

## Children's Health – Why the Environment Matters

NIEHS is committed to understanding how the environment affects a child's health and development. Researchers across the country are discovering that certain chemicals, pollutants, foods, and activities can be more harmful to a fetus and children than to adults.

Children may be more vulnerable to toxins in their environment for several reasons.

- Pound for pound, children eat, drink, and breathe more than adults, meaning they are more exposed for their size.
- Children frequently put objects in their mouths, explore more, and play on the floor and ground.
- Protective systems, such as those that filter pollutants from inhaled air and process chemicals in the body, aren't fully functional in children.
- Childhood is a time of rapid growth and development.

### Growth and development

People are especially vulnerable to environmental pollutants while in the womb, or prenatal period, and throughout childhood. During these times, environmental chemicals are more likely to have impacts on health and normal growth, and can cause serious health effects later in life. For example, research has shown that when pregnant women are exposed to pesticides, their children may have an increased risk of developing childhood leukemia.<sup>1</sup> Much of the most recent NIEHS children's health research is focused on prenatal and childhood exposures.

Although the causes of diseases and disorders are often complex and in many cases unknown, most scientists agree that both the environment and genetics play a role. Since we cannot change our genes, researchers believe that identifying and managing environmental factors offers the best hope for prevention. By protecting children, we may also improve their health as adults.



### Our health

**Asthma and allergies.** In 2010, approximately 7 million, or one in 11, U.S. children had asthma, leading to 10.5 million missed days of school and \$7 billion in medical expenses.<sup>2</sup> Mold, air pollution, cockroach allergens, tobacco smoke, and other exposures can trigger asthma attacks. Children with asthma who are overweight may have worse symptoms<sup>3</sup> and more difficulty controlling them with inhalers or other rescue medications than normal weight children with asthma.<sup>4</sup>

Scientists are still researching what may initially cause asthma. In one study, infants living in homes with high levels of mold associated with water-damaged buildings were more likely to develop asthma by age seven.<sup>5</sup>

From 1994 to 2010, decreasing air pollution in southern California resulted in better lung development among both asthmatic and nonasthmatic children.<sup>6</sup> Other studies have shown that home improvements, such as pest control and ventilation of kitchen exhaust, can lead to fewer symptoms for asthmatic children,<sup>7</sup> especially when combined with instruction on asthma management from health educators.<sup>8</sup>

**Autism.** People with autism spectrum disorder have difficulty interacting with others and show restrictive or repetitive patterns of behavior. The number of U.S. children with autism more than doubled from 2000 to 2010.<sup>9</sup> NIEHS is supporting research to discover how environmental factors and genetics may lead to autism, which has lifelong effects.

Studies found that pregnant mothers exposed to air pollution<sup>10</sup> or experiencing inflammation from ailments such as infections, diabetes, or obesity,<sup>11</sup> had a higher risk of having a child with autism. Research has also shown that pregnant mothers who take folic acid may decrease the risk of their child developing autism.<sup>12</sup>

No link between autism and vaccines containing thimerosal, a mercury-based compound, has been found.<sup>13</sup> (See also Vaccines)

**Cancer.** Exposure to chemicals in the environment may increase the risk of developing cancer. Research has shown that children may have increased risk of developing some types of leukemia when fathers are exposed to pesticides around the time of conception, or mothers are exposed during pregnancy.<sup>1</sup> In other research, it was found that vitamins or folic acid taken by women before conception or during pregnancy reduced the risk of their children developing certain types of leukemia.<sup>14</sup>

**Childhood obesity.** Although an unhealthy diet and lack of exercise are main contributors to weight gain, chemicals in the environment may also interfere with how the body controls weight. These chemicals are known as obesogens. For example, there is strong evidence that prenatal exposure to tobacco smoke, which contains many chemicals, contributes to childhood obesity.<sup>15</sup> Other possible obesogens include the pesticide DDT and chemicals known as polychlorinated biphenyls (PCBs),<sup>15</sup> which are no longer produced in the U.S. but persist in the environment. Bisphenol A (BPA),<sup>16</sup> a chemical used to make plastics, may also be an obesogen. (See also Endocrine disruptors)

