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**Risk Factors for Autism Spectrum Disorder: What We Already Know From Scientific Evidence (Vaccines are Not One of Them)**

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**Introduction**

Autism Spectrum Disorder (ASD) is [defined](https://www.nimh.nih.gov/health/topics/autism-spectrum-disorders-asd) by the National Institute of Mental Health as a neurological and developmental disorder that affects how people interact with others, communicate, learn, and behave. It is a form of neurodivergence that varies widely from person to person. It is not a condition that should be stigmatized; people with ASD are active and valued members of every part of life. Secretary of Health and Human Services (HHS) Robert F. Kennedy Jr., who as of this writing says he is preparing to announce “causes” of a supposed “autism epidemic,” has a long history of fraudulent claims about ASD, including his repeatedly-disproven theory that vaccines cause it.

Among other egregious and factually-incorrect statements, in April 2025, [he stated](https://www.pbs.org/newshour/politics/fact-checking-robert-f-kennedy-jr-s-statements-on-autism), “Most cases [of ASD] now are severe. Twenty-five percent of the kids who are diagnosed with autism are nonverbal, non-toilet-trained, and have other stereotypical features,” garnering immediate and well-deserved outrage from autistic individuals, their loved ones, and scientists, and highlighting his marked lack of knowledge and understanding of this condition.

On April 10, 2025, Kennedy said, “In September [we will know](https://abcnews.go.com/Health/rfk-jr-pledges-answer-autism-epidemic-september/story?id=120694914) what has caused the autism epidemic and we’ll be able to eliminate those exposures.” The reaction of the scientific community ranged from disbelief to naked contempt, and for good reason.

First, Kennedy has egregiously and repeatedly alleged that scientists haven’t studied the “root causes” of ASD, yet *he* would be able to provide all of the answers within 5 months. As of this writing, a cursory search of PubMed, a US government-run database of scientific studies, returned 32,933 results for a search of the phrase “causes of autism.” His promise thus revealed the depth of Kennedy’s misunderstanding of the scientific process. Someone may have explained the outlandishness of his claim, as a week later, he [walked back](https://www.reuters.com/business/healthcare-pharmaceuticals/nih-cms-partner-understand-autism-with-medicare-medicaid-data-2025-05-07/#:~:text=NIH%20and%20Centers%20for%20Medicare,autism%2C%20said%20in%20a%20statement.) his promise of providing all of the answers to all of the causes of autism by September 2025, and instead said he would be able to share “*some* of the answers.” He repeated this updated promise in late August.

Kennedy clearly decided long ago that vaccines in particular cause ASD, rejecting data that debunk this claim and energetically searching for anything that supports his preconceived notion – no matter how tenuous or far-fetched.

Defend Public Health is dedicated to providing accurate information about scientific research and healthcare to counter the misinformation and propaganda now being produced by Mr. Kennedy and others. In this report, we provide evidence-based information regarding why the rate of ASD diagnosis has increased over time in the United States, the known risk factors for the condition, and why scientists can say with confidence that based on the findings from decades of investigation, there is no credible evidence that vaccines are a cause or even a risk factor for the development of autism. This report is based on the rigorous research of the thousands of expert scientists who have, contrary to Kennedy’s assertions, studied ASD for decades.

**Why is the number of cases of Autism Spectrum Disorder (ASD) rising in the United States?**

The number of diagnosed cases of ASD has increased over time. The latest data show that [1 out of 31](https://www.cdc.gov/autism/data-research/index.html) children in the United States have been diagnosed with ASD; this is an increase from a decade ago, when the prevalence rate was estimated at about [1 in 59](https://www.cdc.gov/autism/data-research/autism-data-visualization-tool.html). To understand why this number has grown, remember that this is the number of cases being *diagnosed* and *reported,* rather than the number of cases. The key question then is: Does the increase in reported cases indicate an actual increase in cases, or simply an increase in the percentage of cases being diagnosed and reported?

