Social Susceptibility to Multiple Air Pollutants in Cardiovascular Disease

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Background

Cardiovascular disease (CVD), the leading cause of death in the US, is linked with chronic and acute air pollution exposures.1,2,4

1) Hospital CVD Data – All CVD emergency department (ED) events (n=1.2 million) at NYC hospitals 2005-2011, ICD-9 codes 390-459, from NY State Department of Health Statewide Planning and Research Cooperative System (SPARCS).
2) Citywide Air Pollution Data – Data from NYC Community Air Survey (NYCSS), which monitored 155 sites year-round for two years, and used Land Use Regression (LUR) to model nitrogen dioxide (NO_{2} ), fine particles (PM_{2.5} ), sulfur dioxide (SO_{2} ), ozone (O_{3} ).
3) Daily EPA Data – Daily averages from all NYC Air Quality System (AQS) stations for 2005-2011 were used to create a citywide trend. Daily AQS data was combined with NYCSS surfaces to create day- and residence-specific spatio-temporal estimates.
4) Census Tract Level Social Stressors
   I. SEP – Socioeconomic deprivation index (SDI). Spatially-stratified principal components analysis2 of 27 variables found 7 salient indicators from 2005-2009 American Community Survey (ACS)4.
   III. 2009 Violent Crime Rate/ 10,000 Population – Based on level point data on all violent crime events in NYC in 2009, from NYPD Incident Database.5 Residential population, 2007-2011 ACS.

Analyses

1) Case-Crossover (Conditional Logistic Regression): We tested daily spatio-temporal NO_{2}, PM_{2.5}, SO_{2}, and O_{3} vs. “1” ED CVD events
   - Time-stratified referent sampling, 6-6 lag days.
   - Adjusted for temperature, relative humidity, co-pollutants
   - Bonferroni Adjustment
2) Case-Crossover with Effect Modification: We tested modification in associations between spatio-temporal pollution exposures and risk of CVD, for lag day 0.
   - By tertiles of census tract social stressors
   - Bonferroni Adjustment
3) Survival Analysis: Age at CVD event, by individual race/ethnicity.
   - Cox Proportional Hazards: We tested annual mean NO_{2}, PM_{2.5}, SO_{2}, and O_{3} vs. age at CVD event using Cox proportional hazard models, adjusting for individual race and sex, and area-level SEP.
   - Sensitivity-tested effect of adjusting for all co-pollutants.

Aims

1) In ecologic cross-sectional analyses, test whether exposures to social factors and annual-average pollutants predict community age-adjusted CVD event rates in New York City (NYC).
2) Examine associations between spatio-temporal pollution exposures and CVD events using case-crossover models, across lag days 0-6.
3) Test effect modification by community-level social stressors.

Data

References


Future Directions

- Elucidate effects of residential segregation on observed modification.
- Refined spatio-temporal violence exposure metrics (e.g., by residential vs. daytime population).
- Disentangle modification by poverty into material and social/psychosocial components.
- Address off-support inference in comparing white & black populations differentially distributed across distributions of neighborhood stressors.

Cox Proportional Hazard Models

Results: Pollution was not significantly associated with risk of CVD.
- Individual-level race and sex had greatest effects.
- Non-Hispanic Blacks had a 75% greater relative hazard than did non-Hispanic whites, adjusted for social factors and chronic pollution.

Confounding by Race/ Ethnicity

Figure 4: Percent racial/ethnic composition, by census tract.

Results: Most tracts are largely white or blacks; few are truly mixed. Strong confounding among community factors and individual demographics (with little overlap) complicates interpretation of models for community-level modification.

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