Autism

An Evidence Brief

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Australian Academy of Health & Medical Sciences

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Autism

An Evidence Brief

This evidence brief examines childhood autism, including claims around paracetamol and vaccination. It explains the science that demonstrates that there is no evidence for a causal link between autism and paracetamol, or autism and vaccines.

Autism

Autism Spectrum Disorder (often referred to as autism or ASD)[i] is the collective diagnostic term for multiple congenital neurodevelopmental conditions characterised by persistent social interaction and communication difficulties and restricted behavioural patterns. It affects how the brain develops and processes information, shaping how autistic people see, understand, and respond to the world around them.

Australia's National Guideline for the Assessment and Diagnosis of Autism provides consensus-based recommendations for autism diagnosis and evaluation in Australia. The recommendations follow the 11th edition of the International Classification of Diseases (ICD-11) and the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR, or DSM-5 for short).[1] Both the ICD and DSM are diagnostic manuals for mental health: the DSM is published by the American Psychiatric Association and describes mental disorders in detail, while the ICD is published by the World Health Organization (WHO) and is a broader international standard for health conditions.

The DSM-5, released in May 2013, introduced autism spectrum disorder as a single diagnosis by replacing the previous categories of autistic disorder, Asperger's disorder, and pervasive developmental disorder-not otherwise specified (PDD-NOS). That same year, the Australian government launched the National Disability Insurance Scheme (NDIS), which provides individualised funding to people with permanent disabilities who need support services to enhance their independence and social, educational, and economic involvement.[2]

[i] Autism spectrum disorder, or ASD, is the clinical, diagnostic term used by health professionals in diagnostic manuals. "Autism" is the widely used term to describe the same condition. Within this explainer, ASD and autism are used interchangeably.

Causes of autism

There is no single cause of autism, it comes from a complex interplay between genes and environmental factors that can influence development, usually *in utero*.

The genetic picture

Family history is one of the strongest predictors of autism.[3] Researchers have identified hundreds of genes linked to ASD and the genetic make-up varies from person to person. About 10–20% of cases are thought to be driven by rare genetic variants, many of which are new mutations that arise in sperm or egg cells. In many cases, autism is linked to combinations of common variants inherited from parents, each exerting a small effect but adding up when combined. Adding to the complexity, mutations linked to higher autism risk are also found in people without autism.[4] Further, some genes only exert adverse effects in certain environmental contexts.

Environmental influences

Environmental factors also play a role and the influence they have is most often exerted before birth and may occur in interaction with genetic factors. Older parental age at conception is linked to higher risk factors, which may be explained in part by the accumulation of mutations in sperm or egg cells with age.[5]

Research shows possible weak associations between autism and a whole range of exposures during pregnancy, all of which are likely to be very small and require further investigation to establish whether they play any role and to look at combined effects. This includes maternal conditions such as gestational diabetes, obesity, hypertension and preeclampsia; infections, folic-acid deficiency and exposure to some types of air pollution during pregnancy; and the use of some medications during pregnancy.[4,5,6]

Children born by caesarean section or prematurely, and those with neonatal neurological issues, respiratory problems or atypical developmental patterns in the first six months of life have also been shown to have increased risk.[5] Male sex is consistently associated with higher prevalence.[5,7]

At this stage, research shows possible weak associations with these exposures, but it has not established clear evidence that these associations represent significant risk factors for autism. Findings show inconsistent patterns, are difficult to replicate, and only demonstrate *associations* between variables – not *causal* relationships.