The list of signs and symptoms that go into a diagnosis of any condition changes over time as more research is done and more information becomes available, and this has [happened with ASD](https://www.nature.com/articles/d41586-025-02636-1#:~:text=There%20are%20several%20reasons%20to,Classification%20of%20Diseases%20(ICD).). The criteria for diagnoses have become [broader over time](https://www.nature.com/articles/d41586-025-02636-1#:~:text=There%20are%20several%20reasons%20to,Classification%20of%20Diseases%20(ICD).) as understanding of this condition has grown. In fact, research has shown that as the number of diagnoses of ASD have increased, there has been a concomitant decrease in cases of the [more general category](https://onlinelibrary.wiley.com/doi/abs/10.1002/ajmg.b.32338) of intellectual disability. In addition, advocates, healthcare workers, scientists, and teachers want to ensure that [people diagnosed with ASD](https://publichealth.jhu.edu/2025/is-there-an-autism-epidemic#:~:text=There%20have%20been%20a%20few,subtle%20traits%20and%20symptoms%20better.) have access to healthcare and educational assistance, and this often requires documentation of the diagnosis, meaning that cases are being better documented and reported.

The broadening of diagnostic criteria for ASD, coupled with greater documentation needs for accessing treatment options, educational services, and insurance coverage, has led to increased diagnoses and reports of ASD. This does not mean that the number of people with ASD has increased over time. It means that we have gotten much better at identifying, diagnosing and reporting cases, so that people can have access to the treatments and services that they need. That is good news, not an “epidemic.”

**ASD is a complex condition and its definition has been refined over time as more information becomes available. As the criteria for diagnosing ASD becomes more inclusive, the number of diagnoses will increase, even if the actual number of people with ASD has stayed roughly the same. In the past, people with ASD may have gone undiagnosed or told they had a different condition, such as the more general category of intellectual disability, leading to less appropriate care. A requirement for insurance companies to cover treatments for ASD also increases the number of diagnoses, so that individuals can have access to the best healthcare options available to them.**

**What is known about the causes of ASD?**

No single cause of ASD has been identified to date, as is the case with a great many complex diseases and conditions. However, some risk factors have been identified and confirmed by extensive peer-reviewed research conducted by experts. Genetic background constitutes the primary risk factor for ASD by an overwhelming proportion, but genes are not a 100% guarantee of developing the condition. Environmental factors also contribute to risk, such as having older parents at conception, premature birth, low birthweight, Caesarean delivery, greater maternal body size or diabetes, exposure in the womb to anti-seizure medications such as valproic acid, air pollution, and possibly exposure to some pesticides. Each of these are covered in more detail below.

**Genetic Risk Factors**

[Family history](https://pmc.ncbi.nlm.nih.gov/articles/PMC7821228/) has long been known to be a risk factor for ASD, with having an affected parent or sibling conferring higher odds of a person developing the condition. Overall, heredity is thought to contribute to up to 90% the risk for ASD. Considerations of genetic contributors follow three main lines of research: 1) The identification of specific gene variants that may increase risk; 2) Twin studies that compare concordance of ASD diagnoses; and 3) Biological sex as a risk factor.

With regard to genetic variants, a [meta-analysis](https://pmc.ncbi.nlm.nih.gov/articles/PMC6454898/) comparing genetic data from more than 18,381 people with ASD and 27,969 controls revealed five loci that were significantly associated with ASD. Many of these genes are involved in the [function of neurons or in brain development](https://pmc.ncbi.nlm.nih.gov/articles/PMC6454898/). Others are related to biological processes that identify and eliminate [damaged or misfolded proteins](https://www.sciencedirect.com/science/article/pii/S2667032124000271), which may result in mitochondrial dysfunction or degeneration of neurons. A great deal more research remains to be done on which genetic variants may impact risk for ASD and their functional effects. Identification of these pathways allows for the development of potential treatments.

