

The value of ecologic studies: mercury concentration in ambient air and the risk of autism

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Abstract

Ecologic studies of the spatial relationship between disease and sources of environmental contamination can help to ascertain the degree of risk to populations from contamination and to inform legislation to ameliorate the risk. Population risks associated with persistent low-level mercury exposure have recently begun to be of concern and current reports implicate environmental mercury as a potential contributor in the etiology of various developmental and neurodegenerative diseases including autism and Alzheimer's disease. In this demonstration of preliminary findings, we demonstrate for Bexar County Texas and Santa Clara County California, the hypothesis that the spatial structure of the occurrence of autism has a positive co-variation with the spatial structure of the distribution of mercury in ambient air. The relative risk of autism is greater in the geographic areas of higher levels of ambient mercury. We find that the higher levels of ambient mercury are geographically associated with point sources of mercury emission, such as coal-fired power plants and cement plants with coal-fired kilns. Although this does not indicate a cause, these results should not be dismissed, but rather seen as a preliminary step for generating a hypothesis for further investigation.

Keywords: ambient mercury; autism; ecologic analysis; point sources.

Introduction

Ecologic designs can serve as preliminary diagnostics of population health. A major aim in studying the geographic

variation in health outcomes in ecologic designs is to formulate hypotheses about the etiology of disease by taking into account the spatial co-variation between the disease outcome and environmental factors. Furthermore, the visualization and exploration of co-varying spatial structures can lead to specifying statistical models that explain why one structure varies in response to another (1). Palmer et al. (2) demonstrated a significant association between increased environmental mercury release at the county level and increased rates of autism at the level of the school district across Texas. Ming et al. (3) found concentrations of autism spectrum disorders (ASDs) geographically associated with toxic landfills across the United States (US). Tang et al. (4) demonstrated that exposure to pollutants from a coal-fired power plant in a province of China adversely affected the development of children living in the area. In their 2009 article, Palmer et al. (5) also demonstrated a significant positive association between ambient mercury emission sources and rates of autism across Texas, using geographic proximity to the pollution source as a predictor variable. The results of this study suggested that distance to the source of environmental release explains the association between pounds of release and autism rates. These findings are consistent with prior literature demonstrating that proximity to mercury sources is related to greater loads of mercury in soil and plants (6, 7) and in human studies of occupational exposure (8, 9). Although their study was not intended to link cases of autism to sources of mercury contamination, Van Meter et al. (10) identified geographic clusters of cases of autism in California as a 'first hypothesis-generating step aimed at localized environmental exposures'.

In an unpublished analysis, we used data from the US Environmental Protection Agency (US EPA) National Air Toxics Assessment of 1996 (NATA, available from: <http://www.epa.gov/ttn/atw/nata/>), which is based on a comprehensive analysis of mercury emissions obtained from various State and local air pollution control agencies and from existing databases related to the air toxics regulatory program of the US EPA, including the Toxic Release Inventory. Ambient air mercury compound concentration density estimates were reported in tons per year, per square mile for each county in the US. Using statewide level autism data from the US Department of Education Office of Special Education and Rehabilitative Services 25th report to congress, and statewide estimates of the 1996 NATA data, we show that autism rates among children aged 3–5 years old in 2000 (namely, children conceived or born between 1995 and 1997 – the period during which the 1996 mercury emissions assessment was performed) were significantly higher among states having higher concentrations of ambient air mercury per square mile. Figure 1 depicts this association. The association remains

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