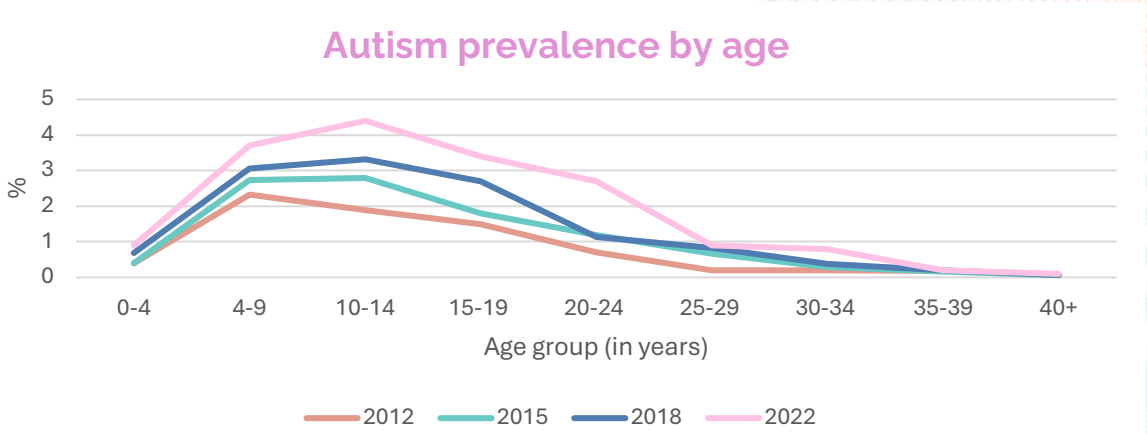
Beyond genes and environment

Emerging research indicates that biological systems such as the gut–brain axis and metabolic markers may also be involved, pointing to mechanisms that could contribute to autism and explain why it presents differently across individuals. However, this research is very early. Large research studies are exploring how autism develops across the lifespan, studying biological markers, testing medicines to help with social difficulties and moving toward more personalised approaches that centre on the experiences of individuals and how best to support them.

Autism trends in Australia

In 2022, there were 290,900 individuals diagnosed with autism in Australia (1.1% of the population). This was a 41.8% increase from 2018, when there were 205,200 (0.8%). Autism diagnoses were higher in males (1.6% of the population) than females (0.7%). Almost three quarters (73.0%) of autistic people had a profound or severe disability.[8]

Diagnosed cases of autism vary by age, with a peak in the 10-14 year old age group and a decline beginning in the late-teen years. For all age groups, the prevalence has generally increased over time.[8]



Source: Australian Bureau of Statistics [8]

Factors linked to the rising prevalence of autism

More accurate modelling

The Global Burden of Disease (GBD) Study in 2021 found globally there are 788.3 cases of autism per 100,000 people.[9] This was a substantial increase compared to the 2019 GBD study, which reported 369.4 per 100,000 people, and this rise was seen especially in high-income nations.[9] This is explained by a change in the study's methodology, including better methods for sourcing data on autism prevalence and improved assessment techniques, delivering more accurate data.[9]

Diagnostic criteria

Changes in diagnostic frameworks also contributed. An Australian study analysed data from more than 32,000 children who received autism-specific funding under the Helping Children with Autism (HCWA) scheme between 2010 and 2015.[10] The introduction of the DSM-5 in 2013 replaced narrower categories such as Asperger's disorder and pervasive developmental disorder-not otherwise specified (PDD-NOS) with a single ASD diagnosis, which initially slowed recorded incidence in Australia, with diagnoses stabilising at around 35–36 per 10,000 children.[10] However, DSM-5 also broadened the diagnostic criteria by modifying the age-of-onset requirement, reducing language severity thresholds, and adding sensory interests, which contributed to more diagnoses of older children and recognition of milder cases.[11] These effects became more visible

after 2015, when the rollout of the NDIS drove a renewed and sharper increase in recorded prevalence. [12,13,14]

Awareness, surveillance, and recognition of milder cases

Beyond systems and diagnostic criteria, changing patterns of awareness have shaped prevalence. Increased awareness among families, together with new surveillance programs, helped in noticing the developmental concerns earlier, with paediatricians and child psychiatrists diagnosing milder cases that might previously have gone unrecognised.[11]

Policy drivers

In the Australian context, increases in autism prevalence have been found to be associated with system and policy reforms, and service-driven diagnostic shifts, with evidence showing clear impacts of the NDIS rollout, lowered diagnostic thresholds, and changes in assessment practices.

