PhD Dissertation Final Oral Defense

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Assessing Exposure to and Risks of Fine Particulate Air Pollution from Multiple Sources

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While fine particulate matter ($PM_{2.5}$) has long been associated with adverse health effects, relatively little is known about the differential risks posed by $PM_{2.5}$ from different sources. Current U.S. regulatory approaches treat all $PM_{2.5}$ as equally risky, regardless of its source. Methods identifying the most harmful particle sources are needed to improve $PM_{2.5}$ control strategies and enhance protection of public health. This work develops and demonstrates a method for assessing exposure to and risks of $PM_{2.5}$ from different sources in the southeastern United States and then applies this method to evaluate the benefits of a case-study state policy.

This research demonstrates a new exposure assessment approach for characterizing population exposure to $PM_{2.5}$ from different sources. Although emissions from power plants, biomass burning, and motor vehicles remain the leading $PM_{2.5}$ sources, ambient levels of $PM_{2.5}$ attributable to these sources, especially power plant emissions, have considerably declined over the past decade in areas where emission source densities are high. The results further suggest that routinely collected data on multiple air pollutants can offer valuable insights into sources of $PM_{2.5}$.

Using source-specific $PM_{2.5}$ exposure estimates, this research introduces a new risk assessment method for quantifying health impacts attributable to different $PM_{2.5}$ pollution sources. The results show that in the southeastern United States, the risk of premature death attributable to the leading air pollution sources declined between 2002 and 2012, preventing thousands of premature deaths.

Finally, this work employs the new risk assessment method to evaluate the benefits of the North Carolina (NC) Clean Smokestacks Act. The combination of state and federal policies to reduce emissions from coal-fired power plants has resulted in significant improvements in air quality and health in NC, and the Clean Smokestacks Act benefited air quality and health beyond the benefits of federal legislation alone.

While current regulatory approaches overlook the potential of source effects, this research demonstrates an integrated method to improve $PM_{2.5}$ control strategies. Future research should evaluate the potential for the development of techniques to combine the best qualities of existing data and methods and continued toxicological and epidemiologic evaluation to support source-based $PM_{2.5}$ risk assessment.

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