

# Exploring Environmental Risk Factors For Autism Spectrum Disorders In Eastern Algeria

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## Abstract

*The prevalence of autism spectrum disorder (ASD) has steadily increased over the past two decades, making it a significant public health concern. However, the lack of epidemiological data in Algeria hinders understanding and management of the disorder. This study aims to explore the major environmental risk factors involved in the development of ASD in Eastern Algeria. Between March and April 2024, 100 patients from the eastern region were gathered from associations and psycho-educational centers. Data were analyzed using SPSS and Excel. Results showed a male predominance (64% boys, 36% girls; sex ratio 1.77:1), with higher ASD frequency among younger children (43%). Advanced paternal age (59%) and parental education level (49%) were significantly associated with early detection of signs ( $p = 0.002$ ). Family history of diabetes (30%) and hypertension (24%) were prevalent, and 15% of children were born from consanguineous marriages. Pregnancy-related factors such as maternal fever (23%), stress (74%), and smoking (23%), were identified as potential risk factors. Birth complications, particularly asphyxia, showed a significant correlation with ASD ( $p = 0.001$ ). Common comorbidities were attention deficit disorder (73%) and hyperactivity disorder (67%). This study provides valuable insights for early detection by highlighting important risk factors of ASD in eastern Algeria.*

**Key words:** Autism Spectrum Disorder (ASD), Risk Factors, Epidemiology, Environment and health.

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## INTRODUCTION

Autism spectrum disorder (ASD) is a complex neurodevelopmental disorder characterized by a broad range of deficits in language, cognition, social abilities, and motor skills, which manifest between birth and 36 months of age (1). Epidemiological studies show that the prevalence of autism has increased fivefold since the 1970s (1 in 10,000 births) (2). ASD is 4–5 times more common in boys than girls, with higher rates of impulsivity, hyperactivity, and aggression in boys (3).

Although the genetic underpinnings of autism have been extensively investigated, environmental factors are increasingly recognized as potential modulators of risk. Several studies have reported that advanced parental age is associated with an increased likelihood of ASD. Furthermore, certain perinatal complications have been identified as significantly linked to autism. Other pregnancy-related factors, such as maternal obesity, gestational diabetes, and cesarean delivery, have also been associated with ASD risk, albeit more moderately (4).

Several genetic syndromes, such as fragile X syndrome (FXS), Rett syndrome, and tuberous sclerosis (TS), are frequently associated with ASD. Many genes have previously been proposed as candidate ASD genes, but very few have been analyzed at the systems level (5). Research also indicates that a number of environmental factors, such as pre- and perinatal factors, contribute to the development of ASD, with advanced parental age associated with a higher frequency of de novo mutations. These environmental factors may influence susceptibility genes directly and induce epigenetic changes, thereby increasing the risk of ASD (6, 2).

Epidemiological studies play a crucial role in the field of public health, and have a wide range of uses, such as identifying risk factors associated with some diseases, preventing and controlling disease in populations, planning health resources, raising public awareness and guiding interventions, policies and strategies (7). However, the lack of epidemiological data on ASD in Algeria, makes it difficult to determine the prevalence of the disorder and its risk factors in this population. This wide gap restricts the creation of informative screening and preventive measures.

The primary aim of our research is to conduct a descriptive cross-sectional epidemiological study of autism in Eastern Algeria, with a particular focus on identifying and characterizing the environmental factors

associated with Autism Spectrum Disorders (ASD) in the region. We will analyze various parameters, such as the age and sex of the patients, the rank within the siblings, the sociocultural level of the parents and family history in order to highlight the impact of some of them on the onset and progression of this complex disorder. This will help providing valuable insights for early detection and intervention strategies in Algeria.

## MATERIALS AND METHODS

### Study context

This retrospective descriptive study was conducted over a two-month period (March to April 2024). Patient data were collected from psychoeducational centers and associations across the Wilayas "provinces" of Constantine, Mila, Annaba, and Batna in eastern Algeria.

