

# Autism Spectrum Disorder and the Environment

Research shows that both genetics and environmental factors likely play a role in autism spectrum disorder (ASD). The National Institute of Environmental Health Sciences (NIEHS) supports research to discover how the environment may influence ASD.

## What is autism spectrum disorder?

Autism spectrum disorder is a developmental brain disorder that generally appears in the first two years of life and affects communication and behavior. The term spectrum refers to the wide range of symptoms, skills, and levels of impairment that may challenge those with ASD. Some are mildly impaired by their symptoms, while others are severely disabled.



### By the numbers

- Autism affects about one in 59 children.<sup>1</sup>
- The number of children identified with autism nearly tripled from 2000 to 2014.<sup>2</sup>
- Nearly four times more boys than girls have autism – one in 38 boys and one in 152 girls.<sup>1</sup>
- People with autism have, on average, more medical expenses per year than people without autism.<sup>1</sup>
- Nearly half of children with autism have average or above-average intellectual ability.<sup>1</sup>

## What are the symptoms?

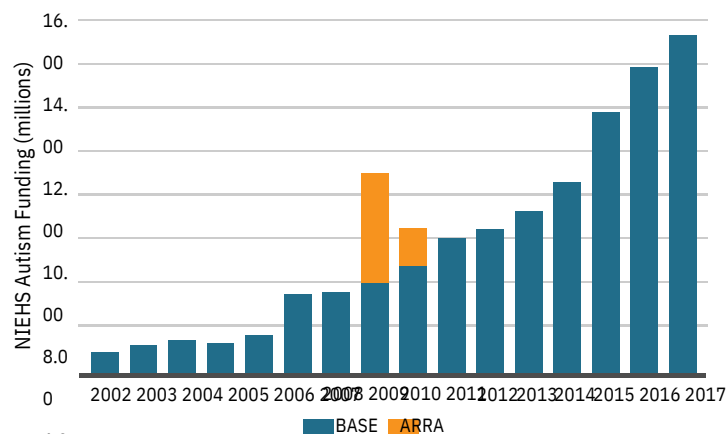
People with autism spectrum disorder often have problems with social and communication skills, as well as restricted and repetitive patterns of behavior. Early, intensive intervention can improve communication, learning, and social skills in children with ASD. Additionally, the disorder may come with other conditions, such as epilepsy, sleep disturbances, and gastrointestinal problems.

## How is NIEHS contributing to research?

NIEHS steadily increased funding of ASD research over the last decade, and this investment is yielding important new discoveries that may help prevent the disorder. The NIEHS autism research program attracts talented scientists from toxicology, epidemiology, and other areas. These researchers are using new ways to measure prenatal exposures, screen for contaminants that may affect brain development, and understand how environmental factors interact with genes in ways that may lead to ASD.

### NIEHS autism research funding

NIEHS funding of autism research reached \$15.7 million in 2017.



ARRA indicates funds from the American Recovery and Reinvestment Act of 2009.



## Environmental factors play a role

### Air pollution

Research supported by NIEHS indicates that early-life exposure to air pollution may be a risk factor for autism spectrum disorder.

- Children of mothers living near a freeway or traffic-related pollution during the third trimester of pregnancy were twice as likely to develop ASD. A distance of 1,014 feet, or a little less than 3.5 football fields, was considered near a freeway.<sup>3</sup>
- Exposure of the mother just prior to birth, and of the child shortly after, to several air pollutants, was associated with increased ASD risk and severity.<sup>4</sup>
- Children with a mutation in a gene called MET, combined with exposure to high levels of air pollution, may have increased risk of autism spectrum disorder.<sup>5</sup>

### Prenatal conditions and maternal factors

Problems with a mother's immune system, certain metabolic conditions, or inflammation during pregnancy may be linked to higher ASD risk for her children.

- Some mothers of children with autism spectrum disorder have autoantibodies, or proteins produced by the immune system that attack tissues or organs in the body, that may interfere with their child's brain development. Research suggests that autoantibodies may be linked to the disorder.<sup>6</sup>
- Maternal diabetes or obesity may be linked to increased likelihood of having a child with ASD or other developmental disability.<sup>7</sup>
- Fever during pregnancy may be associated with increased risk of autism spectrum disorder in children.<sup>8</sup>

### Metals, pesticides, and other contaminants

Prenatal and early childhood exposure to heavy metals, altered levels of metals in the body, pesticides, and other contaminants may be linked to autism spectrum disorder.

