values and age-specific bilirubin thresholds were not consistently available in the medical records for all participants, documented clinical management decisions were used as operational indicators of jaundice severity. Accordingly, neonatal jaundice severity was categorized as mild (no hospital admission or phototherapy), moderate (hospital admission for phototherapy), or severe (hospital admission requiring exchange transfusion).

Clinical decisions regarding phototherapy or exchange transfusion were made according to the local neonatal care protocol at Al-Batool Teaching Hospital, which is based on the American Academy of Pediatrics (AAP) guidelines for the management of neonatal hyperbilirubinemia [12]. In routine practice, phototherapy was initiated for neonates with clinically significant jaundice requiring hospital admission, based on postnatal age, gestational age, and the presence of risk factors such as prematurity, poor feeding, or hemolysis. Exchange transfusion was reserved for severe cases with rapidly rising bilirubin levels or failure to respond to intensive phototherapy, as documented in the medical records. Prematurity was defined as birth before 37 completed weeks of gestation.

Missing data handling

Nine records were excluded during the eligibility assessment because of missing or insufficient information on neonatal jaundice history, which was the primary exposure variable. There were no missing data for any other study variables. After application of the exclusion criteria, the final analytical dataset consisted of 226 children with complete data for all variables included in the analysis. Therefore, a complete-case analysis was performed, and no data imputation methods were applied.

Statistical analysis

Descriptive analyses were performed using frequencies, percentages, means, and standard deviations, as appropriate. Bivariate analyses were conducted to compare ASD cases and controls across key demographic and clinical characteristics. For adjusted analyses, odds ratios (ORs) were estimated using binary logistic regression. The dependent variable was coded

as 1 for ASD and 0 for controls. Variables were selected for the multivariable model based on clinical relevance, prior literature, and potential confounding effects. Sex was retained in the model because it was not used as a matching variable. Age group was frequency matched at the design stage. All statistical analyses were performed using SPSS version 16, and a two-sided p value of < 0.05 was considered statistically significant.

RESULTS

Sociodemographic and clinical characteristics of the study participants.

According to the predefined inclusion and exclusion criteria, a total of 226 children aged 24–60 months were included in the final analysis, comprising 113 children with autism spectrum disorder (ASD) and 113 age-frequency-matched controls. Most participants were male and belonged to the 48–60-month age group. The proportion of males was significantly higher among children with ASD than among controls (76 vs. 59, $p = 0.026$).

The mean age and mean birth weight did not differ significantly between the two groups. Children with ASD were more likely than controls to reside in urban areas and to have a positive family history of ASD ($p = 0.005$ and $p < 0.001$, respectively). Although preterm birth and cesarean delivery were more frequent among ASD cases than among controls, these differences did not reach statistical significance ($p > 0.05$) (Table 1).

Neonatal jaundice exposure and severity.

In the ASD group, 82 children (72.6%) had a history of neonatal jaundice, compared with 53 children (46.9%) in the control group. This difference was statistically significant ($p < 0.001$). Among children with a history of neonatal jaundice ($n = 135$), the distribution of jaundice severity differed between ASD cases and controls. Mild jaundice was more common among controls than among ASD cases (66.0% vs. 39.0%, $p = 0.002$). In contrast, moderate jaundice requiring phototherapy was more frequent among ASD cases than among controls (50.0% vs. 28.3%, $p = 0.008$). Severe jaundice requiring exchange transfusion was also more frequent among ASD cases; however, this difference was not statistically significant ($p = 0.285$). Overall, these findings indicate that neonatal jaundice, particularly moderate jaundice requiring phototherapy, was more common among children with ASD than among controls (Table 2).

Multivariable logistic regression analysis.

Multivariable logistic regression analysis was performed to examine factors independently associated with ASD. As shown in Table 3, male sex was independently associated

Table 1. Baseline characteristics of children with autism spectrum disorder (ASD) and controls