The NDIS was introduced in 2013 and Australia saw an almost threefold increase in autism prevalence between 2009 and 2018, with 30 cases per 10,000 people (0.3%) in 2009 and 83 per 10,000 people (0.8%) in 2018.[12] The NDIS provided a new mechanism of support for individuals with autism, resulting in a driver for individuals and families to seek a diagnosis. Autism and developmental delay together account for almost half of NDIS participants (45%), as of 2023.[12]

A more recent study estimated that the rollout of the NDIS was directly responsible for a 32% increase in autism prevalence, and that the NDIS accounts for nearly half (47%) of new diagnoses since the introduction of the scheme.[13] Australia's autism prevalence has risen faster than in comparable countries, with the NDIS contributing an additional 0.77% of child diagnoses by 2021, driven by broader criteria, diagnostic switching, greater awareness, and policy incentives.[13]

This trend is also seen at the state level, for instance in Western Australia, one study showed an increase in autism prevalence in from 5.1 per 1,000 (0.5%) in 2010 to 20.7 per 1,000 (2.1%) in 2020.[14] This rise was attributed to the fact that families needed a diagnosis to access support, which drove more assessments and formal diagnoses. At the same time, diagnostic practices shifted away from multidisciplinary panels to allow single clinicians to confirm autism, making a diagnosis more accessible.[14] However, we cannot exclude a role also for modern environmental drivers as well as change in diagnosis.

Age and sex patterns

The rise in prevalence has been biggest in the 5–12 years age group, in both males and females.[11] The most frequent age of diagnosis (mode) for both males and females was 5 years from 2012/2013 through 2014/2015 and decreased to 4 years in 2015/2016.[11] The DSM-5 introduced several changes, including changes to the age-of-onset requirement, which has contributed to increases in newly diagnosed older children.[11] Under the previous criteria, in DSM-IV, symptoms had to be present before age 3, but DSM-5 broadened this to the early developmental period, enabling diagnosis in children whose difficulties became apparent later in childhood.[11]

Paracetamol

(Panadol/Acetaminophen/Tylenol)

What is paracetamol?

Paracetamol (also known as acetaminophen or APAP) is one of the most commonly used medicines worldwide for reducing fever and relieving mild-to-moderate pain, including headaches, musculoskeletal pain, and pain associated with viral illnesses. It is widely available over the counter.

Paracetamol use by pregnant women

In pregnancy, clinicians recommend paracetamol ahead of many alternatives because of its established safety profile and efficacy, when taken as directed.[15] Regulatory authorities, including the Australian Therapeutic Goods Administration, US Food and Drug Administration and the European Medicines Agency, classify it as posing minimal risk in pregnancy when taken at the lowest effective dose for the shortest necessary time.[15]

Alternative pain medicines such as non-steroidal anti-inflammatory drugs (NSAIDs) – like ibuprofen/Nurofen - or opioids carry risks in pregnancy and are therefore not usually recommended.

Does paracetamol use during pregnancy cause autism?

There is no causal evidence that paracetamol causes autism. Large, high-quality population studies do not find a causal relationship between paracetamol use and autism.

As noted above, some research studies show possible weak associations between some environmental exposures and autism, but research has not established clear evidence that these associations represent significant risk factors for autism. *Associations* between variables do not necessarily mean *causal* relationships.