### Study population

The study sample consisted of 100 patients with ASD (Autism Spectrum Disorder), aged between 4 and 20 years, with the following regional distribution: 57 from Constantine, 22 from Annaba, 15 from Mila, and 6 from Batna.

### Inclusion criteria

The study involved all patients of any age and gender with a confirmed diagnosis of ASD made by specialist doctors.

### Exclusion criteria

Subjects whose parents refused to complete the questionnaire were excluded from the study.

## METHODS

### Data collection

A questionnaire was prepared to determine the factors influencing the appearance and development of ASD.

The factors analyzed included patient age and sex, sibling rank, parental socio-cultural level, age of parents at child's birth, age of appearance of first symptoms, age of diagnosis, family medical history, consanguinity, blood type, prenatal maternal fever, prenatal maternal stress, maternal tobacco exposure, mode of delivery, perinatal complications, asphyxia and finally comorbidities.

### Data analysis

The data collected were computerized and processed using SPSS and Excel. A chi-square test was performed to check for significance ( $P < 0.05$ ), followed by a frequency analysis to calculate the percentage.

## RESULTS

### Characteristics of population

Our sample consists of 100 patients, with an average age of 9 years  $\pm$  3.34. We noted a male predominance, with 64% boys and 36% girls, corresponding to a boy/girl ratio of 1.77:1. Data show that the highest rate of ASD, is found in the youngest children, reaching 43% (**Table 1**).

Approximately 42% of parents detect signs of autism or developmental disorders in their child before the age of two. Among parents of autistic children, 49% had a university-level education. The chi-square test revealed a statistically significant association ( $P = 0.002$ ) between parental socio-cultural level and the timing of their first concerns.

The results show a progressive increase in ASD diagnoses with age, rising from 4% at birth to 39% by 12 to 24 months.