Characteristic	ASD cases (n = 113)	Controls (n = 113)	Test statistic	p-value
Age distribution				
24–35 months, n (%)	20 (17.7)	20 (17.7)	–	–
36–47 months, n (%)	35 (31.0)	35 (31.0)	–	–
48–60 months, n (%)	58 (51.3)	58 (51.3)	–	–
Mean age, months ± SD	48.6 ± 10.1	47.9 ± 9.8	t = 0.53	0.598
Sex and perinatal characteristics				
Male sex, n (%)	76 (67.3)	59 (52.2)	$\chi^2 = 4.92$	0.026
Mean birth weight, kg ± SD	3.02 ± 0.44	3.07 ± 0.39	t = 0.89	0.349
Preterm birth (< 37 weeks), n (%)	21 (18.6)	14 (12.4)	$\chi^2 = 1.56$	0.197
Cesarean delivery, n (%)	60 (53.1)	48 (42.5)	$\chi^2 = 2.55$	0.110
Family and residential characteristics				
Urban residence, n (%)	79 (69.9)	58 (51.3)	$\chi^2 = 7.91$	0.005
Family history of ASD, n (%)	27 (23.9)	6 (5.3)	$\chi^2 = 16.04$	<0.001

Data are presented as mean ± standard deviation (SD) or number (%).

Student's *t*-test was used for continuous variables, and the chi-square (χ^2) test was used for categorical variables.

Table 2. Exposure to neonatal jaundice and severity among jaundiced children in ASD cases and controls

Characteristic	ASD cases (n = 113)	Controls (n = 113)	Test statistic	p-value
Neonatal jaundice exposure				
Yes, n (%)	82 (72.6)	53 (46.9)	$\chi^2 = 15.62$	<0.001
No, n (%)	31 (27.4)	60 (53.1)	–	–
Severity among jaundiced children only (n = 135)				
Mild (no admission), n (%)	32/82 (39.0)	35/53 (66.0)	$\chi^2 = 9.15$	0.002
Moderate (phototherapy), n (%)	41/82 (50.0)	15/53 (28.3)	$\chi^2 = 7.03$	0.008
Severe (exchange transfusion), n (%)	9/82 (11.0)	3/53 (5.7)	$\chi^2 = 1.14$	0.285

Data are presented as number (%).

Percentages in the severity section were calculated among jaundiced children within each study group.

Chi-square (χ^2) test was used for comparisons between groups.

Table 3. Multivariable logistic regression analysis of factors independently associated with autism spectrum disorder (ASD)

Variable	Category	Adjusted OR	95% CI	p-value
Family history of ASD	Yes	5.37	1.99–14.46	<0.001
	No (reference)	Reference	–	–
Neonatal jaundice	Present	2.85	1.54–5.29	0.001
	Absent (reference)	Reference	–	–
Sex	Male	2.16	1.17–3.98	0.014
	Female (reference)	Reference	–	–
Residence	Urban	1.91	1.06–3.44	0.031
	Rural (reference)	Reference	–	–

OR, odds ratio; CI, confidence interval.

Adjusted odds ratios were obtained from a multivariable binary logistic regression model.

Reference categories are shown for comparison.

with ASD after adjustment (adjusted OR = 2.16, 95% CI: 1.17–3.98, $p = 0.014$). Other factors that remained independently associated with ASD were a positive family history of ASD (adjusted OR = 5.37, 95% CI: 1.99–14.46, $p < 0.001$), neonatal jaundice (adjusted OR = 2.85, 95% CI: 1.54–5.29, $p = 0.001$), and urban residence (adjusted OR = 1.91, 95% CI: 1.06–3.44, $p = 0.031$). These findings suggest that the association between neonatal jaundice and ASD persisted after adjustment for the other variables included in the model.

DISCUSSION

The present age–frequency–matched hospital–based case–control study found that neonatal jaundice was more common

among children with autism spectrum disorder (ASD) than among controls. In the multivariable logistic regression analysis, neonatal jaundice remained independently associated with ASD after adjustment for sex, residence, and family history of ASD. In addition, male sex, urban residence, and a positive family history of ASD were also independently associated with ASD in the study sample.

The higher proportion of males among ASD cases than among controls in the present study is consistent with the well-recognized male predominance in ASD diagnosis. Previous studies have shown that ASD is diagnosed more frequently in males than in females, with proposed explanations including sex-related neurobiological differences, hormonal influences, and differential expression of ASD-related genetic suscepti-

bility [13, 14]. In addition, camouflaging behaviors and less overt symptom presentation among females may contribute to underrecognition and delayed diagnosis, thereby widening the apparent sex difference.

