Maternal and Neonatal Risk Factors Associated with Autism Spectrum Disorder for Children in Kirkuk City

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ABSTRACT

Background: Autism Spectrum Disorder (ASD) is a neurological illness that impacts a child's cognitive abilities, social interactions, and communication skills. The aim was to determine the association between maternal and neonatal risk factors associated with ASD for children in Kirkuk City. **Methods:** A case-control study was conducted on 180 mothers as a non-probability/convenience sample involving 90 mothers of children who were diagnosed with ASD according to the criteria (DSM-5) as a case group and were compared with 90 mothers of healthy children as a control group in Kirkuk city, through the period from November 2023 to December 2024. The collected data was analysed using SPSS version 22.0. Both descriptive and inferential statistical methods were used. The significance level for statistical analysis was set at $P<0.05$. **Results:** The study found that among 90 autistic children, 80% (72) were male, with a significance level of $P=0.002$. Prenatal and natal factors revealed that 78.9% of mothers experienced an unhappy emotional state, significant at $P=0.000$. Additionally, threatened abortions and anaemia were statistically significant at $P=0.000$. Also, 58.9% of the children were born via caesarean section, with 42.2% being elective c/s. 56.7% of children with autism were also bottle-fed. The majority of neonates (61.1%) were affected by jaundice, and 32.2% required phototherapy, significant at $P<0.01$. **Conclusion:** The findings detected several risk factors associated with ASD in children in a case-control study from Iraq. The most important of which were the age of the child and gender, anaemia, threatened abortions and caesarean section (elective c/s), in addition to high bilirubin levels (jaundice) of the neonate and admission to the incubator.

Keywords: ASD; Children; Maternal; Neonatal; Risk Factors

INTRODUCTION

A developmental disability is defined as a severe and persistent impairment that starts during a person's developmental period and is likely to persist indefinitely. It can be caused by mental or physical disabilities, individually or together, that substantially restrict social, vocational, and daily functioning (Joon, Kumar & Parle, 2021). A series of severe neurodevelopmental diseases known as Autism Spectrum Disorder (ASD) is defined as a neurodevelopmental disorder characterised by abnormalities in brain development that lead to a variety of weaknesses that affect how people learn, behave, interact with others and communicate (Kaky, Saleh, & Abdulqader, 2023). According to the CDC, which operates the Autism and Developmental Disabilities Monitoring Network, in just 20 years, the ASD prevalence rate went from 1 in 150 children to 1 in 36 children, which is still the rate as of 2024 (Ogilvie, 2025). Autism spectrum disorder was first described in 1943 by the American child psychologist Leo Kanner. The study showed 11 children whose behaviours were different from others. Kanner hypothesised that they have an innate characteristic that hinders their typical social interactions (Kanner, 1943). ASD is a complicated permanent developmental disability for which the symptoms could typically be present as early as the first year of life, but they usually start before three years of age; hence, the diagnosis is typically made after this age (Garza-Martínez *et al*., 2025).

The incidence of ASD is almost four times higher in boys than in girls 4:1 (Mahajan *et al*., 2025). According to research, the underlying mechanisms of ASD are thought to be most likely polygenic, and environmental variables may enhance the risk of ASD in addition to genetic factors (Jenabi *et al*., 2021). About

35–40% of ASD cases have been linked to genetic variables, while the remaining 60–65% of cases are thought to be caused by environmental, prenatal, perinatal, and neonatal factors (Balachandar *et al.*, 2021). Previous studies have shown that gestational hypertension and threatened abortion are risk factors for ASD (Balachandar *et al.*, 2021). Hajj *et al.* (2022) also identified gestational diabetes and supplement intake as risk factors for ASD. There are theories suggesting that ultrasound during pregnancy and maternal stress significantly increase the likelihood of developing ASD (Ogilvie, 2025). Children delivered by Caesarean section, whether elective or in response to an emergency, have a higher likelihood of developing autism spectrum disorder (Al-Ali *et al.*, 2021). Anaemia in pregnancy affects nearly half of all pregnant women worldwide (Taher & Ghalib, 2023). The importance of iron in brain development has led researchers to link anaemia during pregnancy to an increased likelihood of autism spectrum disorder (ASD) and other neurodevelopmental diseases (Wiegersma *et al.*, 2019; Hamarash & Ramadan, 2023).