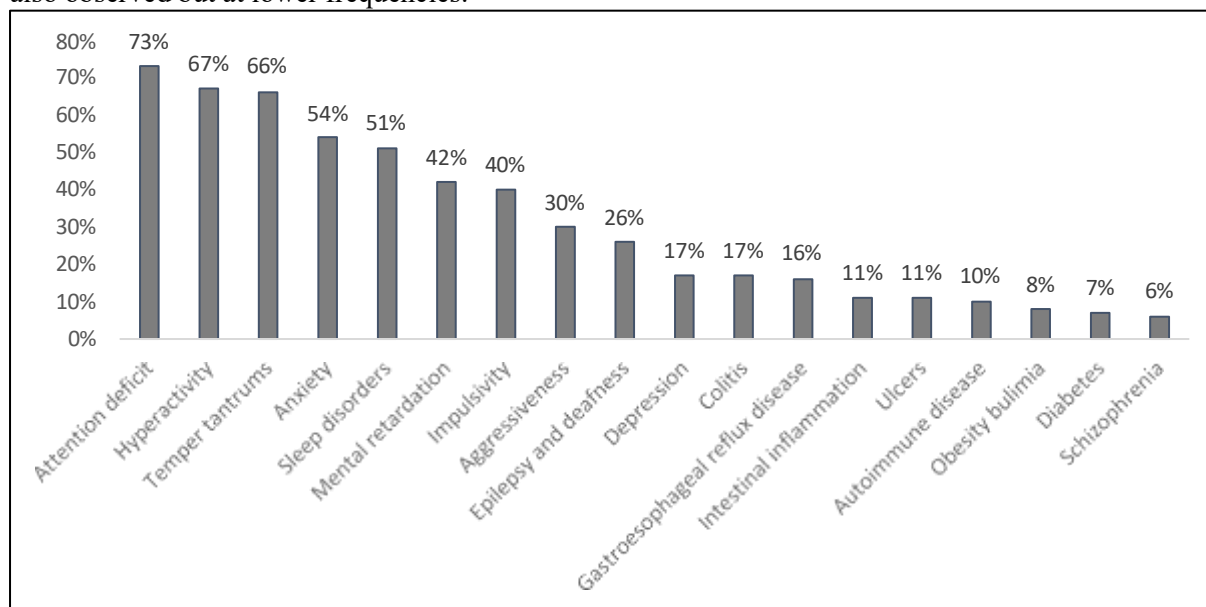
**Table 1. Characteristic of patients**

Population data	Number of patients	
Sex of the patients	64 male	36 female
Patient age distribution (years)	4-6 years	17
	7-9 years	40
	10-12 years	25
	13-15 years	10
	16-18 years	6
	19-21 years	2
Sibling rank	Oldest	27

	Youngest	43
	Middle	23
	Onlychild	7
The first concerns of parents	From birth	9
	< 12 months	18
	[1224] months	42
	[2436] months	17
	> 36 months	14
Parents' socio-cultural level	Medium level	21
	Secondary level	30
	University level	49
Age of diagnosis	From birth	4
	< 12 months	9
	[1224] months	39
	[2436] months	30
	> 36 months	18
The twins	8% are twins	

### Comorbidities

A significant prevalence of comorbidities was observed, revealing the complexity and diversity of the disorders associated with ASD, with frequencies varying according to the type of disorder. As shown in **Figure 1**, the most frequent comorbidities include attention deficit disorder affects 73% of the individuals, while 67% suffer from hyperactivity. Manifestations such as tantrums (54%) and anxiety (51%) are also frequent, often attributed to sensory hypersensitivity, difficulties in communication and social interaction. Less frequent comorbidities include Intellectual disability (48%) and aggressiveness (30%), which can considerably affect quality of life. Rarer, but nonetheless significant problems include severe epilepsy (26%). Additionally, health problems such as obesity (8%), diabetes type 1 (7%), auto-immune diseases (10%), as well as digestive disorders such as gastro-oesophageal reflux, inflammatory colitis (around 17% each), ulcer and intestinal inflammation (11% each) and schizophrenia (5%), were also observed but at lower frequencies.



**Figure 1.** Frequency of comorbidities.

### Study of risk factors

#### Statistical data

Almost 59% of fathers and 39% of mothers were aged 34 or older when their autistic child was born. 85% of parents of autistic children are not consanguineous, while 15% are related by blood. The O+, A+, and B+ categories had the largest rates among RH+ blood groups.

Mothers of autistic children experienced one or more episodes of fever during pregnancy in 23% of cases, with the majority of them experiencing febrile episodes during the first two trimesters. According to the

results obtained, 74% of mothers of autistic children reported experiencing stress during pregnancy. Data show that 77% of mothers of autistic children were not exposed to tobacco during pregnancy, while 23% had been. The majority of mothers (63%) gave birth naturally, while 37% had a cesarean section. Our study found that nearly half (41%) of all deliveries involve complications such as the use of forceps or vacuum extraction during delivery, as well as situations in which the baby's neck was wrapped around the umbilical cord, both of which may raise the risk of autism.