The present study did not find significant differences between ASD cases and controls with respect to mean birth weight, preterm birth, or cesarean delivery. These findings suggest that these perinatal factors were not significantly associated with ASD in this sample. The literature on these variables remains inconsistent. Some studies have suggested associations between prematurity and later ASD diagnosis, possibly because of vulnerability of the immature brain to perinatal injury and altered neurodevelopment [15, 16]. Similarly, cesarean delivery has been discussed as a possible associated factor, although the mechanisms remain uncertain and the evidence is not consistent across studies [17]. The absence of significant associations in the present study may reflect the relatively modest sample size or differences in population characteristics.

Urban residence was significantly more common among ASD cases than among controls, and it remained independently associated with ASD in the adjusted analysis. This finding may reflect a combination of environmental, social, and health-service-related factors. Children living in urban settings may be more likely to be diagnosed because of improved access to specialist services, greater parental awareness, and better referral pathways. Environmental exposures such as air pollution and other urban stressors have also been proposed as possible contributing factors [18, 19]. However, geographic variation in ASD frequency is complex, and not all studies have reported the same pattern [20, 21]. Therefore, the observed association with urban residence should be interpreted cautiously and may partly reflect differences in diagnostic access rather than a direct causal effect.

A positive family history of ASD showed the strongest association with ASD in the present study. This finding supports the substantial contribution of familial and genetic susceptibility to ASD. Previous studies have consistently shown that ASD clusters within families and that the likelihood of ASD is higher among children with affected first-degree relatives [22, 23]. The strong association observed in the current study is therefore biologically plausible and consistent with the broader literature.

Neonatal jaundice was significantly more common among ASD cases than among controls, and this association persisted after adjustment in the logistic regression model. This finding is in line with previous studies and meta-analyses reporting an association between neonatal jaundice or hyperbilirubinemia and ASD [7, 8]. Bilirubin-induced neurotoxicity has been proposed as a possible mechanism, particularly through its effects on vulnerable regions of the developing nervous system, including the basal ganglia and auditory pathways [6]. Al-

though a case-control design cannot establish causation, the present findings support the possibility that neonatal jaundice may be an important early-life factor associated with ASD.

The severity analysis also showed that moderate neonatal jaundice requiring phototherapy was more frequent among ASD cases than among controls. Severe jaundice requiring exchange transfusion was likewise more frequent among ASD cases, but the difference was not statistically significant. These findings may suggest that more severe jaundice is more strongly associated with ASD than mild jaundice; however, caution is warranted in interpreting this pattern. In the present study, jaundice severity was classified according to documented clinical management rather than exact bilirubin measurements, because total serum bilirubin values and age-specific thresholds were not consistently available for all participants. In addition, the number of children requiring exchange transfusion was small, which may have limited the ability to detect a statistically significant difference for this subgroup. Nonetheless, the observed pattern is broadly consistent with prior reports indicating that clinically significant hyperbilirubinemia requiring treatment may be more strongly associated with later neurodevelopmental problems than mild jaundice [8, 24].

From a clinical perspective, these findings support careful recognition and management of neonatal jaundice, particularly in settings where bilirubin monitoring and follow-up may be inconsistent. However, the results should not be interpreted as evidence that neonatal jaundice causes ASD. Rather, the study demonstrates an association within the sampled population and highlights the need for further research using longitudinal designs and more precise exposure measurement.

This study has several limitations. First, the hospital-based case-control design may have introduced selection bias, as participants were recruited from a single tertiary hospital and may not fully represent the general pediatric population. Second, information on neonatal jaundice relied partly on parental report, although it was checked against medical records whenever possible. Third, total serum bilirubin levels and age-specific treatment thresholds were not consistently available, so jaundice severity was classified using documented management decisions, which may have led to some exposure misclassification. Fourth, although controls underwent clinical evaluation and record review to reduce outcome misclassification, the absence of a standardized ASD screening tool among controls may have allowed a small possibility of undetected developmental concerns. Despite these limitations, the study provides useful evidence from a resource-limited setting and contributes to the growing literature on neonatal and familial factors associated with ASD.

Future studies should use larger, preferably prospective,

population-based designs with standardized ascertainment of both ASD and neonatal hyperbilirubinemia. The availability of exact bilirubin measurements, treatment thresholds, and timing of exposure would allow more precise evaluation of whether a dose–response relationship exists. Such studies would also help clarify the extent to which the observed associations reflect biological mechanisms, residual confounding, or differences in access to diagnosis and care.