For instance, a nationwide Swedish cohort of 2.48 million children showed a weak association between autism and paracetamol use during pregnancy – however there are many factors that could lead to such a correlation, known as confounding variables. To reduce the number of confounding variables, studies can look at siblings – who will be exposed to more of the same risks than the rest of the population. In this study, there was no difference in the risk of developing autism between siblings who were exposed to paracetamol during pregnancy and those who were not.[15]

A nationwide Japanese birth cohort of more than 217,000 children born between 2005 and 2022, showed similar results. This study also showed a weak association between autism and paracetamol exposure during pregnancy, but further analysis (e.g. sibling comparisons) by the authors suggested this could be explained by confounding factors.

It is important to note that fevers in pregnant women carry known risks, especially in early pregnancy, when high body temperatures can increase the risk of birth defects and complications, especially if they are not treated. Research that shows an association between autism and paracetamol often also notes a lack of definite evidence for a causal relationship and highlights the importance of using paracetamol to manage fevers because of the known risks.[16]

Vaccination

What is vaccination?

Vaccination involves introducing an inactivated component or weakened form of an infectious pathogen (a vaccine) to an individual so that if they come across it, they will be better protected against the infectious disease. Vaccines prevent people from contracting an infectious disease or reduce the severity of it. They also stop people from experiencing potential complications that can result from a disease. Someone has been 'immunised' once they develop immunity after receiving a vaccine.

In Australia, the National Immunisation Program (NIP) sets out a schedule for the vaccinations recommended to all children to protect them from dangerous infectious diseases.[17] For instance under the NIP, children receive one does of the measles, mumps and rubella (MMR) vaccine at 12 months and a second dose at 18 months. After this, individuals are considered protected for life.

Why is vaccination important?

Vaccination is the most effective method we have to prevent infectious diseases. The WHO estimates that immunisation prevents 3.5 to 5 million deaths a year worldwide.[18] The Australian Institute of Health and Welfare (AIHW) analysed the impacts of vaccination in Australia and found that the rate of vaccine preventable disease burden fell by 31% between 2005 and 2015.[19]

There are some individuals who cannot be vaccinated – for instance, people who are significantly immunocompromised should not receive live vaccines and therefore may not be protected. Even where populations are vaccinated, infectious diseases can still spread. The whole population is only protected if enough of the people in it are vaccinated – this is known as herd immunity. However, for this protection to exist, population vaccination levels need to be very high – usually around 95%. Diseases that are more infectious require a higher proportion of the population to be vaccinated for everyone to be protected.

In the case of the MMR vaccine, for example, all three of these diseases are very contagious, meaning they are easily spread from person to person, through coughing and sneezing. All three diseases can be spread before symptoms appear or by individuals who are infected but never have symptoms. One third of people infected with mumps and half of those infected with rubella will not show any symptoms, but in both cases they can still spread the disease to others.[20]

Due to vaccination, measles and rubella no longer spread from person to person within Australia (most cases in Australia are caught overseas, with measles outbreaks now becoming more common globally), and mumps is now rare in Australia.[20, 21, 22] Because these diseases are so infectious, it is crucial that enough of the population is vaccinated to protect individuals and to avoid individual cases causing outbreaks.

The consequences of disease outbreaks can be very serious, for example, Rubella is the leading vaccine-preventable cause of birth defects globally (congenital rubella syndrome or CRS) and children with CRS can suffer lifelong impacts, including hearing loss, eye and heart defects, and disability.[23]

The AIHW estimates that: [22]

- About 1 in 20 children with measles develops pneumonia, which is the most common cause of death from measles in young children.
- About 1 in 1,000 children with measles develops encephalitis, swelling of the brain that can lead to deafness and intellectual disability.

Does vaccination cause autism?

Multiple studies have shown that there is no link between receiving vaccines and the development of autism, and no link between any vaccine ingredients and autism.