The prevalence of ASD has increased during the past three decades in part due to changes in diagnostic criteria and raised attention (Persson *et al.*, 2020). There is not enough information on the risk factors for ASD in children; even while ASD is only associated with genetic factors, accumulating epidemiological data suggests that maternal and neonatal variables may also be significant (Arafa *et al.*, 2022).

The objective of this study is to find whether maternal and neonatal risk factors are associated with autism spectrum disorders for children in Kirkuk City.

METHODOLOGY

Design and Setting

A case-control study was conducted to determine the prenatal, natal, and neonatal risks associated with autism spectrum disorders in children. The study population consisted of mothers of children with autism spectrum disorder who are training in the autism centres at the paediatric hospital (autism centre), Al-Tamayuz Specialised Centre and Al-Erada Specialised Centre as a case group, and mothers of children without ASD are healthy from primary schools and kindergartens at Al-Kindi Primary School, Al-Hajar Al-Aswad mixed Primary school, Al-Mustansiriya Primary School, Al-Najah Private Primary School, Baba kurkar private Kindergarten and Children of Tomorrow private as a control group in Kirkuk City/north Iraq. The research was done throughout the period from November 2023 to December 2024.

Sampling Technique

A non-probability (convenience) sample consists of (180) mothers included 90 mothers of children who were referred to the autism centres and diagnosed to have ASD according to the criteria (DSM-5) and compared with 90 mothers of children without ASD who are healthy from primary schools and kindergarten pupils within the study area who were selected as a control group and matched to cases by age and place of residency.

Inclusion Criteria

The inclusion criteria for the study comprised mothers of children who met both the DSM-5 criteria for Autism Spectrum Disorder (ASD) and had a Child Autism Rating Scale (CARS) score of 29 or above. Additionally, mothers whose children were diagnosed with autism in conjunction with other developmental disabilities were also included. The study further encompassed mothers of children of all age groups who were present in the centres. In contrast, the control group consisted of mothers whose children did not exhibit any form of developmental disability and were developing typically.

Exclusion Criteria

The exclusion criteria for the study included mothers who declined to participate, and mothers of children diagnosed with developmental disabilities other than autism. The control group was subject to the same exclusion criteria.

Methods of Data Collection

Risk factors (Prenatal, Natal and Neonatal) data were collected from mothers of children with autism and without Autism Spectrum Disorder (ASD) using a self-administered questionnaire written in English. The

author of this study constructed this instrument (questionnaire) after reviewing the literature of similar studies (Arafa *et al*., 2022; Mkhitaryan *et al.*, 2024). Data was collected during face-to-face interviews with mothers.

The Content Validity of the Tool and Reliability

The validity and clarity of the tool used in this study were assessed by sending the questionnaire to a committee of 9 experts in different fields. These experts are (6) Faculty members from the Medical College, University of Kirkuk. (3) experts working in the Ministry of Health (2) at a pediatric Hospital (1) at Azadi Teaching Hospital. Each expert has more than six years of service in his field of specialisation. After the determination of the reliability of the pilot study, the results showed that the inter-examiner test (observer and co-observer) recorded completely adequate reliability in the pilot study at 100%.

Data Analysis

The Statistical Package for Social Science (SPSS) version (22.0) was used for data analysis. Descriptive statistics (mean, standard deviation, and percentage) in addition to inferential data analysis Contingency Coefficients (C.C.) test: Estimating the association tables at *P*-value <0.05.

Ethical Consideration

The research obtained ethical clearance from the Ethics Committee, Faculty of Nursing, University of Kirkuk, Iraq with reference number 2509/7/3 on 1st of October 2023.

