

# Exercise, Air Pollution, and Brain Health

## The Good, the Bad, and the Mixed Bag

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### Related Article

#### Association of Air Pollution and Physical Activity With Brain Volumes

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Neurologists have traditionally been the doctors who are most expert at treating brain disease. Recently, there has been more focus on promoting brain health in an effort to prevent brain disease, and not simply treating problems after they arise. Many people are aware of general recommendations for brain health. These include eating a healthy diet, not smoking, exercising and sleeping regularly, limiting alcohol use, and staying mentally and socially active.

The researchers behind the study that is the subject of this article<sup>1</sup> took a deeper look at 2 key factors that may influence brain health: level of physical activity and exposure to air pollution. In general, physical activity and exercise are thought to be good for the brain. Some previous work suggests that exposure to air pollution is bad for the brain as well as the lungs. But what if you exercise in an area with high level of air pollution? Is the exercise still good for your brain? Or are any gains from exercise offset by the negative effects of exposure to air pollution? Until now, these questions have received little attention.

### How Was the Research Done?

A large study in the United Kingdom called UKB assessed health measures in more than half a million people between the ages of 40 and 69.<sup>1</sup> The researchers obtained general health information from this group. They invited a smaller part of this group to participate in more detailed studies. In one, participants wore a wrist device (similar to a Fitbit) that measured activity levels. In another, detailed MRI scans of the brain were obtained. The researchers also knew where each participant lived and were able to estimate the levels of different types of air pollution to which they were exposed. Therefore, when considering a smaller subset of participants (8,600) from the larger group, the researchers were able to look at connections between levels of physical activity, brain health as measured by MRI scans of the brain, and exposure to air pollution.

They had a hypothesis as to what the study might show. They thought that:

- Those who were more physically active would show less brain shrinkage and healthier white matter (the connections between parts of the brain) than inactive people of the same age
- Those exposed to more air pollution would have more brain shrinkage and less healthy white matter

They did not know what would happen to people who were physically active in areas with heavy air pollution, but they guessed that those people might breathe in more pollution from being more physically active, and that might increase the negative effects of air pollution exposure.

### What Did the Researchers Find?

As they had guessed, there was a strong connection between higher levels of physical activity and higher brain volumes. In other words, those with higher levels of physical activity showed less evidence of brain shrinkage on their MRI scans. The white matter (“wiring”) of the brain also looked healthier in those who were more physically active.

Also, as expected, the researchers found that exposure to air pollution was bad for the brain. The participants in the study did not live in areas with severe air pollution. Mostly they lived in urban areas where the air pollution was mild to moderate. It was clear from the researchers’ findings that more exposure to air pollution was associated with lower brain volumes (more brain shrinkage) than in those with little exposure.

What about those who had high levels of physical activity in areas with more air pollution? Here, the results were mixed. The good news is that there was no evidence of more brain shrinkage in this group than the other groups, but these participants’ white matter appeared less healthy on their brain scans, especially in those who did vigorous physical activity. There was little or no effect of this kind in people who were very inactive.

The results from this study are especially important because it is by far the biggest such study ever done.

### What Does This Mean for People Trying to Keep Their Brains Healthy?

The negative changes in brain health seen with exposure to air pollution were relatively small. For example, the amount of brain shrinkage attributed to air pollution exposure was less than the typical shrinkage seen with 1 year of normal aging. On the other hand, the positive effects of exercise were larger. The researchers estimated that the effect of regular, vigorous exercise on the brain was equivalent to being 3 years younger than a person’s actual age. Still, when these results were looked at together, it was clear that some of the positive effects of exercise were lost when exercise exposed people to more air pollutants. Similar findings have been seen in studies of heart and lung health. In other words, some of the heart-healthy benefits of exercise are lost if the exercise increases exposure to air pollution. It seems like there is a similar tradeoff with brain health.

There is still much that is not known about these factors with regard to brain health. It is important to know that high levels of activity in areas of air pollution did not erase all of the benefits of exercise. The study mostly looked at White participants, and we need to know more about the effects in a broader range of people, especially because people of color often live in areas with higher exposure to pollution. The levels of pollution exposure in this study were mild to moderate, and we need to know more about the effects of exposure to higher levels of pollution experienced by millions of people in other cities around the world.

For now, the authors note that the source of most air pollution is from traffic. They suggest running or biking along paths far from heavy traffic, though such options may be limited for some people in urban areas. In the long run, efforts to combat global warming and reduce dependence on fossil fuels and the air pollution they generate may produce longer-lasting solutions.

# About Brain Health

## The ABCs of Brain Health

As the US population ages, there has been increasing interest in promoting and maintaining brain health. Maintaining brain health as we age is closely tied to our quality of life. Brain health is really just a specialized brand of overall health, and in fact, many things that are good for the overall health of the body are also good for the health of the brain. This is still an evolving area of science and medicine, which is partly why people sometimes feel like they get mixed messages in the media about what is good or bad for brain health as new research emerges. Following is a list of 5 practices that most experts in brain health agree have strong evidence to support them.