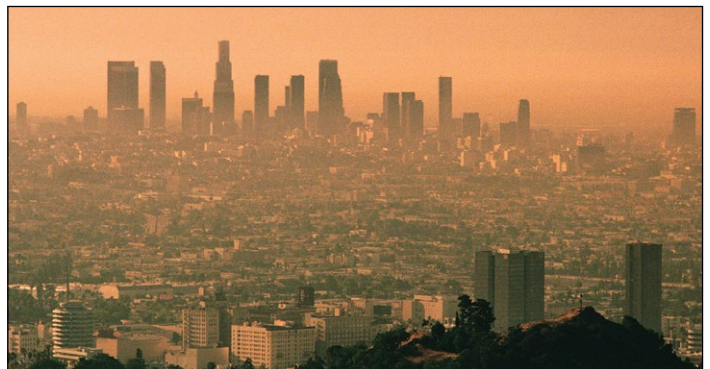


### Damage can be passed down for generations

Some exposures can either permanently alter genes or interfere with the way genes function. These are also called epigenetic changes. Scientists have found that both genetic and epigenetic changes can be passed down to future generations. For example, if pregnant mothers are exposed to certain pesticides or chemicals, their children and grandchildren may be at higher risk for reproductive problems.<sup>17</sup>

**Neurodevelopmental disorders.** Decreases in IQ, problems with fine motor skills, and symptoms of attention deficit hyperactivity disorder (ADHD) have been found in children whose mothers were exposed to high levels of flame retardants, such as polybrominated diphenyl ethers (PBDEs), while pregnant.<sup>18</sup> (See also Flame retardants)

Children are also more likely to have lower IQs or symptoms of anxiety, depression, or attention deficit after prenatal exposure to common air pollutants known as polycyclic aromatic hydrocarbons (PAHs).<sup>19,20</sup> There is evidence that PAHs have a greater effect on behavioral development among children whose mothers were also under stress while pregnant.<sup>21</sup>



### Our environment

**Air pollution.** Air pollution can harm more than just lungs. Research has shown that high air pollution levels have been associated with increases in miscarriages.<sup>22</sup> Improvements in air quality, however, have been shown to have beneficial effects. For example, women from Beijing in their eighth month of pregnancy during the 2008 Olympics, when government intervention temporarily lowered air pollution levels, had babies with higher, healthier birth weights than women exposed to typical air pollution levels during the same dates in 2007 and 2009.<sup>23</sup>

**Arsenic.** Arsenic occurs naturally in soil and groundwater. It is also used in manmade products such as pesticides and wood preservatives. Scientists at NIEHS found that mice prenatally exposed to arsenic in drinking water displayed signs of early puberty and became obese as adults.<sup>24</sup> Other research showed that early life exposures to arsenic may also lead to decreases in IQ and childhood immune system dysfunction.<sup>25,26</sup>

**Endocrine disruptors.** A growing body of evidence suggests that certain chemicals, known as endocrine disruptors, can mimic or interfere with the body's hormones. Endocrine disruptors are found in many everyday products, including plastic bottles and containers, food can liners, detergents, flame retardants, toys, cosmetics, and pesticides. These chemicals are of particular concern because they can alter the body's hormonal balance, which is required for good health and proper development.

