

Air pollution and brain health

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In their article, “Long-term exposure to air pollution and trajectories of cognitive decline among older adults,” Dr. Kulick and colleagues¹ examined the association between exposure to long-term air pollution and cognitive decline in older adults living in New York City.

How was the study done?

Dr. Kulick and colleagues looked at 2 groups of people living in northern Manhattan. The 2 groups are involved in 2 different studies examining factors that affect health in adults living in New York City. In one group (Washington Heights–Inwood Community Aging Project [WHICAP]), the goal of the long-term study is to better understand the relationship between aging and dementia. The second group (Northern Manhattan Study [NOMAS]) is enrolled in a study that evaluates cardiovascular risk factors and health in a multiethnic urban setting. In order to be enrolled in the studies, a person could not have dementia. In other words, these were people who had no cognitive problems when they entered into the trials. For the purposes of this study, there were 5,330 people in the WHICAP study. There were 1,093 in the NOMAS group. With regards to air pollution and cognitive decline, each group was analyzed separately.

There were slight differences between the 2 groups. First, the NOMAS group was generally a little younger. In addition, since NOMAS was looking at cardiovascular risk factors, anyone who had previously had a stroke was excluded. Both groups had detailed cognitive testing (also called neuropsychological testing) at least once during their participation. Both groups lived in northern Manhattan.

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In order to assess air pollution in northern Manhattan, the study authors looked at several factors. First, they used the participants' address and its relationship to the nearest major highway to assess traffic pollution exposure. They used Environmental Protection Agency (EPA) Air Quality System measurements to assess levels of air pollution. More specifically, they looked at measures of nitrogen dioxide (NO₂), fine particles (particulate matter [PM] less than 2.5 μm [PM_{2.5}]) and larger breathable particles (PM <10 μm [PM₁₀]). These types of pollution are routinely measured, and the amount of these is monitored by the EPA.

What were the results?

In relation to air pollution, there was a significant decline in cognitive function in the WHICAP group. These findings support other, prior studies that showed a relationship between air pollution exposure and declining cognition. This result was not observed when the authors analyzed the NOMAS group. In short, the findings did not match. The difference could be due to the subtle differences in the makeup of each group. This mixed result is similar to prior studies that have also shown conflicting answers. In some studies, there was a relationship between cognitive decline and air pollution; in others, there was not.

One possible reason for the difference in this study is that the observed changes were small. In the WHICAP group, the change in cognition was the equivalent of 1 year of aging. Although small, the global impact may be huge. If air pollution

causes more rapid cognitive decline, people who are exposed to long-term pollution may be at higher risk. In places where air pollution is very high, the risk of developing dementia or Alzheimer disease (AD) may be much higher.

Another possible explanation of the mixed results of these studies is that a study can only measure the exposure to pollutants during the study. The study cannot measure lifelong exposure to pollution and its effect on cognition. In order to know the person's lifetime exposure, a study would have to know all of the places a person has lived, and the time spent in each place. Furthermore, the study would need to know the levels of pollution at the time the person lived in that area. In our global society, this would be a very difficult task: What if someone grew up in Mexico City, moved to Switzerland, and later settled in Manhattan? How could a study calculate the lifetime exposure to air pollution for that person?

Why is this important?

There are many possible causes for cognitive decline, dementia, and AD. Some of these causes, like genetics, are untreatable. Other causes, such as high blood pressure, diabetes, and high cholesterol, can be treated. Adopting a healthy diet and incorporating regular exercise improves overall health, including brain health. Studies have already connected air pollution to lung disease and heart disease. Studies like this one suggest that exposure to air pollution also affects brain (neurologic) health. The answer to this seems

Figure Air Quality Index (AQI)

Air Quality Index Levels of Health Concern	Numerical value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for sensitive groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very unhealthy	201 to 300	Health alert: everyone may experience more serious health effects.
Hazardous	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.

Each AQI category is color-coded so that people can easily see whether air pollution is reaching unhealthy levels. Values above 500 are considered beyond the AQI. Reprinted with permission from airnow.gov/index.cfm?action=aqibasics.aqi. Accessed February 22, 2020.

simple. If air pollution contributes to poor health, by adopting environmental policies to improve air quality, we all benefit.

What is Alzheimer disease?