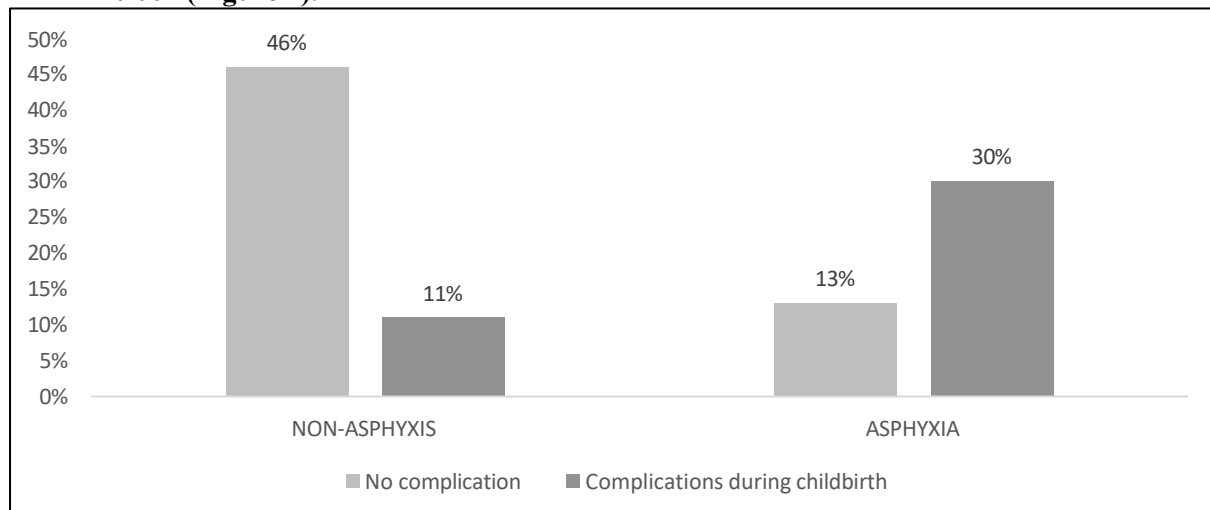
We have observed that 57% of ASD cases occur in the absence of birth asphyxia, whereas 43 % of children with autism have undergone birth asphyxia (**Table 2**).

**Table 2. The different risk factors**

Risk factors	Statistical data		
	Age (year)	Father	Mother
Parents' age at birth of sick child	22-33 years	26	58
	34-45 years	59	39
	46-57 years	15	3
Consanguinity of parents	Yes/No	Yes: 15%	No: 85%
Blood type	A <sup>+</sup> : 33%, A <sup>-</sup> : 2%	AB <sup>+</sup> : 4%, B <sup>+</sup> : 14%	O <sup>+</sup> : 45%, O <sup>-</sup> : 2%
Course of the pregnancy	Prenatal fever Yes: 23% No: 77%	Prenatal stress  Yes: 74% No: 26%	Tobacco exposure during pregnancy Yes: 23% No: 77%
	The birth canal	Natural: 63%	Cesarean: 37%
Perinatal complications	With : 41%	Without: 59%	
Asphyxia at birth	Yes 43%	No 57%	

### Childbirth complications and perinatal asphyxia

There is a significant correlation between complications during childbirth and perinatal asphyxia. The data indicate that perinatal asphyxia cases are linked to is associated with a higher incidence of complications compared to births without asphyxia. This association is statistically significant, with a P value of 0.001 (**Figure 2**).

