Autism and the Environment

Research has shown that environmental factors likely play a role in autism.[1] Studies also indicate that genetics contribute to the disorder.[2] The National Institute of Environmental Health Sciences (NIEHS) supports research to discover how the environment may influence autism. This important environmental research offers real promise for prevention — because you can't change your genes, but you can change your environment.

What is autism?

Autism is a group of developmental brain disorders, known as autism spectrum disorders, that begin early in life and affect how a person acts and interacts with others, communicates, and learns.

What are the symptoms?

Although people with autism have a variety of symptoms that vary in severity, they all have difficulties communicating and interacting with others, and show restricted and repetitive patterns of behavior and interests. Most symptoms are noticeable by the time a child is 2-3 years old, but many children are not diagnosed until later. Early intensive behavioral intervention can improve communication, learning, and social skills in children with autism.

Autism affects people for their entire lives, and often comes with other conditions, such as epilepsy, sleep disturbances, and gastrointestinal problems. Currently, no drugs have proven effective for treating core autism symptoms.

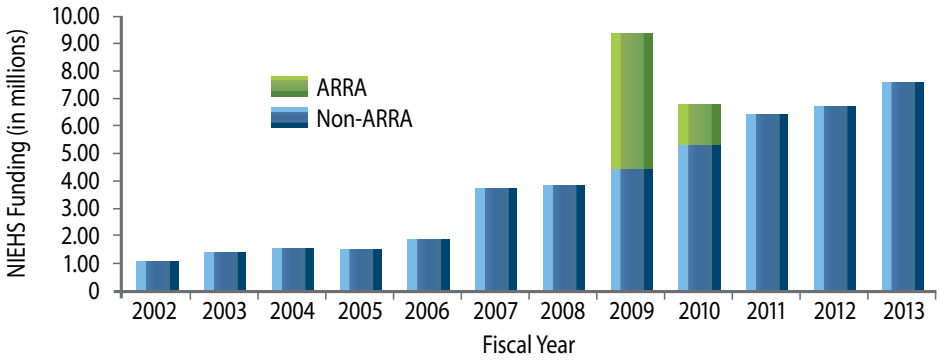
How is NIEHS contributing to autism research?

NIEHS has steadily increased funding of autism research over the last decade, and this investment is producing important new discoveries that may help prevent autism. For example, NIEHS-funded researchers have shown that taking folic acid and avoiding infections during pregnancy can help lower autism risk. Researchers have also shown that problems with the immune system are involved in autism, and that early-life exposure to high levels of air pollution may increase risk, especially for children whose genetic makeup causes them to be more susceptible.

The NIEHS Autism Research Program has attracted talented scientists from toxicology, epidemiology, and other areas. These researchers are using new ways to measure prenatal exposures, screen for contaminants that affect brain development, and understand how environmental factors interact with genes to lead to autism.

NIEHS Autism Research Funding

NIEHS funding of autism research reached $7.5 million in 2013. ARRA indicates funds from the American Recovery and Reinvestment Act of 2009.



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The impact of autism

- Autism affects about one in 68 children.[3]
- The number of children with autism more than doubled from 2000 to 2010.[3]
- Autism is nearly five times more common in boys, one in 42, than girls, one in 189.[3]
- People with autism had average medical expenses of $4,110 to $6,200 more per year than people without autism.[4]
- Nearly half of children with autism, 46 percent, have average or above average intellectual ability.[5]

Environmental factors play a role in autism

Air pollution

Work supported by NIEHS indicates that early-life exposure to air pollution is a risk factor for autism.

- A 2011 study reported that children living within 1,014 feet, or a little less than 3.5 football fields, of a freeway, at birth, were twice as likely to develop autism.[5]
- Building on those findings, in 2013, researchers reported an association between exposure to traffic-related air pollution, as well as components of regional air pollution, and an increased risk of autism.[6]
- A 2014 study pointed to a likely gene-environment interaction. Children whose genetic makeup causes them to be more susceptible to the health effects of high levels of air pollution showed the highest risk for autism.[7]

Prenatal conditions

Researchers funded by NIEHS discovered that problems with the immune system, as well as maternal conditions during pregnancy, are linked with higher autism risk.