The study evaluated the association between air pollution and cognitive decline. As a person's thinking worsens over time, he or she may develop mild cognitive impairment. When the decline in memory, language, and problem-solving skills starts to affect a person's ability to perform everyday tasks, it is called dementia. The most common cause of dementia is AD.²

AD is an illness that causes a gradual loss of cognitive function.³ This change occurs very slowly, and affects people as they get older (usually older than 65; it rarely occurs before age 60). It is estimated that dementia affects 5 of 1,000 people between ages 65 and 70, and as high as 60 to 80 of 1,000 for those over 85.⁴ This means that there are about 4.5 million people in the United States who are living with AD.

There are many factors that lead to the development of AD. In some people, there is a genetic component. They may inherit genes that predispose them to developing AD. Some of these genes are the *APOE* gene, *PSEN1*, or *PSEN2*. However, for most people, the cause of AD seems to be multifactorial. Causes include high blood pressure, high cholesterol (lipids), stroke, diabetes, brain trauma, and a sedentary lifestyle. In addition, AD has been linked to chronic exposure to environmental substances like secondhand smoke, air pollution, and pesticides. It has been proposed that the more risk factors a person has, the more likely he or she is to later develop AD.

A person with AD most often complains of memory problems. At first, AD affects short-term memory (like recalling what you had for lunch yesterday). Later, it may affect long-term memory (like life events that may have occurred when the person was young).⁵ However, AD affects many other brain functions. For instance, a person with AD may also have problems with language (finding the right words to say), problems with judgment, changes in sleep patterns, and changes in mood or behavior. For instance, a person who was always mild-mannered may become more aggressive, suspicious, or belligerent when he or she develops AD.

If AD is suspected, a doctor may order a series of medical tests. Brain imaging (MRI, PET), blood and genetic testing, and detailed cognitive testing (also called neuropsychological testing) are often performed. In some people, an analysis of the fluid that surrounds the brain (called CSF) may be performed. The fluid is taken through a small needle inserted into the lower back, which is called the lumbar spine. This type of test is called a lumbar puncture; many people refer to it as a spinal tap. However, there is no single medical test that makes the diagnosis of AD. Instead, the diagnosis is made based on the combination of the person's symptoms, medical examination, and the results of these medical tests.

There is a growing list of treatments for AD. Often, the treatment consists of a combination of medicines, vitamins (like vitamin E), dietary adjustments, exercise, and cognitive rehabilitation. The treatment plan is individualized, and often involves family members. AD affects more than just the person who has the illness. Often, the caregivers need caring too. To be able to take the best care of the patient with AD, the primary caregiver must take care of himself or herself. The caregiver should be encouraged to learn more about the disease, and seek support from family, friends, and professionals.

Air pollution: A brief overview

Air pollution is a mixture of gases and fine solid particles that are carried by the air. Air pollution is highest in industrial areas and cities. Pollution comes from many places. Some comes from cars and other motor vehicles: as the fuel is burned in the engine, gases and particles are produced, and released into the air. Factories produce both chemical pollution, some of which goes into the air, as well as small particles. When some of these chemicals or gases react with sunlight, ozone is produced. Ozone is one of the main components of smog. When ozone is inhaled, it causes a number of lung and breathing problems.

The small particles in air pollution are also called PM. PM can be due to dusts, smoke (for instance, secondhand smoke from cigarettes), or pollens. Particles are also formed because there are chemical reactions between different air pollutants. There are 2 kinds of PM that pose health concerns: PM₁₀ (larger particles) and PM_{2.5} (very fine particles). The size of the particles is measured in microns (a micron is 1 millionth of 1 meter). PM₁₀ are 10 μm (or 10 millionths of a meter). PM_{2.5} are 2.5 μm (2.5 millionths of a meter).

The EPA uses the Air Quality Index (AQI) to measure air pollution (figure).

The EPA calculates the AQI EPA for 5 major air pollutants: ozone, particle pollution (also known as PM), carbon monoxide, sulfur dioxide, and nitrogen dioxide. The AQI grades the level of pollution by giving it a number: the higher the number, the greater is the concern for health issues. Exposure to air pollution has been linked to many kinds of lung and heart illnesses like asthma, heart attacks, and stroke.⁶

For more information

Brain & Life
brainandlife.org

Alzheimer's Association
alz.org

Family Caregiver Alliance
caregiver.org

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