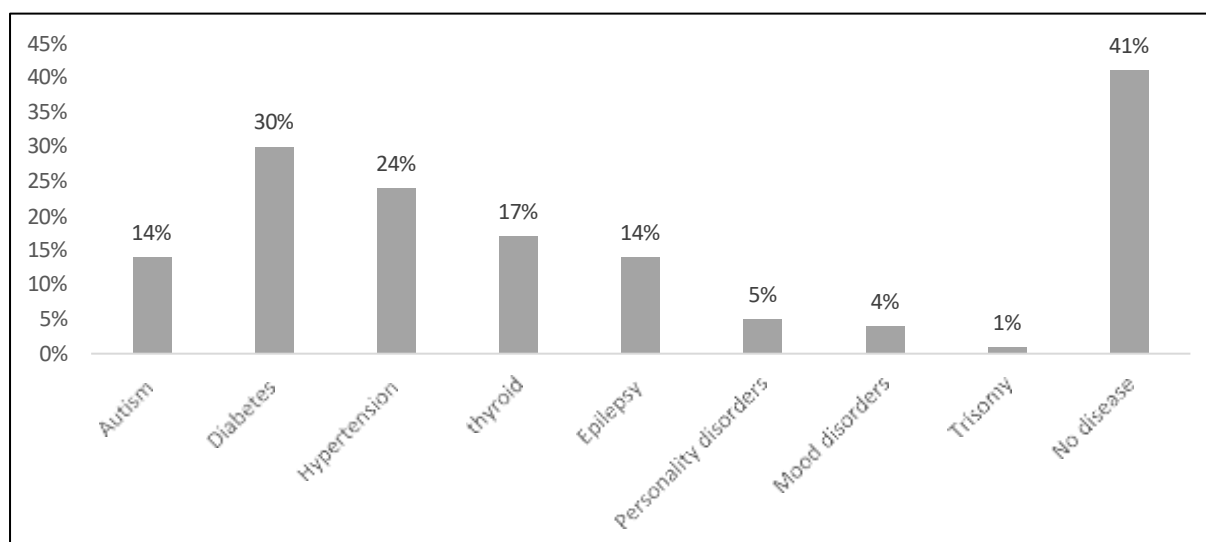


**Figure 2. The correlation between childbirth complications and perinatal asphyxia**

### Family history

According to the data, there are notable percentages of different medical disorders in the relatives of the patients. The highest rate of these findings was diabetes (30%), followed by hypertension (24%). Next Additionally, 14% of patients have autism and epilepsy, and 17% have a history of thyroid issues. 5% of cases are affected by personality disorders, 4% by mood disorders, and 1% by trisomy.

Our results suggest that there might be a potential association between a family history of autism spectrum disorder (ASD) and consanguinity. This correlation is statistically significant, with a P value of 0.001 (**Figure 3**).



**Figure 3. Distribution of patients according to family history.**

## DISCUSSION

Epidemiological studies consistently show a higher prevalence of ASD in boys than in girls, with a generally accepted ratio of four boys to one girl (8, 9). This bias in favor of boys can be attributed to several factors, including: prenatal exposure to high levels of testosterone, which could increase risk by affecting cerebral development in boys (10). The existence of a female protective effect against the development of ASD gives girls a higher tolerance threshold than boys for the expression of these disorders (11). Our results, in line with the study by Alvares et al. (12), show that younger children are more likely to develop this disorder. However, Banerjee and Adak (13) reported that older children were most susceptible to autism.

Most parents detect early signs of autism in their children by the age of two. The period between the ages of 12 and 24 months is critical in terms of a child's social interactions and the development of language skills. Parents thus become more perceptive of their children's behaviors, leading them to observe differences from typical development. Children of parents with a university education are more often diagnosed with ASD than those whose parents have less education (14). Twin studies have revealed that the concordance rate of autism spectrum disorder (ASD) is higher in monozygotic twins than in dizygotic twins. However, this concordance remains partial: even in monozygotic twins, who share an identical genetic background, one may have autism while the other does not (15,16). These observations highlight the combined influence of environmental and genetic factors in the onset of ASD.

Significant comorbidity with other conditions, including attention deficit, hyperactivity and temper tantrums, was observed in our study. A study conducted by Fucà et al. (17) found that a significant proportion of high-functioning individuals with autism also have psychiatric disorders, with anxiety and mood disorders predominating. They also reported that young people with several comorbidities often show more severe symptoms and reduced adaptive functioning. Attention deficit hyperactivity disorder, anxiety, depressive disorders, epilepsy, intellectual disability, sleep disorders, visual or hearing impairment, and gastrointestinal syndromes are frequently observed in persons with autism (18). Because of their correlation with worsening symptoms and decreased adaptive functioning, these comorbidities underscore the necessity of thorough diagnostic and treatment strategies.

Advanced parental age, especially that of the father, is associated with a higher likelihood of ASD. There are two main reasons for this. Firstly, the high rates of *de novo* mutations in the fathers' spermatozoa, which occur spontaneously due to the nature of spermatogenesis, involving a greater number of cell divisions (19). On the other hand, the chromosomal abnormalities and aneuploidies often found in oocytes contribute to congenital developmental abnormalities in children born to older mothers (20). This connection is supported by our findings, which emphasize the interaction of environmental and genetic factors in the development of ASD.

