

# The Link Between Fossil Fuels and Neurological Harm

## SUMMARY

Burning fossil fuels produces harmful air pollution and increases people's exposure to toxic chemicals that can harm their brains and nervous systems. There is an emerging scientific consensus that air pollution from fossil fuel use is harmful to children's developing brains and may also affect the cognitive functioning of older adults—although not all studies have found these results. In children, exposure to air pollution has been linked to development delays, reduced IQ, cognitive deficits and autism spectrum disorder. In adults, exposure to air pollution has been linked to higher rates of dementia and Alzheimer's Disease.

The very young, the elderly and people with low household income are especially vulnerable to the harmful impacts of exposure to toxic chemicals in the air.

## WHAT ARE FOSSIL FUELS AND HOW ARE THEY USED?

**Fossil fuels** – including **oil, coal and natural gas** – are **non-renewable resources** formed from the remains of prehistoric plants and animals buried deep in the Earth, subjected to immense pressure and heat over millions of years. The world's reliance on burning fossil fuels to produce electricity, heat, transportation and industry began during the Industrial Revolution.

Today, fossil fuels remain the world's primary energy source.

## WHAT IS THE LINK BETWEEN FOSSIL FUELS AND AIR POLLUTION?

Burning fossil fuel releases hundreds of toxic pollutants, including fine particulate matter (PM), black carbon, polycyclic

aromatic hydrocarbons (PAHs), mercury, lead, nitrogen oxides, sulfur dioxide and carbon monoxide. People breathe in these toxic chemicals when they are exposed to air pollution.

## MOST AIR POLLUTION IS CREATED BY THE BURNING OF FOSSIL FUELS.

According to the U.S. Department of Energy, over the past 20 years, **three-fourths of human-caused emissions were produced from burning fossil fuels.**<sup>1</sup>

Almost everyone in the world is affected by air pollution; only one person in 10 lives in a city with air clean enough to meet World Health Organization (WHO) air quality guidelines.<sup>2</sup>

**Fuel combustion creates 85 percent of airborne particulate pollution.**<sup>3</sup> Inhaling these tiny particles can be extremely harmful to human health and development, particularly early in life. An estimated 2 billion children live in areas exceeding WHO guidelines for fine particle exposure.

## HOW DOES EXPOSURE TO AIR POLLUTION HARM THE BRAIN?

While much is known about how polluted air affects the lungs and heart, we are just beginning to learn about how it can also harm the brain. **Over the past decade, many studies have linked exposure to outdoor air pollution to harmful impacts on the brain.**

Air pollution contributes to **neurodevelopmental** damage to the growth and functioning of the brain and nervous system. In addition, an emerging body of scientific evidence suggests that air pollution may also be a factor in **neurodegenerative** disorders that many older adults experience.<sup>4</sup>

**As the evidence mounts about the harmful effects of air pollution on people's brains, the world's health professionals and health organizations are becoming increasingly concerned.**

- In 2013, WHO cited emerging evidence of links between exposure to fine particles and problems with neurodevelopment and cognitive function. The report cited longitudinal cohort studies in Asia, Canada, Europe and the U.S.<sup>5</sup>
- In 2016, *Environmental Health Perspectives* published a joint public statement issued by 14 scientific or medical associations and 50 scientists representing the disciplines of pediatrics, toxicology, public health and neurobiology. The *Project TENDR* (Targeting Environmental

Neurodevelopmental Risks) *Consensus Statement* noted evidence of danger to children in the United States due to air pollution, listing fossil fuel-related air pollutants (including particulate matter, PAHs, and nitrogen dioxide) as “prime examples of toxic chemicals that can contribute to learning, behavioral, or intellectual impairment, as well as specific neurodevelopmental disorders such as ADHD [attention deficit hyperactivity disorder] or autism.”<sup>6</sup>

- In its 2017 report, the *Lancet Commission* on Pollution and Health stated that “pollution is now understood to be an important causative agent of many non-communicable diseases including ... neurodevelopmental disorders.” Specifically, it noted “emerging evidence” of causal associations from air pollution exposure to fine particulate matter and **decreased cognitive function, attention-deficit or hyperactivity and autism in children**, as well as **dementia in adults**.<sup>7</sup>

**THE VERY YOUNG, THE ELDERLY AND THOSE LIVING IN POVERTY ARE MORE VULNERABLE TO TOXIC EXPOSURES THAN OTHERS.**

Prenatal and early childhood exposures to air pollution and toxic chemicals in general can be especially damaging, as these are critical periods of development.

The overwhelming majority of brain development occurs during the prenatal period, when most of the brain's 86 billion neurons are formed.<sup>8</sup> Critical brain development continues from infancy through age 6. What's more, because of their smaller size, higher breathing rate and unique behaviors, children experience greater exposure to air pollutants than adults.<sup>9</sup> Neurological damage that occurs during childhood may continue to cause harm over the course of a person's lifetime.<sup>10</sup>

**CHILDREN IN LOW-INCOME POPULATIONS ARE ALSO DISPROPORTIONATELY HARMED BY EXPOSURE TO AIR POLLUTION.**

In the United States, people in low-income communities and communities of color experience disproportionately high exposure to particulate air pollution and air pollution from coal-fired power plants.<sup>11</sup> Poor children living in developing countries are also disproportionately exposed to air pollution.<sup>12</sup> The effects of toxic exposure may be further magnified by poor nutrition, lack of social support, and psychosocial stress due to poverty or racism.<sup>13</sup>

While children are especially vulnerable to toxic exposures from air pollution because they are still developing, the elderly may also be at increased risk from environmental exposures due to deterioration associated with the aging process.<sup>14</sup>



## EVEN EXPOSURES BELOW WHAT ARE CURRENTLY CONSIDERED “SAFE” LEVELS OF RESIDENTIAL AIR POLLUTION HAVE BEEN SHOWN TO CAUSE HARM.

