Pollution May Dim Thinking Skills, Study in China Suggests

By **Mike Ives**

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HONG KONG — A large study in China suggests a link between air pollution and negative effects on people's language and math skills.

The link between pollution and respiratory diseases is well known, and most experts now believe that small particulates may also raise the risk for strokes and heart attacks. Whether this form of air pollution impairs cognition is not yet certain, but several studies have hinted at a connection.

The latest study, by researchers based in China and the United States, analyzed how long-term exposure to air pollution affected performance on nationwide math and word-recognition tests by more than 25,000 people across 162 Chinese counties. It was published on Monday in Proceedings of the National Academy of Sciences.

The authors based their findings on models they built that combined weather and pollution data from specific locations in China where people had taken nationwide tests in 2010 and 2014, as well as the test scores themselves. Their analysis tried to document how short- and long-term pollution exposure might have affected the scores — and, by extension, the test-takers' brains.

The authors found that the cognitive impact of cumulative exposure among the test takers was especially pronounced among older men, and that the results were troubling in part because cognitive decline and impairment are risk factors for Alzheimer's disease and other forms of dementia.

The study "further amplifies the need to tackle air pollution now to protect the health of particularly the young and elderly populations," Heather Adair-Rohani, a technical officer for public health and environment at the World Health Organization in Geneva, which was not involved in the study, said in an email.

Atmospheric pollution has long been recognized as a significant threat to global public health.

In 2016, the W.H.O. reported that 92 percent of people worldwide breathe what it classified as unhealthy air. It defined that air as having concentrations of fine particulate matter, known as PM2.5, above 10 micrograms per cubic meter, or 35.3 cubic feet.

The agency said in May that outdoor air pollution caused approximately 4.2 million premature deaths worldwide in 2016, more than a million of them in China, and that short- and long-term exposure increased the risk of stroke, heart disease, lung cancer and chronic and acute respiratory diseases.

This month a study in the journal Environmental Science & Technology Letters calculated that air pollution was reducing average life expectancies; the exact risk depended on location — around nine months in Russia, for example, or 1.9 years in Egypt.

But few epidemiological studies have analyzed associations between air pollution and cognition in older adults, a team of researchers from France and Britain wrote in a 2014 study in the journal Epidemiology. Their study found that traffic-related pollution in greater London was associated with declining cognitive functions over time among study participants, who had an average age of 66.

In China, which already has the world's largest population of people with dementia, the number is expected to rise to 75.6 million by 2030, up from about 44.4 million in 2013, according to a report that year by Alzheimer's Disease International, a nonprofit based in Chicago.

The new study's findings "imply that the indirect effect on social welfare could be much larger than previously thought," the authors wrote. "A narrow focus on the negative effect on health may underestimate the total cost of air pollution."

The study used test scores from the 2010 and 2014 editions of China Family Panel Studies, an interview-based exam given nationwide, as well as air-quality data from readings of three types of pollutants: sulfur dioxide, nitrogen dioxide and particulate matter that is smaller than 10 micrometers in diameter, called PM10.

"Essentially, we compare the same person in two time periods," said Zhang Xin, the study's lead author and a pollution expert at Bejing Normal University, referring to the study's methodology. "The major variation stems from exposure to local air pollution at the date of interview, which is largely random."

The study found that "accumulative exposure" had a pronounced impact on verbal test scores — especially for older, less-educated men — and that cutting the local concentration of PM10 to levels that meet United States Environmental Protection Agency air quality standards would move people up from the median, or 50th percentile, to the 58th percentile on math test scores and the 63rd percentile on verbal scores.

He Guojun, an economist at the Hong Kong University of Science and Technology who studies pollution in China, said that he hoped the new study would be the first of many to examine apparent links between pollution and cognition in China. "The paper is quite solid, both in terms of data and methodology and results," said Dr. He, who was not involved in the study.

The research tried to minimize the impact of other variables besides pollution. For example, it excluded test takers who migrated across counties between 2010 and 2014, and others who worked in mining, smelting, wood processing and other "polluted occupations."

However, Dr. He said, measuring long-term effects of pollution exposure can be difficult, in part because individual exposure depends on so many factors — including, for example, whether a person uses air filters at home.

In another critique, Rajasekhar Balasubramanian, an air quality expert at the National University of Singapore, noted that while the study's authors speculate that continued exposure to pollution can alter brain chemistry, they offered no clinical proof. (The authors agreed, writing that the hypothesis should be explored

further.)

But Dr. Balasubramanian said the study was useful in part because, while the effects of pollution on children's cognition had been documented by epidemiologists, this was the first to focus on such risks to China's older people. He said similar research was now needed in other countries.

"The outcome of such studies would provide a sound scientific basis for tightening air quality standards to curtail air pollution and protect public health in both developing and developed countries," Dr. Balasubramanian, who was not involved in the study, said in an emailed statement.

As public outrage has grown in China over smog and respiratory illnesses related to it, officials have in recent years closed hundreds of coal-fired power plants, imposed limits on driving and residential coal burning, and sent teams of police officers to inspect factories.

But China's carbon dioxide emissions increased last year, and even though the country is on its way to meeting its major climate change goals, many of its cities still have dangerously high levels of outdoor air pollution.

In one sign of the problems, a study published in April found that about 142 million people, or just over half the population surveyed in 155 Chinese cities, were exposed in 2014 to average annual "multicontaminant concentrations" that were above the World Health Organization's limits. The study said that eastern China and megacities were worst affected.