- **BPA.** Much concern about endocrine disruptors has focused on BPA, a compound that is widely used in the manufacture of polycarbonate plastics and epoxy resins. Research with mice and rats has shown that low-dose BPA exposure produces a wide spectrum of developmental and reproductive effects, including an increase in aggressive behavior, early onset of puberty, changes in mammary gland development, and a decrease in testosterone levels and sperm production.<sup>17,27</sup>
- **DDT.** DDT is a pesticide that was used in the past to control mosquitoes and other insects. Girls exposed to DDT during the prenatal period may have an increased risk of developing breast cancer.<sup>28</sup>
- **Dioxins.** Dioxins, a group of compounds mainly produced by improper burning of waste, persist in the environment. They are absorbed in the fat of animals and passed on to people through consumption of foods, such as meat, dairy products, and fish. Early life exposure to dioxins can delay puberty and increase risk of some cancers, such as breast and ovarian cancer.<sup>29</sup>
- **Phthalates.** Phthalates are compounds used in many consumer products, such as nail polish, hairspray, deodorant, and shampoo. Studies have found an association between exposure to phthalates during pregnancy and increased risk of childhood asthma,<sup>30</sup> as well as altered hormone levels in boys that may delay puberty.<sup>31</sup> Phthalates have also been associated with delayed puberty in girls.<sup>32</sup>
- **Lavender and tea tree oil.** Chemicals considered natural can also interfere with hormones. Lavender and tea tree oil have been found to mimic estrogen, causing breast enlargement in young boys.<sup>33</sup>

**Flame retardants.** Researchers discovered that children are exposed to many types of flame retardants found in an array of products from car seats to changing table pads.<sup>34</sup> These chemicals, which are added to polyurethane foam and other products to slow the spread of flames, can be inhaled or absorbed through a child's skin. Evidence links exposures to flame retardants with a range of health effects, including lower IQ and increased hyperactivity.<sup>35</sup>



**Lead.** Some environmental contaminants can permanently change the way the body works. Research found early exposure to lead may change the hypothalamic-pituitary-adrenal axis, a complex system that controls many organ functions. This may explain why early lead exposure significantly increases the risk of lower IQ, hypertension, cardiovascular disease, diabetes, schizophrenia, and neurodegenerative disease later in life.<sup>36</sup>

**Maternal smoking.** Research has shown that maternal smoking may play a significant role in childhood obesity. A study of 35,000 children born between 1959 and 1964 found that children of smokers had an increased risk of becoming overweight before the age of 8. The link between maternal smoking and obesity was stronger in girls than boys.<sup>37</sup>



**Vaccines.** Vaccines are commonly used as a protection against diseases. Research has also shown vaccines may offer extra protection against allergies and asthma. In one study, children who were vaccinated for measles, mumps, and rubella had lower levels of allergy and asthma than unvaccinated children.<sup>38</sup> Other studies have shown that exposure to chemicals in the environment may interfere with the body's ability to benefit from vaccines. Children exposed to higher levels of perfluorinated compounds (PFCs) had a weaker immune system response than children with lower PFC exposures, reducing the protective effects of vaccines.<sup>39</sup> PFCs are commonly used as stain protection on furniture and as a grease barrier in food packaging.

## Our research

In 2014, NIEHS spent about \$115 million on children's environmental health research. Some researchers are working with human populations, some study laboratory mice and rats, and others examine how cells react to environmental exposures. All of these types of research contribute to our understanding of children's health and the environment.

Some major NIEHS-funded studies include the following.

**Centers for Children's Environmental Health and Disease Prevention:** NIEHS and the U.S. Environmental Protection Agency (EPA) jointly fund collaborative research centers, aimed at protecting children from environmental threats, reducing health risks, and promoting health and well-being.

**Childhood Autism Risks from Genetics and the Environment (CHARGE):** As the first comprehensive, population-based study of environmental and genetic causes of autism, researchers at the University of California, Davis are studying the causes and risk factors for autism and developmental delay.

## Children's Health Exposure Analysis Resource (CHEAR):

The CHEAR program provides access to a network of laboratories and data analyses tools, so researchers can add or expand the inclusion of environmental exposures in their children's health research.

**Mexico Childhood Asthma Study:** Scientists at NIEHS are conducting a study of children with asthma in Mexico City, looking at genes that may play a role in children's response to ozone, a primary component of urban smog.



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

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