What's Next?

Expanded research during the past five years has answered many pressing questions about the health effects of PM and related exposures, but much remains to be learned. We do not yet understand the role of long-term PM exposure in the development of chronic disease. Further research is also needed to determine how long-term exposure combines with short-term fluctuations in PM levels to trigger acute problems such as heart attacks. In response to these needs, EPA recently issued a Request for Applications to examine the health effects of exposure to PM over a 10-year period.

EPA's research office will be investigating the significance of new hypotheses to explain the mechanisms by which PM causes disease and death. New research is needed to explain the effects of different physical and chemical properties of PM on human health, particularly on the most susceptible populations. With this understanding and an ability to link sources of PM to observed health effects, researchers will be able to produce information to help develop targeted control strategies to reduce human exposure.

EPA is completing the Air Quality Criteria Document for Particulate Matter, a comprehensive assessment of PM health and exposure science. This document will review the results of the approximately 2,000 studies that have been published since the last review in 1996. EPA will use this information to issue a proposal outlining whether the NAAQS should be revised.

Now that the National Monitoring Network has compiled several years of detailed $PM_{2.5}$ monitoring data, there is a critical need to accelerate research to help implement the NAAQS. EPA will use modeling and monitoring data to determine which states and regions are out of compliance with the NAAQS. EPA's research office is developing new analytical tools that will help these states and regions achieve NAAQS compliance.

Conclusions

EPA estimates that its current regulations to reduce air pollution can save tens of thousands of lives per year. It is estimated that hundreds of thousands of annual hospitalizations for cardiovascular and respiratory illnesses can be prevented by implementing these regulations. The monetary benefits alone from reduced deaths are estimated to be in the range of $100 billion per year. Future research will help to ensure that the populations most vulnerable to the effects of PM will be protected, and that the regulations will be implemented in the most effective ways possible.

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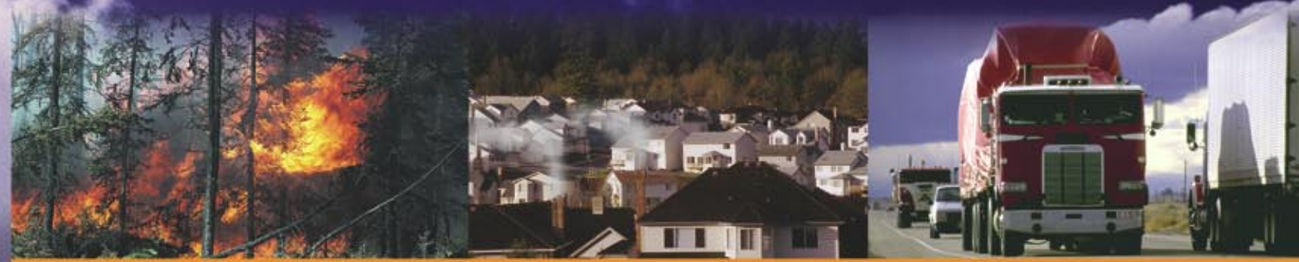
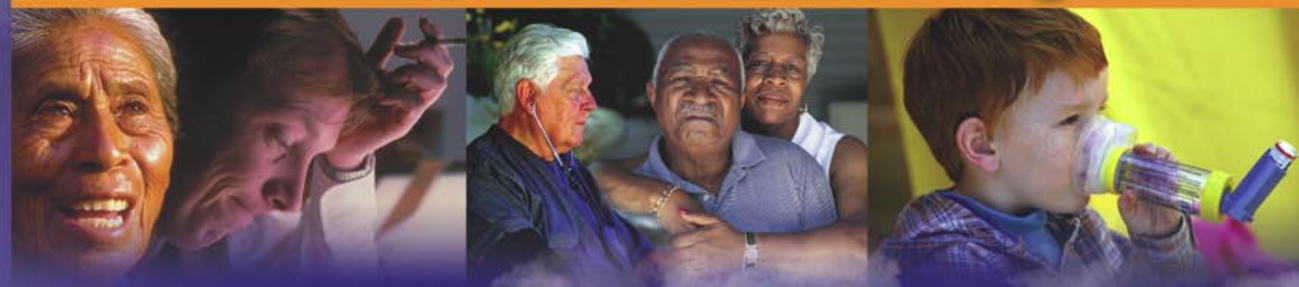