RESULTS

Table 1: Characteristics of Child's Distribution Associated with ASD and Non-ASD Children with Comparisons Significant

Characteristics of Children	Groups	Case		Control		C.S. (*)
	Classes	No.	%	No.	%	*P*-value
Age (months)	**< 60 m**	**43**	**47.8**	**26**	**28.9**	CC = 0.223 *P*=0.002 (HS)
	60 -120	40	44.4	56	62.2	
	> 120 m	7	7.80	8	8.90	
	Total	90	100	90	100	
	Mean ± SD	64.92 ± 26.78		76.06 ± 27.37		
Gender	**Male**	**72**	**80**	**53**	**58.9**	CC = 0.223 *P*=0.002 (HS)
	Female	18	20	37	41.1	
	Total	90	100	90	100	
Child's Order	**First**	**38**	**42.2**	**33**	**36.7**	CC = 0.152 *P*=0.236 (NS)
	Second	23	25.6	25	27.8	
	Third	11	12.2	20	22.2	
	Fourth or above	18	20	12	13.3	
	Total	90	100	90	100	

(*) HS: Highly Sig. at P<0.01; S: Sig. at P<0.05; NS: Non-Sig. At P>0.05; Testing is based on a Contingency Coefficient test (CS or CC). Levels marked in bold indicate the Risk Factors associated with ASD.

The results in Table 1 show that the numbers of children recorded half of the study sample, 43 (47.8%), in the case group. The number of male children was the majority of the study sample, 72 (80.0%) in the case group; in terms of birth order, 42.2% of the ASD children were first-born compared to 36.7% in the control group.

The results in Table 2 show the association between prenatal and natal risk factors and ASD. As shown, there was a high association between multiple Pregnancies, threatened Abortion, anaemia during pregnancy, Gestational Hypertension, unstable emotional status, and type of caesarean section with ASD at *P*<0.01. In the meantime, there was a weak association between taking (folic acid, iron), gestational Diabetes, paracetamol and ASD at *P*>0.05, and the finding of the study was a significant association between vaginal Bleeding During Pregnancy, taking antibiotics, Calcium, mode of delivery, Type of Anesthesia During Cesarean Section and ASD at *P*<0.05.

Table 2: Distribution of Characteristics with the Prenatal and Natal Risk Factors with Significant Comparisons

Prenatal and Natal Factors	Groups	Case		Control		C.S. (*)
	Classes	No.	%	No.	%	*P-value*
Multiple Pregnancy	No	72	80	86	95.6	CC = 0.231
	Yes	**18**	**20**	**4**	**4.4**	*P*=0.001
	Total	90	100	90	100	(HS)
Threatened Abortion	No	66	73.3	85	94.4	CC = 0.276
	Yes	**24**	**26.7**	**5**	**5.6**	*P*=0.000
	Total	90	100	90	100	(HS)
Vaginal Bleeding during Pregnancy	No	66	73.3	78	86.7	CC = 0.164
	Yes	**24**	**26.7**	**12**	**13.3**	*P*=0.025
	Total	90	100	90	100	(S)
Paracetamol	No	66	73.3	66	73.3	CC = 0.000
	Yes	**24**	**26.7**	**24**	**26.7**	*P*=1.000
	Total	90	100	90	100	(NS)
Antibiotic	No	43	47.8	59	65.6	CC = 0.177
	Yes	**47**	**52.2**	**31**	**34.4**	*P*=0.016
	Total	90	100	90	100	(S)
Folic Acid	**No**	**25**	**27.8**	**15**	**16.7**	CC = 0.132
	Yes	65	72.2	75	83.3	*P*=0.073
	Total	90	100	90	100	(NS)
Iron	**No**	**33**	**36.7**	**31**	**34.4**	CC = 0.023
	Yes	57	63.3	59	65.6	*P*=0.755
	Total	90	100	90	100	(NS)
Calcium	**No**	**43**	**47.8**	**59**	**65.6**	CC = 0.177
	Yes	47	52.2	31	34.4	*P*=0.016
	Total	90	100	90	100	(S)
Anaemia	No	38	42.2	71	78.9	CC = 0.351
	Yes	**52**	**57.8**	**19**	**21.1**	*P*=0.000
	Total	90	100	90	100	(HS)
Gestational Hypertension	No	72	80	86	95.6	CC = 0.231
	Yes	**18**	**20**	**4**	**4.4**	*P*=0.001
	Total	90	100	90	100	(HS)
Gestational Diabetes	No	84	93.3	88	97.8	CC = 0.107
	Yes	**6**	**6.7**	**2**	**2.2**	*P*=0.148
	Total	90	100	90	100	(NS)
Unstable Emotional Condition	No	19	21.1	74	82.2	CC = 0.522
	Yes	**71**	**78.9**	**16**	**17.8**	*P*=0.000
	Total	90	100	90	100	(HS)
Mode of Delivery	Normal vaginal	37	41.1	51	56.7	CC = 0.154
	Caesarean section	**53**	**58.9**	**39**	**43.3**	*P*=0.037
	Total	90	100	90	100	(S)
Type of Cesarean Section	Normal	37	41.1	51	56.7	CC = 0.221
	Elective	**38**	**42.2**	**19**	**21.1**	*P*=0.0097
	Emergency	15	16.7	20	22.2	(HS)
	Total	90	100	90	100	
Type of Anaesthesia During Cesarean Section	Normal	37	41.1	51	56.7	CC = 0.189
	Regional	**12**	**13.3**	**4**	**4.4**	*P*=0.035
	General Anesthesia	**41**	**45.6**	**35**	**38.9**	(S)
	Total	90	100	90	100	

