Relating ambient particulate matter concentration levels to mortality using an exposure simulator

Catherine A. Calder
The Ohio State University
Christopher H. Holloman
Steven M. Bortnick
Warren J. Strauss
Michele Morara
Battelle Memorial Institute

Abstract

Since the EPA began widespread monitoring of $PM_{2.5}$ concentration levels in the late 1990s, the epidemiological community has performed several observational studies relating $PM_{2.5}$ levels directly to various health endpoints including mortality and morbidity. Recent research, however, suggests that human exposure to the constituents of $PM_{2.5}$ may differ significantly from ambient (or outdoor) $PM_{2.5}$ levels measured by monitors since people spend a great deal of time in various indoor environments. To address this concern, we propose a three-stage Bayesian hierarchical model as an alternative to the Poisson Generalized Additive Model (GAM) that is traditionally used to characterize the relationship between $PM_{2.5}$ levels and health endpoints. Our approach includes a spatial model relating monitor readings to average county $PM_{2.5}$ levels and an exposure simulator that links average ambient $PM_{2.5}$ levels to average personal exposure using activity pattern data. We apply our model to a study population in North Carolina where we explore the effect of $PM_{2.5}$ exposure on cardiovascular mortality over a three-year period.