U.S. Environmental Protection Agency Research and Development

Particulate Matter Research Program



Five Years of Progress

Particulate Matter Research

Background

The U.S. Environmental Protection Agency (EPA) strives for every American community to have safe and healthy air. Research has shown that exposure to particulate matter (PM) air pollution is linked to increases in respiratory health problems, hospitalization for heart or lung disease and even premature death. The National Ambient Air Quality Standards (NAAQS) for PM, set by EPA in 1997, were designed to respond to this PM research and move the nation closer to achieving the Clean Air Goal. In 1998, Congress mandated that EPA accelerate its investigation of PM health effects and find ways to reduce the risks associated with exposure to PM. In response, EPA's research office developed a program to coordinate the work of its own scientists with that conducted by academics, partners such as the Health Effects Institute, and other Federal agencies such as the National Institutes of Health and the Department of Energy. The results of this effort have improved our understanding of the potential impacts of PM on human health, helped us develop tools to reduce harmful exposures, and advanced the science for future reviews of the PM NAAQS.

EPA research on PM has been conducted within a framework developed by the National Research Council (NRC) of the National Academy of Sciences, an independent committee of experts that was assembled at the request of EPA in 1998. The NRC Committee on Research Priorities for Airborne Particulate Matter identified the agenda that guided EPA in developing its PM research program. Eleven areas were specified to encourage researchers to:

- Evaluate actual PM exposures
- Determine the exposures of susceptible subpopulations to PM
- Determine the characteristics of PM from various emission sources
- Develop models to test air quality management strategies
- Assess the hazardous components of PM
- Determine what happens to PM after it is deposited in the lung
- Separate the effects of PM from other, gaseous pollutants and assess the effects of long-term exposure to PM
- Ascertain which subpopulations are most susceptible to PM effects
- Discover the specific biologic mechanisms by which PM causes adverse health effects
- Examine various statistical methods for estimating exposure to PM
- Develop technical support for modeling and measurement techniques

Results

PM Is Linked to Disease: Numerous studies conducted throughout the U.S. and the world have shown that short-term exposure to PM can adversely affect human health. Generally, exposure to PM is associated with illness and premature death independent of the effects of other, gaseous pollutants in the atmosphere. The very young, the genetically predisposed, the elderly, and those with pre-existing heart or lung disease are most susceptible to the adverse health effects of PM. Striking findings also suggest that extended PM exposure can lead to chronic disease and/or a shortened life span.

Fine Particles Move Indoors: Scientists have found that $PM_{2.5}$, the component of PM smaller than 2.5 micrometers in diameter, penetrates easily into most indoor environments—where people spend much of their time. While the strength of the correlation can vary by season and location, it appears that outdoor $PM_{2.5}$ levels reasonably represent personal exposure to $PM_{2.5}$. Exposure studies have also shown that background levels of other, gaseous pollutants, such as ozone and nitrogen dioxide, can be surrogate indicators for personal $PM_{2.5}$ exposure.

People with Lung Disease Collect More Particles in their Lungs: New findings demonstrate that $PM_{2.5}$ deposits in critical regions of the lung after it enters the respiratory tract. Some parts of a diseased lung collect 8 to10 times more particles than a healthy lung, a fact that has major implications for people with lung disease. This work suggests that people with lung disease may be more affected by increasing levels of PM because they receive greater doses.

Possible Mechanisms for Disease: We now have multiple hypotheses to explain how the chemical and physical properties of PM could produce disease. Further, we can now experimentally investigate the mechanisms that enable very small concentrations of inhaled PM to cause changes in the heart and lung that lead to increased illness and death. The laboratory and field evidence does not implicate one specific toxic quality of PM to the exclusion of others. Qualities such as the size of the PM and presence of certain chemical components, such as metals, all appear to contribute to its toxicity.

Models and Tools to Implement the PM NAAQS: Researchers have developed more advanced tools to measure and model fine particles. The models enable researchers to estimate how much PM will travel from a source of potentially toxic particles to populations that can be affected and to predict how reductions in PM emissions can impact exposure miles away. New, specialized measurement techniques should help us measure the particle size and composition of diverse kinds of PM and PM from unconventional sources.

Five Years of Progress