

Questions and Answers about a Study of Autism and Hazardous Air Pollutants¹
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STUDY BASICS

Why did you study hazardous air pollutants and autism?

The number of children reported to have autism and its related disorders (abbreviated ASD for autism spectrum disorders) has grown in the last 10-15 years. This has led to concerns that something in the environment may contribute to ASD. So as a first step to examine this concern, we used some data already available to explore whether autism might be related to hazardous air pollutants (HAPs). HAPs are chemicals in outdoor air that have been linked to cancer, nervous system problems, effects on development, or other health effects in animal studies. The Clean Air Act of 1990 directed the federal EPA to set limits on emission sources and to evaluate the health risks associated with HAPs.

How did you do the study?

We compared estimated levels of HAPs around the time of birth in children later diagnosed with an ASD to children without autism. We used information from the federal EPA on estimated levels for 19 HAPs that might possibly affect early brain development. HAPs levels were assigned to the children based on their address at birth in 1994. We obtained some general information on the mothers and the children (e.g. race, gender, birthweight, parent's education and age) from the birth certificate to see if these might help explain any findings.

What were the results of your study?

We found that the children with ASD were about 50% (or 1.5 times) more likely than the other children to have been born in areas with higher estimated levels of metals or chlorinated solvents in outdoor air. Cadmium, mercury, and nickel were the metals most associated with ASD, and it was not entirely possible to separate their effects. Among the solvents, trichloroethylene and vinyl chloride contributed most to these associations. Aromatic solvent levels were not associated with ASD. We also found some evidence that diesel particulate matter may be associated with the risk of ASD.

There is some uncertainty in calculating these statistical estimates of risk based just on our study sample, so we also calculated a range of risks taking that uncertainty into account. The range for metals and chlorinated solvents was from 1.1 (or almost no increase in risk) to 2 times the risk.

What do these results mean?

Because there is a statistical association does not necessarily mean there is a causal link. There are some limitations in using these estimates of HAPs levels for small geographic areas. For one, we did not take actual measurements of the chemicals in the air at the homes of the children in this study. Also, we do not know if a mother lived at the same address during her whole pregnancy as she did when the baby was born. We do not know how much time a mother spent outdoors in the area where she lived. Due to these reasons and because it is one of the first

studies of its type, we can't draw definite conclusions from this one study. Our results must be seen as preliminary, but they suggest some chemicals to study further.

From our study, we do not know what levels of HAPs might be harmful to a developing baby. However, babies and children generally are more sensitive than adults to effects from exposures. We also don't know which time period of exposure may be most important (that is, when during pregnancy or early childhood).

Could your findings be explained by something else?

We also tried to look at other factors that could be related to ASD and possibly explain a link with HAPs. The birth certificates have some information about the mother and child (e.g. race, sex, parent's age and education), but not much. These factors did not change our results. There may be other factors influencing the results that we did not have information on, like other chemicals in the area or personal habits such as diet or smoking.

What should parents do?

Because this is the first study of its type, the results need to be duplicated to come to more concrete conclusions. Parents should continue to watch for additional studies about autism.

Are there other studies with similar results?

No, this is the first study to look at ASD in relation to HAPs levels at birth in the United States. Researchers in other states are planning to repeat the study to see if they get the same results. One study in Texas looked at air-born mercury levels emitted from industries at the time the children were school-age and found a slightly increased risk of autism with higher levels. A few other studies have looked at the effects of a different form of mercury (called methyl mercury) found in fish and food, which is known to be harmful to a baby's brain at high levels. These studies have not found an association with autism, but they weren't designed to look that closely at autism. There has also been concern over another form of mercury (ethyl-mercury) used for some medical purposes, including as a preservative in vaccines (called thimerosal). Scientific experts have not found proof to support an increased risk from thimerosal based on the human studies done so far. Thimerosal has been removed from children's vaccines. Cadmium is another metal we looked at. Studies in rats and mice have shown that cadmium may have effects on the growth or behavior of the offspring. There are no other studies we know about on cadmium in relation to autism. Some chlorinated solvents have been linked to other effects during pregnancy, like slower growth of the baby. One recent study found lower scores on intelligence and behavioral tests in the children of women who worked with solvents.

ACTIONS AND NEXT STEPS

Were the chemical levels found in the area you studied especially high?

We don't really know, because we have no guidelines or benchmarks for HAPS and autism. "Benchmark" concentrations represent a level of potential public health concern and long term exposure below this level is not expected to result in adverse health effects. However, HAPs are not routinely measured or regulated. We can compare the estimated levels in our study area to benchmark concentrations based on cancer risk. The EPA estimates exceeded recommended cancer benchmarks in only a few census tracts for nickel, benzene and vinyl chloride. Urban

areas like the San Francisco bay area tend to have higher levels of these HAPs than other areas. But generally, exposure to many of these chemicals is likely to be less in outdoor air than from other sources.

What can an individual do to avoid or limit exposures to these chemicals?

Our study has not found a clear link between autism spectrum disorders and air pollutants, but our results do suggest that this is an important area for more research. We also cannot tell what levels may be harmful from this study. In general, it is a good idea to avoid unnecessary chemical exposures, especially during pregnancy. However, it would be hard for an individual to avoid exposures from the sources we studied because they are in the outdoor air. Cars and trucks are the main sources of HAP emissions generally in California. Smaller area sources such as dry cleaners, gas stations, auto paint shops and residential wood burning are the main outdoor sources of many of the metals and chlorinated solvents we examined.