Additional information on genetic contributions to ASD comes from [twin studies](https://pubmed.ncbi.nlm.nih.gov/26709141/)–those that compare concordance of ASD diagnoses between identical twins and fraternal twins or other sibling pairs. Because identical twins share the same genetic code, examining how often one twin has ASD if the other does can provide powerful evidence of the degree to which genes impact autism development. A[meta-analysis](https://pubmed.ncbi.nlm.nih.gov/26709141/) conducted in 2015 demonstrated that if one member of an identical twin pair has ASD, the other has a likelihood of up to 98% of having it, too. For fraternal twins, this figure was about 53%. The researchers concluded that genes contribute to [64%-91%](https://acamh.onlinelibrary.wiley.com/doi/pdf/10.1111/jcpp.12499) of the risk of ASD overall. Genetics clearly play a major role, but don’t account for 100% of the risk, which means that other factors may increase the odds of developing autism, either independently or through gene-environment interactions.

Finally, [male sex](https://pmc.ncbi.nlm.nih.gov/articles/PMC4164392/) has long been known to be a risk factor for the development of ASD. The condition is diagnosed at a [ratio](https://pmc.ncbi.nlm.nih.gov/articles/PMC4164392/) of about 4:1 in favor of males. The reasons for this are unclear, but research suggests that [sex hormones](https://pmc.ncbi.nlm.nih.gov/articles/PMC4164392/) such as testosterone, differences in [gene expression](https://pmc.ncbi.nlm.nih.gov/articles/PMC4164392/) in the brain between males and females, or the [presence of the Y chromosome](https://www.nature.com/articles/s41467-024-53211-7) itself, may influence risk.

**Environmental Risk Factors:**

In the context of scientific research, risk factors classified as environmental refer to anything that is not genetic but may influence health. Because it is known that genetic contributors cannot be the sole cause of ASD, a great deal of research has been done to examine exposures that may affect ASD risk either independently or through interactions with genetic variants. Gene-environment interactions are [implicated](https://www.nature.com/articles/s41435-022-00192-6) in a wide variety of diseases and conditions through numerous pathways.

Having a specific gene associated with risk for a condition does not render every individual susceptible to that condition, nor does every environmental exposure affect every individual in the same way. This is why studying gene-environmental interactions is both crucial and extremely complex.

***Viral or bacterial infections***

A greater understanding of the relationship between [infectious and chronic disease](https://www.ncbi.nlm.nih.gov/books/NBK83680/) has emerged over the past few decades, with associations shown for some types of cancer, multiple sclerosis, Type 1 diabetes, and, as recently ascertained, [LongCOVID](https://www.cdc.gov/long-covid/about/index.html).  So it makes sense to explore the contribution of viral or bacterial infections, either [while in the womb or after birth](https://pmc.ncbi.nlm.nih.gov/articles/PMC7197040/), on the development of ASD.

One of the [earliest infections](https://www.mdpi.com/1660-4601/16/19/3543) linked to the development of ASD was fetal exposure to [maternal rubella](https://pubmed.ncbi.nlm.nih.gov/31546693/) (German measles) during pregnancy. This observation helped researchers consider whether other infections may also have a role in ASD. A study of more than [550,000 children](https://jneurodevdisorders.biomedcentral.com/articles/10.1186/s11689-022-09422-4#MOESM2) in Sweden showed that a viral or bacterial infection during childhood significantly increased the risk of developing ASD afterward, and this relationship was strongest for infections of the central nervous system like meningitis or encephalitis. Another [study](https://www.sciencedirect.com/science/article/pii/S1750946721001148#:~:text=Highlights,infectious%20gastrointestinal%20diseases%20in%20children.) of 48,762 children with ASD and 243,810 controls revealed that several gastrointestinal infections during early childhood, including salmonella, E.coli, and viral gastroenteritis, were linked to a later diagnosis of ASD.

As was observed with maternal rubella infection, childhood infections are not the only ones that are related to a higher risk for ASD. Exposure to maternal infection while in the womb may also confer risk. A [study](https://www.sciencedirect.com/science/article/abs/pii/S0889159114004528) of 2,371,403 individuals showed that the children of women who were hospitalized with an infection during pregnancy were 30% more likely to develop ASD than those of mothers who were not.