- Researchers used baby teeth that had fallen out to compare levels of lead, manganese, and zinc in children with ASD to their twin without the condition. They found children with autism spectrum disorder were low on manganese and zinc, metals essential to life, but had higher levels of lead, a harmful metal, during specific time periods of development.<sup>9</sup>
- Another study found that zinc-copper cycles, which regulate metal metabolism in the body, were altered in children with ASD.<sup>10</sup>
- Additionally, maternal exposure to insecticides during early pregnancy was associated with higher risk of the disorder in their children.<sup>11</sup>
- Researchers are also studying chemicals, such as bisphenol A, phthalates, flame retardants, and polychlorinated biphenyls, to see if they affect early brain development and possibly play a role in ASD.

No link has been found between autism and vaccines, including those containing thimerosal, a mercury-based compound.<sup>12</sup>

### Nutrition

NIEHS-funded studies found that taking recommended levels of prenatal vitamins may help lower the risk of autism spectrum disorder. Furthermore, research suggests taking vitamins and supplements might provide protection from certain environmental contaminants during pregnancy.



- Women who took the daily recommended dosage of folic acid during the first month of pregnancy had a reduced risk of having a child with ASD.<sup>13</sup>
- Researchers found pregnant mothers who took multivitamins, with or without additional iron or folic acid, were less likely to have a child with ASD or intellectual disability.<sup>14</sup>
- Prenatal vitamin intake during the first month of pregnancy may also reduce ASD risk in siblings of children with the disorder.<sup>15</sup>

## Collaborations

The Interagency Autism Coordinating Committee (IACC) is a federal advisory committee that coordinates federal efforts and provides advice to the secretary of the U.S. Department of Health and Human Services on issues related to autism spectrum disorder. NIEHS partners with members of IACC to summarize advances in autism research and participate in strategic planning for research needs. The committee works closely with the public to hear their concerns and recommendations for research.



**CHARGE** – The Childhood Autism Risks from Genetics and the Environment (CHARGE) study seeks to identify causes and contributing factors to autism spectrum disorder. Launched in 2003, this study enrolls children with autism, with developmental delay but not autism, and with typical development. CHARGE conducts medical exams and collects blood and urine samples from the children, and also obtains information on environmental exposures, health, lifestyle, and behavior from their parents.

**MARBLES** – The Markers of Autism Risk in Babies – Learning Early Signs (MARBLES) study follows women at high risk of giving birth to a child with autism. Women are enrolled during early pregnancy and their children are followed to age 3. By collecting data from mothers and their babies throughout critical periods, these studies can help identify and measure environmental exposures that may affect early stages of brain development.

**EARLI** – The Early Autism Risk Longitudinal Investigation (EARLI) study enrolled a large group of pregnant mothers of children with autism. Siblings born after the child with autism spectrum disorder were subsequently followed through 3 years of age, to see if they developed the disorder. The EARLI study continues to follow the children and examine possible environmental risk factors to ASD, as well as possible links between genes and the environment, known as gene-environment interactions.



## Population-based research

Studies with large numbers of people have revealed patterns that may indicate the involvement of environmental factors in ASD. NIEHS funds several studies that include participants from across the United States, as well as in Australia, Denmark, Finland, Israel, Norway, Sweden, and South Korea, including the following:

## What's next?

In addition to identifying environmental factors that may affect the risk of autism spectrum disorder, NIEHS-funded researchers continue to investigate how these factors may interact with a person's genes. This information may help lead to prevention strategies and treatments, and also pinpoint areas that need further research.

- NIEHS continues to promote collaboration and dialogue among researchers. Combining data from different studies may help facilitate identification of ASD risk factors.

- Using data on genes known to be involved with ASD, scientists are screening chemicals that could interact with those genes. This research may help reveal environmental factors that increase risk, as well as provide information about specific gene-environment interactions.

- NIEHS is also interested in learning more about environmental exposures, such as air pollution and related changes at the cellular level, that affect brain development.

For more information on the National Institute of Environmental Health Sciences, go to [www.niehs.nih.gov](http://www.niehs.nih.gov).

To learn more about NIEHS autism research, visit [www.niehs.nih.gov/research/supported/health/autism](http://www.niehs.nih.gov/research/supported/health/autism)

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