CONCLUSION

Family history of ASD, neonatal jaundice, male sex, and urban residence were independently associated with ASD. A history of neonatal jaundice was more common among children with ASD than among controls, and moderate jaundice requiring phototherapy was also observed more frequently in the ASD group. These findings support a possible role for familial and early-life factors in ASD. Owing to the case–control design, the results should be interpreted as associations rather than evidence of causation. Further large-scale prospective studies are needed to confirm these findings and clarify the underlying mechanisms.

ETHICAL DECLARATIONS

• Ethics Approval and Consent to Participate

The study protocol was reviewed and approved by the Ethics Committee of the College of Medicine, University of Diyala, Iraq (Approval No. 2023AJM963; 12 December 2023). Written informed consent was obtained from the parents or legal guardians of all participating children before data collection. All procedures were performed in accordance with the Declaration of Helsinki.

• Consent for Publication

None.

• Availability of Data and Material

The datasets are available from the corresponding author upon reasonable request.

• Competing Interests

The authors declare that there is no conflict of interest.

• Funding

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• Use of Generative Artificial Intelligence

The authors declare that no generative AI tools were used in the preparation, writing, or editing of this manuscript.

• Authors' Contributions

All authors contributed equally to the design and conception of the study. All authors reviewed the manuscript and approved the final manuscript.

REFERENCES

- [1] Qin L, Wang H, Ning W, Cui M, Wang Q, New advances in the diagnosis and treatment of autism spectrum disorders. *European Journal of Medical Research* 2024;29(1):322. <https://doi.org/10.1186/s40001-024-01916-2>
- [2] Zeidan J, Fombonne E, Scorch J, Ibrahim A, Durkin MS, Saxena S, et al., Global prevalence of autism: A systematic review update. *Autism Research* 2022;15(5):778–790. <https://doi.org/10.1002/aur.2696>
- [3] Love C, Sominsky L, O'Hely M, Berk M, Vuillermin P, Dawson SL, Prenatal environmental risk factors for autism spectrum disorder and their potential mechanisms. *BMC Medicine* 2024;22(1):393. <https://doi.org/10.1186/s12916-024-03617-3>
- [4] White TA, Miller SL, Sutherland AE, Allison BJ, Camm EJ, Perinatal compromise affects development, form, and function of the hippocampus part two; preclinical studies. *Pediatric Research* 2024;95(7):1709–1719. <https://doi.org/10.1038/s41390-024-03144-0>
- [5] Diala UM, Usman F, Appiah D, Hassan L, Ogundele T, Abdullahi F, et al., Global Prevalence of Severe Neonatal Jaundice among Hospital Admissions: A Systematic Review and Meta-Analysis. *Journal of Clinical Medicine* 2023;12(11):3738. <https://doi.org/10.3390/jcm12113738>
- [6] Pranty AI, Shumka S, Adjaye J, Bilirubin-Induced Neurological Damage: Current and Emerging iPSC-Derived Brain Organoid Models. *Cells* 2022;11(17):2647. <https://doi.org/10.3390/cells11172647>
- [7] Merino-Andrés J, Pérez-Nombela S, Álvarez Bueno C, Hidalgo-Robles Ruiz-Becerro I, Fernández-Rego FJ, Neonatal hyperbilirubinemia and repercussions on neurodevelopment: A systematic review. *Child: Care, Health and Development* 2024;50(1):e13183. <https://doi.org/10.1111/cch.13183>

