Assessing Uncertainty in Spatial Exposure Models for Air Pollution Health Effects Assessment

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Numerous epidemiologic studies now use models of intra-urban exposure, but there has been little systematic evaluation of the performance of difference models. In this paper we develop a modeling framework for assessing exposure model performance and the role of spatial autocorrelation in health effects estimation. Data was obtained from an exposure measurement substudy of subjects from the Southern California Childrens Health Study. We examine how the addition of spatial correlations to a previously described unified exposure and health outcome modeling framework affects estimates of exposure-response relationships using the substudy data. The methods proposed build upon previous work by Molitor et al., which developed measurement-error techniques to estimate long-term NO2 exposure and its effect on lung function in children. This paper further develops these methods by introducing between- and within-community spatial autocorrelation error terms. The analytical methods developed are set in a Bayesian framework where multi-stage models are fitted jointly, properly incorporating parameter estimation uncertainty at all levels of the modeling process. Findings suggest that the inclusion of residual spatial error terms improves the prediction of health effects. The results also demonstrate how residual spatial error may be used as a diagnostic for comparing exposure model performance.

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