- Research showed that some children are born to mothers with antibodies that interfere with fetal brain development in ways that could lead to autism.[8]
- Maternal diabetes and obesity, which are associated with inflammation, both have strong links to the likelihood of having a child with autism or another developmental disability.[9]
- During pregnancy, elevated levels of inflammation, which can come from an infection, were linked with an increased risk of having a child with autism. This finding may help to identify preventive strategies.[10]

Nutrition

According to NIEHS-funded research, prenatal vitamins may help lower autism risk.

- Women who took a daily prenatal vitamin during the three months before and during the first month of pregnancy, were less likely to have a child with autism than women not taking the supplements. This was more evident in genetically susceptible women or children, suggesting that a gene-environment interaction could be responsible.[11]
- A later study identified folic acid as the source of the protective effects of prenatal vitamins. Women who consumed the daily recommended dosage during the first month of pregnancy had a reduced risk of having a child with autism.[12]

Mercury and other contaminants

There continues to be concern about autism and mercury exposure. NIEHS funds research examining this and exposures to other contaminants.

- Eating fish is the primary way that we are exposed to organic mercury. A 2013 study examined people in the Republic of Seychelles, where fish consumption is high. The study found no association between prenatal organic mercury exposure and autism behaviors.[13]
- Scientists can test for recent exposure to organic mercury with blood tests. Researchers found that after adjusting for dietary and other mercury sources, children with autism had blood mercury levels that were similar to those found in children without autism.[14]
- Researchers are also studying other contaminants, such as bisphenol A (BPA), phthalates, heavy metals, flame retardants, polychlorinated biphenyls (PCBs), and pesticides, to see if they affect early brain development and play a role in autism.

Collaborations

Much of the research funded by NIEHS addresses priorities identified by the Interagency Autism Coordinating Committee, which coordinates all autism efforts within the U.S. Department of Health and Human Services. NIEHS also collaborates with the U.S. Environmental Protection Agency, other NIH institutes, and various autism research and advocacy groups.

Population-based research

Studies that look at large numbers of people can reveal patterns that may indicate the involvement of environmental factors in autism. NIEHS funds studies with participants in various parts of the United States, as well as in Australia, Denmark, Finland, Israel, Norway, Sweden, and South Korea. Key projects include the following:

CHARGE – The Childhood Autism Risks from Genetics and the Environment study seeks to identify causes and contributing factors for autism, by conducting medical exams and collecting biological samples from children, and obtaining information on environmental exposures, health, lifestyle, sociodemographics, and behavior from their parents. Launched in 2003, this study is enrolling children with autism, children with developmental delay but not autism, and children with typical or expected development.

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

What's next?

In addition to identifying environmental factors that may influence autism risk, NIEHS-funded researchers are investigating how these factors may interact with a person's genes. This information could identify new targets for prevention and therapies, and also point to areas that need to be examined in human studies.

- Researchers are studying early-life exposures, using blood samples from participants in the MARBLES study. The investigators want to understand whether these exposures cause DNA to change in a way that influences brain development and affects risk of autism.
- Stem cells from people with fragile X syndrome are being studied for gene-environment interactions. By using these stem cells to create sets of neurons that are identical, except for a gene known to be involved in autism, researchers can better understand how different forms of this gene influence susceptibility to environmental factors.
- Using data on genes known to be involved with autism, investigators are screening chemicals that interact with those genes, to identify which chemicals may increase autism risk. This research will help reveal environmental factors that increase autism risk and provide information about specific gene-environment interactions.

For more information on the National Institute of Environmental Health Sciences, go to **www.niehs.nih.gov**.