***Premature birth or low birth weight***

Premature birth or low birth weight are associated with a [number](https://www.mayoclinic.org/diseases-conditions/premature-birth/symptoms-causes/syc-20376730#:~:text=Cerebral%20palsy.,harm%20vision%20and%20cause%20blindness.) of long-term health challenges, including cerebral palsy, learning delays, and vision, hearing, and mental health sequelae, leading to the hypothesis that they may also be related to ASD. A large [study in Sweden](https://publications.aap.org/pediatrics/article/148/3/e2020032300/181145/Preterm-or-Early-Term-Birth-and-Risk-of-Autism?autologincheck=redirected) examined the birth and follow up health records of every child born from 1973-2013. Records from a total of 4,061,795 children who survived at least one year after birth were analyzed. The results showed that preterm birth was significantly associated with higher risk for a diagnosis of ASD, and the earlier an infant was born, the higher the risk of ASD. A [study](https://www.sciencedirect.com/science/article/abs/pii/S0891422213002035?via%3Dihub) conducted in Taiwan estimated that the risk of ASD was about 2-4 times higher for preterm births than for full term.

With regard to low birth weight, [research done](https://www.nature.com/articles/s41598-022-06094-x) in Korea that included data for 2,143,652 children showed that the odds of a child being diagnosed with ASD were significantly increased with decreasing birth weight. A [study](https://onlinelibrary.wiley.com/doi/10.1002/aur.2260) in Israel of all births from 2000-2012 revealed similar findings.

***Birth by Caesarian section***

Caesarian deliveries in the United States have [generally increased](https://www.ajog.org/article/S0002-9378%2818%2930293-X/fulltext) over time, with about [1 in 3 babies](https://www.cdc.gov/nchs/fastats/delivery.htm#:~:text=Number%20of%20vaginal%20deliveries:%202%2C431%2C500,all%20deliveries%20by%20Cesarean:%2032.3%25) being delivered via this method in 2023. Combined with increasing prevalence of ASD, scientists considered whether method of birth and ASD might be related.

[Research done](https://pmc.ncbi.nlm.nih.gov/articles/PMC5837358/) using records from 4,987,390 births in Norway, Sweden, Denmark, Finland, and Western Australia showed a statistically significant but modest increase in the odds of ASD among babies born via a planned Caesarean section compared to a vaginal birth. Another [study](https://www.sciencedirect.com/science/article/abs/pii/S0749379722001088) conducted in California included records from 1,488,425 children who were born between 1992 and 2012. All of the pregnancies were considered to be low-risk, and researchers compared induced vaginal births and births by Caesarian section to non-induced vaginal delivery. They found that babies born after induction were 7% more likely to later be diagnosed with ASD, those born via Caesarian section were 26% more likely, and those who were delivered after induction and Caesarian section combined were 31% more likely to eventually be diagnosed.

***Maternal obesity or gestational diabetes***

Maternal body size has been studied in relation to the development of ASD in offspring. In a [meta-analysis](https://www.sciencedirect.com/science/article/pii/S0165178124004347?via%3Dihub) of data from 3,680,937 mothers and their children from throughout the globe, researchers found an increased risk for a diagnosis of ASD among mothers with a body size classified as obese. Similar results were supported in a separate [meta-analysis](https://www.nature.com/articles/srep34248) which showed an increased risk for ASD with both maternal overweight and obesity. However, there is complexity in these relationships given that maternal diabetes, particularly gestational diabetes, has also been identified as a risk factor for ASD.

A [study](https://pmc.ncbi.nlm.nih.gov/articles/PMC4732357/) conducted in Boston found that, combined with maternal obesity, Type 2 diabetes before pregnancy was associated with higher odds of having a child diagnosed with ASD. However, research from a [larger](https://pubmed.ncbi.nlm.nih.gov/25871668/#:~:text=Results:%20During%20follow%2Dup%2C,independently%20associated%20with%20ASD%20risk.) study conducted in California using data from 322, 323 children born between 1995 and 2009 showed that pre-pregnancy Type 2 diabetes was not related to risk for ASD in offspring, though gestational diabetes diagnosed at 26 weeks of pregnancy or before was.

