



## Exposure to Fine Particulate Matter (PM<sub>2.5</sub>) Increases Health Risks for Californians

### The Issue

One of the air pollutants of greatest concern for California and the nation has been particulate matter, especially PM<sub>2.5</sub>. PM<sub>2.5</sub> is a complex pollutant composed of microscopic particles 2.5 micrometers or smaller that can be inhaled deep into the lungs. PM<sub>2.5</sub> can be directly emitted from combustion or formed by chemical processes in the atmosphere. Long-term exposure to particulate matter, such as PM<sub>2.5</sub>, has consistently been linked to premature death<sup>1</sup>. The strongest association has been with deaths from cardiovascular causes. However, previous studies on the health effects of exposure to PM<sub>2.5</sub> typically include individuals from across the U.S. who may be subject to conditions that are different from those found in California. Previous studies have also raised the issue of how inhaled PM<sub>2.5</sub> affects the cardiovascular system. Scientists have recently started to study cardiovascular function, since alterations in these functions are hallmarks of cardiovascular disease.



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### Research Goals

In order to address this research gap, the studies discussed here examine the impact of air pollution on a population of men and women in California and on a separate population of elderly women educators (which may represent a more sensitive population). Understanding whether and how inhaled PM<sub>2.5</sub> can alter cardiovascular cellular functions pose challenges that limit our ability to adequately assess the level of risk that exposure to PM<sub>2.5</sub> poses to cardiovascular health. These studies, funded by the Air Resources Board (ARB) and the South Coast Air Quality Management District, address how the cardiovascular health of Californians is affected by PM<sub>2.5</sub> exposure statewide, and provide information on the mechanisms by which cardiovascular health is impacted.

### Results

The statewide study of 76,000 men and women tracked from 1982 to 2000 found:

- Significant associations with PM<sub>2.5</sub> exposure and elevated relative risks for death from cardiovascular disease, with the largest risk being observed for death due to heart attacks.
- Elevated risks for death due to heart attacks that were similar to the risks seen in national studies on the impact of PM<sub>2.5</sub> exposure on premature death.

The study of 100,000 women in California found:

- Exposure to PM<sub>2.5</sub> resulted in an elevated risk for death from heart attacks.
- Among post-menopausal women, exposure to PM<sub>2.5</sub> resulted in an elevated incidence of stroke.

<sup>1</sup> U.S. Environmental Protection Agency. Integrated Science Assessment for Particulate Matter (Final Report). 2009.

- A third study was conducted on mice, and was designed to investigate mechanistic pathways that could explain how inhaled PM2.5 could contribute to heart attacks and strokes. A common cause of heart attacks and strokes is development of clots in the blood stream. One suggested explanation is that PM2.5 exposure activates platelets, the key cells involved in blood clotting, so that they form clots which then trigger heart attacks and strokes. The study examined the platelets of mice exposed to PM2.5 from the San Joaquin Valley Air Basin, in both urban and rural areas, and found platelet activation in both winter and summer, which could promote clotting and lead to stroke and heart attacks.

## Conclusions and Impact

The results from the first two studies showed that PM2.5 exposure poses a health risk similar to that found in nationwide assessments. The third study used mice to investigate some of the potential mechanisms by which PM2.5 can damage the cardiovascular system and showed that PM2.5 can lead to heart-related illnesses. ARB estimates there were 7,300 to 11,000 annual premature cardiovascular or respiratory deaths associated with PM2.5 exposure in California from 2006 to 2008. PM2.5 in California mainly results from motor vehicle pollution, which is the focus of most of ARB's control and incentive programs. These programs have led to a 42 percent reduction in annual-average PM2.5 levels from 2000 to 2011. Although air quality is improving in all communities throughout the state, these studies demonstrate that there is a need to continue to reduce exposure to PM2.5 in California.

## Related Research

In addition to regulations to reduce mobile source pollution and other sources of PM2.5, ARB is also funding studies to reduce pollution exposures. These include development of guidance on the use and cost-effectiveness of in-duct and portable high-efficiency filtration for reducing exposure to air pollution from both indoor sources and outdoor sources that have infiltrated into the home. Another study is looking at the extent to which cabin filters in cars and school buses can reduce exposures to roadway pollution at a relatively low cost.



## More Information

For more information on the Health Effects of Air Pollution Research, visit [www.arb.ca.gov/research/health/health.htm](http://www.arb.ca.gov/research/health/health.htm).

## About the Air Resources Board's Research Program

California's progress on addressing environmental problems is guided by a strong scientific knowledge base. The Air Resources Board sponsors a comprehensive program of research into the causes, effects, and solutions of the air pollution problem, supporting its regulations on cars, trucks, fuels, power plants, and other sources. The research is done under the guidance of ARB's Research Screening Committee and in partnership with the University of California system and other research institutions.

Learn more about these projects including their final reports, public seminars, articles in scientific journals, and other products by visiting [www.arb.ca.gov/research](http://www.arb.ca.gov/research).