A Cochrane Review analysed 138 studies covering more than 23 million children and found that MMR and MMRV vaccines (the latter also protects against varicella, or chickenpox) are highly effective, for example preventing measles in 96% of children after two doses and mumps in 86% of children after two doses. The review found no credible evidence linking MMR or MMRV to autism or other serious conditions.[24]

These pooled conclusions are reinforced by large individual studies. One study looked at all the children born in Denmark between January 1991 and December 1998, 537,303 children in total. Nearly 100,000 of them were unvaccinated. The data showed no difference in autism rates between vaccinated and unvaccinated children.[25] Another Danish cohort followed 657,461 children born between 1999 and 2010 and again found that MMR vaccination did not increase autism risk – there was no difference in the rates of autism between vaccinated and unvaccinated children.[26] This study also looked at sibling history of autism and autism risk factors to children in the cohort, and found that even in children who were genetically susceptible to autism, the vaccine did not increase the likelihood of autism.

Another meta-analysis pooled data from more than 1.25 million children across the US, UK, Poland, Japan, and Denmark. It also found no relationship between vaccination and autism or MMR vaccination and autism. It also looked at some of the components that are sometimes included in these vaccines, specifically thimerosal which contains ethylmercury, and again found no link with autism. The evidence is consistent across settings, study designs, and decades.[27]

More recently, a Danish study of 1.22 million children (1997–2018) examined cumulative exposure to aluminium-containing vaccines. It found no increased risk of autoimmune, allergic, or neurodevelopmental disorders, including autism and ADHD, with results stable across extended follow-up to age 8.[28]

Together, the weight of evidence from systematic reviews, meta-analyses, and national registries converges on the same strong conclusion: vaccination, including with MMR or MMRV, is not associated with autism. While research continues into the complex genetic, biological, and environmental influences on autism, there is no evidence to date that vaccines cause autism and this issue has been intensively studied.

Vaccination uptake among autistic children and their siblings

Australian research shows that autistic children are less likely to be fully vaccinated than their peers. Families described barriers such as sensory overload in clinics, anxiety around procedures, and service-level obstacles. Concerns around vaccination and autism were raised by caregivers, but lower coverage was explained more by sensory, behavioural, and structural challenges than by vaccination concerns.[29]

Siblings of children with autism are also less likely to be fully vaccinated. A comparative study reported a significant difference in immunisation status between siblings: in younger siblings of children with autism, one or more immunisations were delayed in 48% of them and were declined in 12%; whereas for the older child with autism, immunisation had been delayed for 16% of them and declined for only one child.[30] Parents who already have one child with autism may delay or decline vaccines for subsequent children, placing them at increased risk of preventable infectious diseases.[30] Although the size of this study was only small, it is worth noting that there was no difference in the rates of autism diagnosis between immunised and non-immunised younger siblings.

Why do people think that vaccination causes autism?

Timing coincidence

Autism characteristics typically start to appear before the age of 2-3 years old but may only become evident later when developmental and social demands increase. It can sometimes be diagnosed as early as 18 months of age, with reliable diagnosis possible by 2 years old.[31] However, many children receive a definitive diagnosis later, with average age around 4 to 5 years, but diagnosis also occurs in late childhood or adulthood.[32] Autism frequently co-occurs with other conditions, such as language, learning, or other health difficulties.

Signs of a developmental delay, like the delays seen with autism, typically start to be seen around the time a child should start to speak and interact more fully with people around them. This is around the same age at which childhood vaccines are given, especially the MMR vaccine. The overlap in timing could therefore appear to be connected – that the vaccines cause autism – however, large population-based studies show that it is not a causal relationship, it is a coincidence of timing.

Debunked research

The vaccine-autism myth gained traction after a fraudulent 1998 study by Andrew Wakefield claimed a link between the MMR vaccine and autism. This small, flawed study (involving only 12 children) was later exposed for unethical processes, falsified data and undisclosed conflicts of interest, and it was fully retracted by the journal that published it. Despite its withdrawal, the claims made were amplified by media and anti-vaccine activists, seeding lasting fears that are still widely shared today. Repeated large-scale studies undertaken since this fraudulent research have shown no connection between vaccines and autism, but the misinformation has already taken hold.

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