Although we studied outdoor levels of HAPs, many of the same chemicals come from sources in the home. You can reduce your exposure to HAPs at home by avoiding sources of combustion such as smoking and burning wood, incense or candles. You could also avoid using products that contain hazardous chemicals. Household products that may contain hazardous chemicals are cleaning agents, pesticides, some paints, glues, automotive fluids, air deodorizers, mothballs and mercury thermometers. You can buy more environmentally safe products or use natural cleaners such as vinegar and baking soda. See: www.ewg.org Safe Shopping Guide for information on safer household products.

Other personal actions include watching what we eat. One form of mercury is found in the diet and some fish are known to have high levels. Pregnant women can eat less of these types of fish. A website for fish consumption is Natural Resources and Defense Council at: www.nrdc.org/health/effects/mercury/index.asp. As far as vaccines, thimerosal has been removed from routine children's vaccines, but may be present in other vaccines. Women who are pregnant can ask for thimerosal-free vaccines. A woman who thinks she may work with chemicals can get information from her employer about what is present at the workplace and safety precautions to take.

What are the next steps?

Autism is, unfortunately, a fairly common disorder that often brings lifelong disability. It is important that children receive early attention and programs to help them perform to their best ability. Money for research is essential to identify causes and to find ways of preventing autism. Our findings may provide clues about some environmental factors possibly related to higher risks of autism that need to be studied further. We are working with other scientists to design similar studies for other regions to try to verify our results. We also hope to repeat this study with children born in a later year, 1996.

BACKGROUND ON AUTISM

What is autism?

Autism and its related disorders are developmental disabilities that include a continuum (or spectrum) of severity, so they are called autism spectrum disorders (ASD). The disorders affect a

person's social skills, their speech and communication, and their behaviors. People with ASDs might repeat actions over and over again. They might want to have routines where things stay the same so they know what to expect and have trouble if family routines change. They often have trouble understanding other people's facial expressions and social cues. Some affected children have very limited speech. The disorders usually have lifelong effects on a person's ability to function in school or a workplace.

How common is autism? Is it becoming more frequent?

The number of children being treated or receiving services for autism has been increasing. Studies done in California and other places show that some of the increase is due to changes in the way autism is diagnosed and awareness of the condition. But we do not know how much is due to that alone. Studies in Europe, Asia and the United States since 1985 have found that up to 6 of every 1,000 children have an ASD using the current guidelines for diagnosis.

What causes autism?

The causes of autism are not well known. Autism is a disorder of the brain that happens while the baby is still growing, most likely before the baby is born. Autism sometimes runs in families, so there is a genetic component, and several studies are trying to find out which genes may be involved. Other studies, like this one, are looking at non-genetic factors during pregnancy or infancy that may play a role in autism. The different genetic and non-genetic factors may interact to cause autism.

MORE DETAILS ON HOW THE STUDY WAS DONE

Who conducted the study?

The California Center for Autism and Developmental Disabilities Research and Epidemiology (CADDRE) is run by the Department of Health Services (CDHS), with funding from the federal Centers for Disease Control and Prevention (CDC). Additional funds for looking at HAPs were provided by the Agency for Toxic Substances and Disease Registry (ATSDR), which is one part of CDC charged to study health effects of these kinds of chemicals.

How did you identify children for this study?

CADDRE was funded to conduct detailed monitoring (or counting) of autism in 6 counties of the San Francisco Bay Area for specific years. Working closely with the California Department of Developmental Services (DDS), the Kaiser Permanente Medical Care Program, and private medical care providers, we identified children with diagnoses of ASD by age 8 that were born in 1994. We compared 284 children with an ASD to a group of 657 children without autism. These were randomly chosen from birth certificates of other births in 1994 in the SF Bay Area.

How did you determine exposures to HAPs?

The Environmental Protection Agency (EPA) estimates the average outdoor air concentrations (or levels) of HAPS for census tracts in the U.S. every few years because they are not routinely measured. Census tracts are generally small areas of several thousand people. EPA uses a mathematical model that is based on factory emissions, land use (commercial and residential)

and traffic, weather patterns, and knowledge about how these chemicals are broken down in the environment. HAPs estimates were available for 1996 and are thought to be fairly consistent from one year to the next within each census tract. We used the birth address of the children in the study to assign census tracts. Then we linked to the EPA HAPs data to get the estimated levels of the 19 chemicals of interest to us. Census tracts with high levels of one chemical often have high levels of other similar chemicals. Because it is hard to separate them, we looked at the chemicals in groups that tend to be released together. We split the levels of each chemical or group of chemicals into four categories from lowest to highest. We did not have any actual personal measurements of chemical levels for the children in this study.

How do you protect the confidentiality of the information you collected?

All information we collect is kept confidential, or private, according to the law. We use password protection and encryption for data files with any personal information. After linking the databases, personal identifiers (name, address, etc.) were taken off the files used for analysis, and only grouped results are calculated and presented. This study was approved by the California Committee for the Protection of Human Subjects.

¹ **Autism Spectrum Disorders in Relation to Distribution of Hazardous Air Pollutants in the San Francisco Bay Area.** Gayle C. Windham PhD, Lixia Zhang MPH, Robert Gunier MPH, Lisa Croen PhD, Judith Grether PhD. Environmental Health Perspectives 2006

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