(*) HS: Highly Sig. at P<0.01; S: Sig. at P<0.05; NS: Non-Sig. At P>0.0; Testing based on a Contingency Coefficient test (CS or CC).

Table 3: Distribution (Neonatal Factors) for Studied Sampled with Comparison's Significance

Neonatal Factors	Groups	Case		Control		C.S. (*)
	Classes	No.	%	No.	%	P-value
Feeding Type	Breastfeeding	22	24.4	52	57.8	CC = 0.418 P=0.000 (HS)
	Bottle feeding	**51**	**56.7**	**12**	**13.3**	
	Mixed	17	18.9	26	28.9	
	Total	90	100	90	100	
Birth Asphyxia	No	73	81.1	86	95.6	CC = 0.180 P=0.014 (S)
	Yes	**17**	**18.9**	**4**	**4.4**	
	Total	90	100	90	100	
Admission Neonatal Intensive Care Unit	No	73	81.1	86	95.6	CC = 0.219 P=0.003 (HS)
	Yes	**17**	**18.9**	**4**	**4.4**	
	Total	90	100	90	100	
Neonatal Convulsion	No	87	96.7	90	100	CC = 0.129 P=0.081 (NS)
	Yes	**3**	**3.3**	**0**	**0.00**	
	Total	90	100	90	100	
Baby High Bilirubin Level (Jaundice)	No	35	38.9	64	71.1	CC = 0.308 P=0.000 (HS)
	Yes	**55**	**61.1**	**26**	**28.9**	
	Total	90	100	90	100	
Admission to Incubator	Non-Applicable	60	66.7	80	89.9	CC = 0.261 P=0.001 (HS)
	Need for Phototherapy	29	32.2	10	11.1	
	Blood Exchange	1	1.10	0	0.00	
	Total	90	100	90	100	

(*) HS: Highly Sig. at P<0.01; S: Sig. at P<0.05; NS: Non-Sig. At P>0.05; Testing is based on a Contingency Coefficient test and Binomial test (CS or CC).

The results in Table 3 showed that significant differences are accounted for in at least $P<0.05$ between observed frequency distributions concerning samples studied regarding "Neonatal Factors", except for "Neonatal Convulsion", since no significant differences are accounted for at $P>0.05$.