A 2018 Dutch study published in *Biological Psychiatry* found that prenatal exposure to outdoor air pollution – even at levels currently considered safe in European Union policies – was associated with brain abnormalities later in childhood. Specifically, children exposed *in utero* exhibited a thinner outer layer of the brain (the cortex) at ages six to ten years. These abnormalities were associated with impaired impulse control.<sup>15</sup>

## MANY RIGOROUS STUDIES HAVE DOCUMENTED THAT AIR POLLUTION HARMS PEOPLE’S BRAINS.

- A longitudinal study of mothers and children in New York City’s North Harlem produced some of the earliest evidence linking PAH exposures in pregnant women to cognitive defects and behavioral disorders in their children at ages three and five. Three-year-olds exposed prenatally to high levels of PAHs exhibited lower mental development scores on standardized tests and a higher risk for cognitive delays.<sup>16</sup> At age five, they performed lower on IQ tests than children with lower exposure rates.<sup>17</sup>
- As these children grew older, they continued to exhibit adverse neurological impacts – including anxiety, depression and hyperactivity – compared to children less exposed before birth to PAHs.<sup>18</sup>
- A review of 31 studies published between 2006 and 2015 found that **traffic-related air pollution has been associated with cognitive impairment**. Pollution exposure in utero was associated with increased risk of neurodevelopmental delay. Exposure during childhood was associated with poor neurodevelopmental outcomes in younger children and decreased academic achievement and neurocognitive performance in older children. In older adults, exposure to traffic pollution was associated with cognitive decline.<sup>19</sup>
- In a study of 263 children ages 8 to 12, higher exposure to urban traffic pollution was linked to slower brain maturation.<sup>20</sup>
- Four studies investigating prenatal exposure to PAHs found links to delayed verbal, psychomotor and/or general development in children.<sup>21</sup>
- A 2014 cross-sectional study in the U.S. found an association between postnatal exposure to PAHs and special education needs in boys.<sup>22</sup>
- Three studies that investigated prenatal exposure to air pollutants found increased exposure was associated with an increased risk for autism spectrum disorder.<sup>23</sup>
- The 2013 Nurses Health Study II found an increased risk for autism disorder related to perinatal (late pregnancy and newborn) exposure to diesel exhaust, particulates, lead, manganese and nickel.<sup>24</sup>
- Four studies investigating pre- and postnatal exposure to nitrogen dioxide and fine particulates showed an association with autism spectrum disorder.<sup>25</sup>
- A study of 524 children enrolled in the Childhood Autism Risks from Genetics and the Environment study in California found exposure to traffic-related air pollution (nitrogen dioxide and fine particulate matter) during pregnancy and the first year of life was associated with autism.<sup>26</sup>
- While fewer studies have investigated the potential harms of outdoor air pollution on the brains of older adults, the evidence is growing stronger that air pollution experienced by many older adults is one cause of neurodegenerative problems.
- A 2017 study from the University of Southern California found living in areas where fine particle levels exceed EPA standards **increased the risks for global cognitive decline by 81 percent and all-cause dementia by 92 percent** in people with a genetic risk for Alzheimer’s Disease.<sup>27</sup>
- A large population-based study in Ontario, Canada found that living close to heavy traffic was associated with a higher incidence of dementia.<sup>28</sup>
- A 2017 meta-predictive analysis found increased air pollution levels may impact susceptibility to Alzheimer’s Disease.<sup>29</sup>

## CONCLUSION

Scientists and health professionals have long known that exposure to air pollution causes respiratory damage, such as asthma. A growing body of science now indicates that air pollution from burning fossil fuels is contributing to serious neurodevelopmental problems in the very young that may be life-altering, as well as to neurological decline in aging adults. These health consequences of fossil fuel use inflict major economic and societal costs that will continue to increase until we shift course toward clean energy sources.

## ENDNOTES

- 1 <https://www.energy.gov/science-innovation/energy-sources/fossil>
- 2 <https://ehp.niehs.nih.gov/ehp299/>
- 3 <http://www.thelancet.com/commissions/pollution-and-health>
- 4 *Neurotoxicology*. 2016 Sep;56:94-106. doi: 10.1016/j.neuro.2016.07.007. Epub 2016 Jul 19.
- 5 [http://www.euro.who.int/\\_\\_data/assets/pdf\\_file/0004/193108/REVIHAAP-Final-technical-report.pdf](http://www.euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report.pdf)
- 6 Project TENDR: Targeting Environmental Neuro-Developmental Risks. The Consensus Statement, *Environmental Health Perspectives*, volume 124/number 7/July 2016. <http://dx.doi.org/10.1289/EHP358>.
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