***Parental age***

Advanced parental age is often defined as having an infant at age 40 or above for both men and women. It has been associated with a higher risk for several different adverse health outcomes, including [neurodevelopmental and psychiatric](https://pmc.ncbi.nlm.nih.gov/articles/PMC10692762/#:~:text=*%20Mothers%20(stratification):%20%E2%89%A540.%20*%20Fathers%20(stratification):%20%E2%89%A545.) disorders, and has also been shown to be associated with the development of ASD.

A [study](https://www.nature.com/articles/mp201570#:~:text=There%20was%20a%20joint%20effect,well%20as%20disparately%20aged%20parents.) conducted with data from children from five countries, Denmark, Israel, Norway, Sweden and Western Australia, included information on more than 5,700,000 children. A comparison of mothers who gave birth between 40 and 49 years of age to those aged 20-29 found an increased risk for ASD in the older mothers’ children. Children born to mothers younger than 20 years old also had a higher risk of ASD. For fathers aged 50 years and older, similarly greater odds were reported, though not for younger fathers. A [meta-analysis](https://bmcpsychology.biomedcentral.com/articles/10.1186/s40359-024-02184-9) also revealed that both maternal and paternal age was statistically significantly associated with a higher risk for a child born with ASD.

***Exposure to air pollution and environmental toxicants***

The evidence that exposure to air pollution may be related to the risk of ASD has been growing over the past decade. When examining particulate matter in the air and ASD diagnoses among [40,245 children](https://www.nature.com/articles/s41598-023-30877-5) born in Sweden between 2000 to 2009, researchers reported increasing risk of later diagnoses of ASD with increasing exposure to air pollution.

[Another study](https://pubmed.ncbi.nlm.nih.gov/25286049/) conducted with records from more than 14,000 births in California and North Carolina revealed a higher risk of ASD among those exposed to higher levels of air pollution from traffic specifically, and this relationship was particularly strong for third-trimester exposure. [Research](https://ehp.niehs.nih.gov/doi/10.1289/ehp.1408133?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed) performed in a cohort of 116,430 female nurses in the United States supported these results, demonstrating that higher exposure to particulate matter during pregnancy was significantly associated with a higher risk for a child diagnosed with ASD.

Research in the area of environmental toxicants is incredibly complex due to challenges with assessing exposures and timing of exposures. A [meta-analysis](https://www.nature.com/articles/tp20144) that reviewed studies of pesticides, phthalates, polychlorinated biphenyls (PCBs), solvents, toxic waste sites, air pollutants and heavy metals found that the evidence was strongest for a possible link with air pollutants and pesticides. In particular, prenatal exposure to organophosphate pesticides and polychlorinated biphenyls conferred a higher risk for ASD.

***Medication use***

Theuse of certain medications during pregnancy has been shown to increase the risk of having a child who is eventually diagnosed with ASD. Several [anti-seizure medications](https://www.sciencedirect.com/science/article/abs/pii/S1059131125001116), particularly valproic acid, are related to a higher risk of ASD. [Antidepressants](https://jamanetwork.com/journals/jamapediatrics/fullarticle/2476187), particularly selective serotonin uptake inhibitors (SSRI) have also been investigated, with associations to ASD being strongest for maternal use during the [third trimester](https://bmcmedicine.biomedcentral.com/articles/10.1186/s12916-024-03617-3#:~:text=Several%20studies%20have%20established%20an,in%20ASD%20development%20%5B8%5D.). However, studies have shown [conflicting results](https://pmc.ncbi.nlm.nih.gov/articles/PMC5870683/#:~:text=Pooled%20OR%20was%201.51%20(1.15,use%20during%20pregnancy%20and%20ASD.), and findings may be particularly influenced by study design. Therefore, caution around any conclusive statements related to maternal antidepressant use and ASD is warranted.  Numerous other medications, including [acetaminophen](https://jamanetwork.com/journals/jama/fullarticle/2817406), have been investigated and found not to be related to the development of ASD.