DISCUSSION

The mean age of the children was 64.92 ± 26.78 months in the case group and 76.06 ± 27.37 months in the control group. Regarding the gender variable, the proportion of male children was statistically significantly higher in the ASD group, which is in line with a study by Mkhitaryan *et al.* (2024), which found a larger proportion of male children in the ASD group. Furthermore, the findings of the research showed there was no statistically significant correlation between autism spectrum disorder and child order. That disagrees with a study by Mkhitaryan *et al*. (2024), who revealed a highly significant association between ASD cases being the first child in the family compared to controls.

Regarding prenatal risk factors, there were significant differences between the cases and controls in anaemia during pregnancy, unstable emotional status, and taking antibiotics; calcium showed significant differences in usage between cases and controls. The results are in line with the findings of Mkhitaryan *et al*. (2024) that anaemia during pregnancy, self-reported stress during pregnancy and use of various medications, including vitamins, calcium preparation and antibiotics, resulted in cases and controls differing significantly (all $P<0.05$). This study revealed that more than half of mothers experienced a detrimental emotional state during pregnancy, characterised by prenatal stress or exposure to social and environmental tensions, which was highly significantly correlated with autism as an essential variable. Therefore, a previous study in the Kurdistan Region at Sulaimania City supported this finding by Kareem, Azize and Muhammad (2017), which reported over half the sample size was experiencing significant emotional distress (prenatal stress). Regarding variables multiple pregnancy, threatened abortion, vaginal bleeding, and hypertension with pregnancy were statistically significant. This result agrees with Arafa *et al*. (2022), who found multiple pregnancies, vaginal bleeding during pregnancy, and hypertension with pregnancy were associated with significant increases in the odds of ASD.

Similarly, the findings of the current study came in line with research by Ravi and Mendonca (2023); it seems children of moms who have previously threatened with abortion have an almost tenfold increased odds ratio of high risk for autism as compared to children of mothers who have never threatened abortion. Furthermore, the study results indicate that gestational diabetes mellitus, folic acid, iron, and paracetamol showed no significant differences. Findings this study disagrees with an investigation conducted by Mkhitaryan *et al*. (2024) that suggests maternal taking of medication such as paracetamol and iron during pregnancy may increase the odds of ASD in offspring. Similarly, the findings of this study support research conducted by Ravi and Mendonca (2023) that found gestational diabetes was statistically non-significant at $P > 0.05$. Then, the results of the current investigation are inconsistent with research conducted in China by Jiang *et al*. (2024), which indicates that maternal use of folic acid supplements during prenatal phases may lower the incidence of ASD in offspring.

About the mode of delivery, the majority of the study samples were born via caesarean section in the cases group. Findings of the article showed the odds of autism are higher among those born via C-section compared to those born via normal deliveries. This discovery is especially significant because it is consistent with a prior study carried out by Al-Zalabani, Al-Jabree and Zeidan (2019) who found a correlation between ASD and caesarean birth. It is advised that preventive steps should be taken to steer clear of needless cesarean sections. The findings indicate that more than half of the cases of (ASD) that were sampled are accounted for by the elective and emergency categories. Specifically, the findings of the current study show the type of caesarean is highly significantly connected to ASD. The research findings agree with the study of the meta-analysis by Zhang *et al*. (2019), which revealed caesarean sections are prearranged, typically for medical or personal Children delivered through C-section have a significantly higher likelihood of their offspring being diagnosed with ASD compared to those born vaginally. It is worth noting that the results indicate that a majority of the patients analysed for the ASD sample were found to have undergone regional and general anesthesia. The finding of the current study shows the type of anaesthesia significantly connected to ASD. The use of general anaesthesia during caesarean delivery is associated with a higher probability of ASD compared to the use of regional anaesthesia. This finding is consistent with a prior investigation conducted by Yang *et al.* (2021), who reported that CS conducted under GA carries a higher risk of ASD than vaginal births.

The results of the research showed that more than half of the children in the sample with autism were bottle-fed, unlike the control group, where more than half were breastfed during the neonatal period for this the finding of the current study showed a highly statistically significant difference between the two groups. Similarly to the findings of Aloufi *et al*. (2002), the number of autistic children who were never breastfed was significantly higher than non-autistic children; a child with ASD may also be significantly impacted by insufficient consumption of "beneficial" omega-3 and omega-6 Polyunsaturated Fatty Acids (PUFA) obtained from the mother during pregnancy or lactation.