- [8] Jenabi E, Bashirian S, Khazaei S, Association between neonatal jaundice and autism spectrum disorders among children: a meta-analysis. *Clinical and Experimental Pediatrics* 2020;63(1):8–13. <https://doi.org/10.3345/kjp.2019.00815>
- [9] Mohammed NA, Mahmood NS, Alezzi JI, Ahmed BM, Aljefri MA, Maternal Risk Factors for Autism Spectrum Disorder. *Diyala Journal of Medicine* 2024;27(2):1–12. <https://djm.uodiyala.edu.iq/index.php/djm/article/view/1221>
- [10] Kujabi ML, Petersen JP, Pedersen MV, Parner ET, Henriksen TB, Neonatal jaundice and autism spectrum disorder: a systematic review and meta-analysis. *Pediatric Research* 2021;90(5):934–949. <https://doi.org/10.1038/s41390-020-01272-x>
- [11] American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th ed., text rev. ed. Washington, DC: American Psychiatric Publishing 2022. <https://doi.org/10.1176/appi.books.9780890425787>
- [12] Kemper AR, Newman TB, Slaughter JL, Maisels MJ, Watchko JF, Downs SM, et al., Clinical Practice Guideline Revision: Management of Hyperbilirubinemia in the Newborn Infant 35 or More Weeks of Gestation. *Pediatrics* 2022;150(3):e2022058859. <https://doi.org/10.1542/peds.2022-058859>
- [13] Napolitano A, Schiavi S, La Rosa P, Rossi-Espagnet MC, Petrillo S, Bottino F, et al., Sex Differences in Autism Spectrum Disorder: Diagnostic, Neurobiological, and Behavioral Features. *Frontiers in Psychiatry* 2022;13:889636. <https://doi.org/10.3389/fpsy.2022.889636>
- [14] McFayden TC, Putnam O, Grzadzinski R, Harrop C, Sex Differences in the Developmental Trajectories of Autism Spectrum Disorder. *Current Developmental Disorders Reports* 2023;10(1):80–91. <https://doi.org/10.1007/s40474-023-00270-y>
- [15] Liu P, Liu S, Zhang J, Identifying the Risk Factors of Autism Spectrum Disorders in Infants Born Preterm: A Systematic Review and Meta-Analysis. *European Child & Adolescent Psychiatry* 2026; <https://doi.org/10.1007/s00787-025-02946-9>
- [16] Crump C, Sundquist J, Sundquist K, Preterm or Early Term Birth and Risk of Autism. *Pediatrics* 2021;148(3):e2020032300. <https://doi.org/10.1542/peds.2020-032300>
- [17] Taniya MA, Chung HJ, Al Mamun A, Alam S, Aziz MA, Emon NU, et al., Role of Gut Microbiome in Autism Spectrum Disorder and Its Therapeutic Regulation. *Frontiers in Cellular and Infection Microbiology* 2022;12:915701. <https://doi.org/10.3389/fcimb.2022.915701>
- [18] Duque-Cartagena T, Dalla MDB, Mundstock E, Neto FK, Espinoza SAR, de Moura SK, et al., Environmental Pollutants as Risk Factors for Autism Spectrum Disorders: A Systematic Review and Meta-Analysis of Cohort Studies. *BMC Public Health* 2024;24(1):2388. <https://doi.org/10.1186/s12889-024-19742-w>
- [19] Moschetti A, Giangreco M, Ronfani L, Cervellera S, Ruffilli MP, Nume C, et al., An Ecological Study Shows Increased Prevalence of Autism Spectrum Disorder in Children Living in a Heavily Polluted Area. *Scientific Reports* 2024;14(1):17159. <https://doi.org/10.1038/s41598-024-67980-0>
- [20] Jiang X, Chen X, Su J, Liu N, Prevalence of Autism Spectrum Disorder in Mainland China Over the Past 6 Years: A Systematic Review and Meta-Analysis. *BMC Psychiatry* 2024;24(1):404. <https://doi.org/10.1186/s12888-024-05729-9>
- [21] Thomaidis L, Mavroei N, Richardson C, Choleva A, Damianos G, Boliias K, et al., Autism Spectrum Disorders in Greece: Nationwide Prevalence in 10–11 Year-Old Children and Regional Disparities. *Journal of Clinical Medicine* 2020;9(7):2163. <https://doi.org/10.3390/jcm9072163>
- [22] Wang HE, Cheng CM, Bai YM, Hsu JW, Huang KL, Su TP, et al., Familial Coaggregation of Major Psychiatric Disorders in First-Degree Relatives of Individuals with Autism Spectrum Disorder: A Nationwide Population-Based Study. *Psychological Medicine* 2022;52(8):1437–1447. <https://doi.org/10.1017/S0033291720003207>
- [23] Xie S, Karlsson H, Dalman C, Widman L, Rai D, Gardner RM, et al., The Familial Risk of Autism Spectrum Disorder with and without Intellectual Disability. *Autism Research* 2020;13(12):2242–2250. <https://doi.org/10.1002/aur.2417>
- [24] Chou HC, Lin HC, Huang KH, Chang YC, Associations between Neonatal Jaundice and Autism Spectrum Disorder or Attention Deficit Hyperactivity Disorder: Nationwide Population-Based Cohort Study. *Journal of the Formosan Medical Association* 2023;122(11):1150–1157. <https://doi.org/10.1016/j.jfma.2023.05.010>