To learn more about NIEHS autism research, visit **www.niehs.nih.gov/research/supported/dert/programs/autism** or contact the program lead, Cindy Lawler, Ph.D., at lawler@niehs.nih.gov.

1. Lyall K, Schmidt RJ, Hertz-Picciotto I. 2014. Maternal lifestyle and environmental risk factors for autism spectrum disorders. Int J Epidemiol 43(2):443-464.
2. Jeste SS, Geschwind DH. 2014. Disentangling the heterogeneity of autism spectrum disorder through genetic findings. Nat Rev Neurol 10(2):74-81.
3. Developmental Disabilities Monitoring Network Surveillance Year 2010 Principal Investigators; Centers for Disease Control and Prevention (CDC). 2014. Prevalence of autism spectrum disorder among children aged 8 years - autism and developmental disabilities monitoring network, 11 sites, United States, 2010. MMWR Surveill Summ 63(2):1-21.
4. CDC (Centers for Disease Control and Prevention). 2014. Autism Spectrum Disorder – Data and Statistics. Available: http://www.cdc.gov/ncbddd/autism/data.html [accessed 6 June 2014].
5. Volk HE, Hertz-Picciotto I, Delwiche L, Lurmann F, McConnell R. 2011. Residential proximity to freeways and autism in the CHARGE study. Environ Health Perspect 119(6):873-877.
6. Volk HE, Lurmann F, Penfold B, Hertz-Picciotto I, McConnell R. 2013. Traffic-related air pollution, particulate matter, and autism. JAMA Psychiatry 70(1):71-77.
7. Volk HE, Kerin T, Lurmann F, Hertz-Picciotto I, McConnell R, Campbell DB. 2014. Autism spectrum disorder: interaction of air pollution with the MET receptor tyrosine kinase gene. Epidemiology 25(1):44-47.
8. Nordahl CW, Braunschweig D, Iosif AM, Lee A, Rogers S, Ashwood P, Amaral DG, Van de Water J. 2013. Maternal autoantibodies are associated with abnormal brain enlargement in a subgroup of children with autism spectrum disorder. Brain Behav Immun 30:61-65.
9. Krakowiak P, Walker CK, Bremer AA, Baker AS, Ozonoff S, Hansen RL, Hertz-Picciotto I. 2012. Maternal metabolic conditions and risk for autism and other neurodevelopmental disorders. Pediatrics 129(5):e1121-e1128.
10. Brown AS, Sourander A, Hinkka-Yli-Salomaki S, McKeague IW, Sundvall J, Surcel HM. 2014. Elevated maternal C-reactive protein and autism in a national birth cohort. Mol Psychiatry 19(2):259-264.
11. Schmidt RJ, Hansen RL, Hartiala J, Allayee H, Schmidt LC, Tancredi DJ, Tassone F, Hertz-Picciotto I. 2011. Prenatal vitamins, one-carbon metabolism gene variants, and risk for autism. Epidemiology 22(4):476-485.
12. Schmidt RJ, Tancredi DJ, Ozonoff S, Hansen RL, Hartiala J, Allayee H, Schmidt LC, Tassone F, Hertz-Picciotto I. 2012. Maternal periconceptional folic acid intake and risk of autism spectrum disorders and developmental delay in the CHARGE (CHildhood Autism Risks from Genetics and Environment) case-control study. Am J Clin Nutr 96(1):80-89.
13. Van Wijngaarden E, Davidson PW, Smith TH, Evans K, Yost K, Love T, Thurston SW, Watson GE, Zareba G, Burns CM, Shamlaye CF, Myers GJ. 2013. Autism spectrum disorder phenotypes and prenatal exposure to methylmercury. Epidemiology 24(5):651-659.
14. Hertz-Picciotto I, Green PG, Delwiche L, Hansen R, Walker C, Pessah IN. 2010. Blood mercury concentrations in CHARGE Study children with and without autism. Environ Health Perspect 118(1):161-166.