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Fine Particles Increase Hospital Admissions for Heart Failure and Cardiovascular Disease

Francesca Dominici, PhD

Short-term exposure to fine particulate matter—the microscopic particles that pollute the air—increased hospital admissions for cardiovascular and respiratory disease among Medicare participants, according to a study of 204 U.S. urban counties conducted by researchers at the **Johns Hopkins Bloomberg School of Public Health** and Yale University's environment school. In 2002, for every 10 μg/m3 increase in particulate matter, the researchers calculated 11,000 additional cardiovascular and respiratory disease hospitalizations. Increased risk for cardiovascular disease hospitalizations, as a result of increased levels of particulate matter, was highest in counties located in the eastern United States. The study authors created a reproducible approach for tracking the health risks of air pollution nationwide. The study is published in the March 8, 2006, edition of the *Journal of the American Medical Association*.

Particulate matter is an airborne mixture of solid particles and liquid droplets. The solid particles come in numerous shapes and sizes and may be composed of different chemical components. Fine particles, defined as 2.5 micrometers or less in size (approximately 1/30th the diameter of a human hair), can penetrate deep into the body's respiratory system. Airborne particles come from a variety of sources, including coal-burning power plants, factories, automobiles, tilled fields, stone crushing and the burning of wood. Other particles may be formed in the air when sunlight and water vapor react with gases emitted from burning fuels.

"By linking geographical locations and the health information of roughly all Medicare enrollees to the national air pollution and weather monitoring network, and to the U.S. census data, we can now routinely estimate health effects of air pollution nationally and regionally," said the study's lead author, Francesca Dominici, PhD, associate professor in the Department of Biostatistics at the Bloomberg School of Public Health.

The researchers estimated associations between day-to-day changes in hospital admission rates for cardiovascular and respiratory outcomes (heart failure, heart rhythm disturbances, cerebrovascular events, peripheral vascular disease, ischemic heart disease, chronic obstructive pulmonary disease and respiratory infection), as compared to fine particulate matter levels for 204 U.S. urban counties from 1999 to 2002. The study included 11.5 million Medicare enrollees who lived, on average, 5.9 miles from fine particulate matter monitors. The study authors used same

day hospitalizations for injuries as control measurements.

Dominici and her colleagues found that a 10 μg/m3 increase in particulate matter was associated with a 1.28 percent increase in the risk of admission for heart failure. Cook County, which includes Chicago, can be used as an example. The area has an annual average fine particle level of 16 μg/m3 and a high level of 56 μg/m3. For each 100 hospital admissions for heart failure, the study results showed approximately one extra hospital admission associated with each 10 μg/m3 daily fine particulate matter increase. Therefore, on days with the highest fine particle levels, the study results predicted five extra hospital admissions for each 100 hospital admissions.

The oldest group of study participants also experienced higher risks of ischemic heart disease, heart rhythm disturbances, heart failure and chronic obstructive pulmonary disease associated with high particulate matter level days. As expected, the researchers did not find any association between levels of fine particulate matter and injuries.

"Our study makes available all of the relevant material, software and methodology that support the principal findings. Reproducibility is critical for large studies with significant implications such as this one," said Roger D. Peng, PhD, co-author of the article and an advocate for making research reproducible by others.

Previously, researchers at the Bloomberg School of Public Health reported an association between particulate matter levels and mortality nationwide. Other research studies at the School showed associations between particulate matter and premature death from cardiopulmonary causes, hospitalization for respiratory or cardiovascular diseases and exacerbation of respiratory diseases.

"This study shows an ongoing threat to health from airborne particles. The sources of particles contributing to the observed risks need to be identified so that control strategies can be targeted efficiently. Research is shifting toward the difficult task of identifying the characteristics of particles that determine their toxicity," said Jonathan M. Samet, MD, senior author of the study and chair of the Bloomberg School of Public Health's Department of Epidemiology.

Samet, Dominici and colleagues last month received an $8 million Science to Achieve Results grant from the U.S. Environmental Protection Agency to establish a new center at the Bloomberg School to study the health effects of particulate matter.

More information on the Medicare Air Pollution Study 1999-2002 can be found at www.biostat.jhsph.edu/MCAPS.

Q&A: The Hazards of Fine Particulate Matter

Additional study authors from the Bloomberg School of Public Health are Roger D. Peng, PhD, Luu Pham, Aidan McDermott, PhD, Scott L. Zeger, PhD, and Jonathan Samet, MD. Michelle L. Bell, PhD, with the Yale School of Forestry and Environmental Studies, also coauthored the study.

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