The above are the known risk factors that have consistently been shown to be related to the development of ASD. Now we must turn to addressing the false information suggesting that vaccines are a cause of ASD. Unfortunately, misinformation and disinformation inaccurately blaming vaccines for higher rates of ASD diagnosis continue to spread online. Both before and since his appointment as HHS Secretary, Robert F. Kennedy Jr. has been a main originator and amplifier of this misinformation, even though research has repeatedly proven him wrong.

**Why are scientists and healthcare providers confident that vaccines do not cause ASD?**

No single vaccine has been accused of being a cause of ASD more often than the MMR (Measles, Mumps, Rubella) vaccine, but a great deal of scientific evidence makes it clear that this is a false claim. In short, if all vaccines, or even just MMR, were ended today, ASD would continue to be diagnosed just as often. However, this fact hasn’t stopped unscrupulous people from spreading misinformation online, and often, they target specific vaccine ingredients.

One ingredient that was formerly in some childhood vaccines, thimerosal, has often been named as the culprit for causing ASD. [Research](https://pubmed.ncbi.nlm.nih.gov/12949291/) done in Denmark included data for every child born between 1971 and 2000, before and after thimerosal was included in vaccines. The results showed that not only did ASD diagnoses not increase over time during the period that thimerosal was used, but the rate of ASD did not drop after thimerosal was removed. It must be noted that [thimerosal was removed](https://www.cdc.gov/vaccine-safety/about/thimerosal.html) from all childhood vaccines in the United States in 2001 as well, yet diagnoses of ASD have continued to rise, utterly disproving the claim that thimerosal was ever the cause of ASD.

Another vaccine ingredient that has been targeted by misinformation is aluminum, tiny amounts of which are sometimes included in vaccines to help the body mount a more robust immune response. [Research](https://www.acpjournals.org/doi/10.7326/ANNALS-25-00997) published in 2025 that was done in Denmark with data from more than a million children born between 1997 and 2020 showed that none of the 50 disorders studied, including ASD, showed any relationship to the amount of aluminum exposure from vaccines. Mr. Kennedy [demanded](https://www.nature.com/articles/d41586-025-02682-9) that this paper be retracted, based not on science but because he doesn’t like the results. *Annals of Internal Medicin*e, a very prestigious medical journal, correctly refused to do so.

Large studies have also investigated whether rates of ASD are higher among those who are vaccinated compared to those who are unvaccinated, and have found that they are not. One of the [earliest](https://www.nejm.org/doi/full/10.1056/NEJMoa021134) large studies included data from every child born in Denmark between 1991 and 1998, yielding a total of 537,303 participants. No difference in the rate of ASD diagnosis was observed between children who had been vaccinated and  those who had not.

Another [study](https://pubmed.ncbi.nlm.nih.gov/30831578/) done in Denmark included data from every single baby born from 1999-2010. Researchers followed more than 650,000 babies over time to compare the rate of ASD diagnoses between those who were vaccinated and those who were not. Of these babies, about 31,000 were not vaccinated with MMR or other vaccines. The results showed that the rate of ASD diagnosis was higher (17%) among children who were not vaccinated compared to those who were.

[Research](https://jamanetwork.com/journals/jama/fullarticle/2275444) done in the United States using health insurance information looked at data from more than 95,000 children who had an older sibling who had been diagnosed with ASD, and who therefore had a higher risk for the development of ASD than the general population. The research found no relationship between MMR vaccination and the risk of ASD.

**In conclusion, the question of whether vaccines, especially MMR, actually cause ASD has been asked, answered, and resolved to the satisfaction of scientists and healthcare workers. *Vaccines do not cause autism.***

Unfortunately, the subject has now become more of a political whirlwind than a serious question of fact. With powerful forces enjoying vast funding and political muscle to promote utterly false theories about the causes of ASD, we can expect that papers using dishonest methods will likely be produced that claim to “prove” that vaccines cause ASD. Some of these may well come from Kennedy’s HHS, which seems intent on promoting the fictional idea of an autism “epidemic,” but wherever they come from, their methodology must be scrutinized carefully. We have a great deal of evidence about the causes of autism, including a large body of evidence that vaccines are not even a minor factor. Sadly, we seem to have reached the point where statements from the U.S. Government on this subject cannot be trusted.