The current study shows neonates that had birth asphyxia, and this was statistically significant. This agreement with the findings of Yuan *et al.* (2024) showed neonates who suffered birth asphyxia were 13.42 times more likely to be diagnosed with ASD. The findings of this study indicate a higher likelihood of (ASD) in children who have been admitted to the neonatal intensive care unit (NICU). This conclusion is consistent with the findings of a prior study conducted by Arafa *et al.* (2022), which found admission to the NICU was associated with an increased likelihood of ASD.

Further, the findings of the current study indicated no significant correlations were identified between autism spectrum disorders and neonatal convulsions. This result disagrees with the literature of a previous study by Arafa *et al*. (2022); it seems neonatal convulsions were associated with the increased odds of ASD. Also, according to the results, the majority of the participants of patients with ASD had elevated bilirubin levels (jaundice) and some which necessitated phototherapy; this was highly statistically significant, which agrees with the results by Tunç, Çiçek and Kiliçbay (2021), who found that the ASD group had considerably more evident jaundice than the control group, which necessitated hospitalisation and phototherapy compared to the control group.

Nursing Intervention and Rationale: Sarwar, 2023.

Impaired Verbal Communication related to Language and Social Deficits

Intervention: Utilise visual aids, pictorial boards or communication technologies to assist the patient in

describing requirements and preferences.

Rationale: Visual aids and alternate communication can enhance expression, alleviating frustration and augmenting communication efficacy.

Social Isolation Associated with Challenges in Social Interactions and Restricted Communication Abilities

Intervention: Involving the patient in structured social activities with individuals who are familiar to them, beginning with brief, non-demanding interactions.

Rationale: The gradual development of social confidence through structured social interactions can foster a sense of ease in social environments over time.

Nutritional Imbalance: Inadequate Intake Relative to Physiological Needs Associated with Food Sensitivities or Limited Dietary Preferences

Intervention: Collaborate with a dietician to develop a nutritional plan that includes the patient's chosen foods while progressively integrating new options.

Rationale: Customising a dietary regimen to align with the patient's tastes enhances the acceptability of novel foods, hence augmenting nutrient intake.

Limitation

This study has several limitations that should be considered when interpreting the findings. Firstly, the use of a non-probability (convenience) sampling method may introduce selection bias, limiting the generalisability of the results beyond the study population in Kirkuk City. Secondly, the reliance on self-reported data through interviews with mothers may be subject to recall bias, especially regarding prenatal and neonatal events that occurred several years earlier. The study did not control certain potential confounding variables such as socioeconomic status, parental education levels, or genetic predispositions, which may have influenced the observed associations. The cross-sectional nature of the case-control design also precludes any determination of causal relationships between the identified risk factors and ASD. Lastly, the sample size, although adequate for initial associations, may not be sufficiently powered to detect smaller effects or interactions between multiple risk factors. Future research with larger, randomly selected cohorts and longitudinal designs is recommended to validate and expand upon these findings.

CONCLUSION

The study revealed that an investigation of prenatal, natal and neonatal variables provides essential insights into their correlation with ASD. The findings of the study confirm the hypothesis that the causes of ASD are multifaceted; while only one cause may elevate the risk, associations between caesarean sections and self-reported stress, gestational hypertension, vaginal bleeding, threatened abortion, anaemia during pregnancy, and taking Calcium during pregnancy were recognised as substantial risk factors for ASD. The study finds during the examination of neonatal variables, significant data indicate increased ASD incidence among bottle-fed infants, birth asphyxia, Neonatal Intensive Care Unit (NICU) hospitalisations, and jaundice. It is recommended to include further studies addressing new items to assess the potential effect of maternal and neonatal factors on the development of ASD in offspring.

Conflict of Interest

The authors affirm that there are no conflicting objectives.

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