Fifteen percent (15%) of autistic children come from consanguineous marriages. This finding compares favorably with the Indian study by Mamidala et al (21), which found a consanguinity rate of 20%, and a meta-analysis led by Elhassan and Alshaban from Qatar University (22) which estimated the rate at 24% among ASD cases. Some studies have suggested an association between consanguinity and a higher

incidence of ASD. Research in populations with common cousin marriages has shown a higher prevalence of ASD. The theory is that consanguinity may expose individuals to genetic variations that, in combination with other factors, may contribute to the development of autism. This increases the risk of having an autistic child to 15%, compared to 1.5% in the general population (23).

The course of the pregnancy is an important factor in the good health of the children. A study by Hornig et al. (24) showed that prenatal fever, particularly when it occurs in the second trimester of pregnancy, is associated with an increased risk of autism spectrum disorders in children, with the risk increasing with the number of fever episodes. Chronic or intense maternal stress during pregnancy is a potential risk factor for the development of ASD in children. Several mechanisms may explain this association. On one hand, stress disrupts the functions of the placenta, increasing the uptake of the stress hormone cortisol by the foetus. Secondly, it can affect the mother's immune system, which can affect the foetus. Additionally, stress causes vasoconstriction, which reduces blood flow to the placenta. This reduces the supply of nutrients and oxygen to the baby (25). It has been suggested that there might be an association between tobacco exposure and autism. Studies conducted by Von et al. and Hertz-Picciotto et al. (26, 27) have provided further evidence to support this association. They have shown that there is a persistent link between smoking during pregnancy and an increased risk of autism in children.

Perinatal research has focused on the risks associated with complications of childbirth, such as preterm birth, cesarean section, fetal distress, postpartum haemorrhage, and prolonged labour. Similarly, studies on newborns have shown neonatal distress, including low birth weight, birth asphyxia (lack of oxygen), infections, epilepsy, neonatal complications and jaundice (28, 29). Several previous studies have also looked into the links between birth complications and the risk of children developing autism, citing the work of Gardener et al. (30), Langridge et al. (31) and Mahboub et al. (28). One hypothesis is that neonatal asphyxia could damage nerve cells and disrupt neuronal development, by reducing oxygen to the brain. These changes may then affect the brain circuits responsible for the cognitive, social and behaviour functions often associated with ASD (32).

Family history plays a significant role in the risk of developing autism spectrum disorders. Research has shown that genetic predisposition is an important factor in the development of autism. Dhanasekara et al. (33) identified diabetes and hypertension as common family histories in patients with ASD, while Magdalena et al. (34) reported a high prevalence of thyroid problems. Xie et al. (35) also revealed a 30% rate for epilepsy in the family history of autistic people. Yu et al. (36) highlighted the potential link between mood and personality disorders and the risk of ASD. Family studies further highlight the importance of genetic factors in ASD, showing strong family aggregation and an increased risk of recurrence in siblings of affected individuals (37).

## CONCLUSION

Autism is a major public health and societal challenge. The importance of in-depth research to better understand this neurodevelopmental disorder is underlined by its increasing incidence and profound impact on the daily lives of individuals, their families and the community. Studies on autism conducted in Algeria remain limited and do not allow for a full assessment of this problem. However, the results of this research have allowed the identification of some dominant factors likely to increase the risk.

Our findings reveal several key elements. The advanced age of the parents (> 34 years), particularly the fathers, at the time of the childbirth, appears to be an increased risk factor for autism. The sociocultural level of parents also seems to play a role, with more educated parents being more likely to report early concerns. Parental consanguinity in families with autistic children may be another risk factor that increases the rate of autism in the population.

Specific prenatal events, such as maternal fever in the second trimester, exposure to tobacco, stress and birth complications (forceps, asphyxia) also increase this risk. It should be mentioned that a family history of diabetes, hypertension and epilepsy was frequently observed in our patients, suggesting a significant genetic component, as well as a high prevalence of several comorbidities. People with a family history generally have an increased risk of developing the condition compared to those without such a history.

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