### Get Plenty of Sleep and Stay on a Regular Sleep Schedule

Understanding what happens in the brain during sleep is an active area of ongoing research. We know that sleep helps with memory formation. Processes to clear potentially toxic substances from the brain also occur during sleep. Chronic interruptions of sleep from conditions like sleep apnea or other sleep disorders or constant changes in sleep schedule can affect brain function both in the short term and long term.

### Eat a Healthy Diet

This is an area that can be confusing, as one often sees news clips about the latest “superfood” that helps with brain function. It appears more likely that overall diet practices, rather than single foods, are most important to promote brain health. There is much research to support following a Mediterranean diet to promote brain health. This diet focuses on plant-based foods including whole grains, healthy fats like olive oil, and fish, with limited red meat and salt.

### Keep the Brain Active

This is an essential component of brain health. Not everyone has to do crossword puzzles: anything that makes one think—playing bridge, learning a new language, learning a new musical instrument—is beneficial to the brain and can strengthen and develop new connections in the brain. Most important is getting out of the routine and limiting passive activities like watching television. Any activity that feels like it takes a lot of mental energy is worthwhile.

### Stay Connected to Friends and Family

Humans are social animals, and social interactions are complex to navigate. Regular social interactions are good exercise for the brain. On the other hand, being isolated and having few social interactions has been clearly shown to be detrimental to brain health, and can also lead to anxiety and depression, which can add to negative effects on the brain.

### Get Regular Exercise

Exercise does not have to be at high intensity to be beneficial. Walking is a simple way to get beneficial exercise. Any other aerobic activity such as biking, swimming, or playing tennis can have similar benefits. People should aim to do one of these activities for 30–60 minutes several times per

week. This practice can have substantial benefits for the brain, as discussed more below.

## Measuring Brain Health

There are several ways to measure brain health. One way is to test the function of the brain with cognitive tests. These include tests of memory, language, problem solving, and similar tasks. This testing can be time consuming, and some of the tests can be challenging to interpret, for example because of cultural or language differences. Another way to measure brain health is to look at the structure of the brain by examining pictures of the brain such as CT scans and MRI scans. CT scans take pictures of the brain by taking multiple X-rays and having a computer reconstruct the images into a 3D picture. An MRI scanner uses a strong magnet (and no radiation) to take even more detailed pictures of the brain in 3 dimensions.

It is a fact of life that with aging, our brains gradually get smaller over time. When detailed pictures of the brain are taken in an MRI scanner, researchers can measure the size of different brain structures in the 3D MRI pictures. This method is called measuring brain volumes. While we all lose some brain volume over the decades, this process does not follow the same path in all people. People with certain brain diseases such as multiple sclerosis or Alzheimer disease have more rapid loss of brain volume. Although it is not a perfect measure, looking at brain volume in studies of various aspects of brain health can give a pretty good measure of whether something is good for the brain (slower loss of brain volume) or bad for the brain (more rapid loss of brain volume).

## Focus on Exercise and the Brain

This month's Patient Page explores the effects of exercise on the brain. This is an area supported by a large number of studies in animals and humans showing benefits of exercise for the brain. There are probably several ways exercise benefits the brain. Exercise helps keep the heart and lungs healthy and improves blood flow to the brain. In the same way that it helps keep blood vessels in the heart healthy and helps prevent heart attacks, exercise also helps keep blood vessels in the brain healthy and prevents stroke. People who exercise regularly are likely to have better control of their blood sugars, and are less prone to developing diabetes, which can have negative effects on brain health. Exercise can also do another amazing thing in the brain: it can help promote the birth of new brain cells. It is commonly believed that we are born with a certain number of brain cells and gradually lose them over the course of our lives. We now know that is not correct. Although our brains do lose brain cells and gradually get slightly smaller or “atrophy” over time, certain areas of the brain also make new brain cells, and this process is enhanced by exercise.

## Focus on Air Pollution and the Brain

We have known for years that exposure to air pollution is bad for the lungs and can worsen conditions like asthma and heart disease. It is becoming increasingly clear that living in areas with high levels of air pollution is bad for the brain also. There are several active research groups looking at the effects of air pollution on brain health, including the one that is the subject of this month's Patient

Page. Another Patient Page article from 2020 discussed a study showing that exposure to air pollution was associated with more rapid cognitive (thinking) decline.<sup>2</sup> Several earlier studies have used either brain imaging (pictures of the brain) or cognitive testing (testing of the thinking functions of the brain) to assess the effects of air pollution. Small particles that are components of air pollution are absorbed in the lungs and can travel through the blood and affect distant organs, including the brain. Researchers have to try to separate the direct effects of air pollution from other factors. For example, if people living in areas of high air pollution do not do as well on tests or have brain scans that do not look as healthy, researchers must consider whether that is a direct effect of air pollution on the brain, or whether that group of people differs in some other important ways (for example, level of education or socioeconomic status). Only with continued research can we be confident that it is the air pollution that is the direct cause of greater brain problems. Given the mounting evidence, avoiding long-term exposure to air pollution should be a goal for brain health for all people.

## For More Information

### Brain & Life

[brainandlife.org](http://brainandlife.org)

### American Brain Foundation

[americanbrainfoundation.org](http://americanbrainfoundation.org)

### McKnight Brain Foundation

[mcknightbrain.org](http://mcknightbrain.org)

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