The Complex Interactions Between Socio-Economic Position and Traffic-Related Air Pollution Effects

Marie S. O’Neill
Associate Professor of Epidemiology and Environmental Health Sciences
University of Michigan School of Public Health

Health Effects Institute Annual Meeting
Denver, Colorado
May 3, 2016
Health is socially patterned

- Socio-economic gradients not confined to just ‘the poor’-seen across whole range
- Individual & area level social determinants
- Influences occur throughout life course
- Environmental (physical) exposures may contribute to observed gradients

Research Triangle Park, NC Environmental Health Perspectives. 2005.
Commonly used indicators of socio-economic position (SEP)

• Individual
  – education, occupation, income

• Neighborhood/area
  – Composition (% people with high school degree, % literacy, % poverty)
  – Contextual (features of the community or society, parks, food stores, crime rate, social networks)
Air pollution, health and SEP

• Different effects of air pollution on health by SEP may be observed because of different patterns of
  – Exposure
  – Susceptibility
  – Both

Conceptual model: Neighborhoods and health

Air pollution exposure can differ by socio-economic level

- proximity to roadways: \( \uparrow \) particle/NO\(_2\) exposure, \( \downarrow \) O\(_3\) exposure (scavenging)
- settlement patterns (center city vs. suburbs), topography/meteorology
- indoor and occupational exposures
- location-dependent
  - Mexico City: richer neighborhoods, high O\(_3\)
  - Santiago, Chile: poorer neighborhoods, high PM
Individual susceptibility patterned by socio-economic factors

- Medical conditions (diabetes, CVD, asthma)
- Age structure of population
- Life “choices”: smoking, diet, exercise
- Access to anti-oxidant rich foods
- Infections (crowding, sanitation)
- Life course experience
Potential pathways for low education to increase susceptibility & exposure

Low educational attainment

↓

Lower health status (diabetes, hypertension)

↓

Low wage job, low income neighborhood

↓

- Higher levels of indoor pollutants (e.g., NO₂ from gas stove)
- Proximity to outdoor pollutant sources (e.g., diesel exhaust)
- Few nearby supermarkets with fresh fruits/vegetables
- Crowded living conditions (higher infection level)
- Low quality health care (access limited, prevention lacking)
- Violence/insecurity (in home or neighborhood) leading to stress
Research limitations

• Studies reveal patterns by education, but difficult to disentangle whether exposure, susceptibility or other factors contribute

Census tracts in Detroit showing green space and population characteristics relevant to vulnerability

Neighborhood Features Affecting Environmental Exposures

- Impervious Surface
- Vegetation
- Housing Quality
World Health Organization Air Quality Guidelines Global Update 2005: Environmental Equity Chapter


- Other AQG chapters address
  - international inequalities in exposure
  - socio-economic factors as correlate or indicator of individual susceptibility

http://www.who.int/phe/health_topics/outdoorair_aqg/en/
Environmental justice/equity

- Like value of life, term has an ethical component
- More than ‘inequality’ in exposure/outcome
- Addresses procedural justice

- Implicit moral judgment that environmental inequalities are unfair and we need to rectify them
- Intranational, international, and intergenerational justice
- **Fairness** as a goal of environmental management
  (South African constitution, State of California law)
Policy applications for ‘environmental equity’

• National standards, international guidelines typically pick one level
• Equity concerns not often taken into account in risk assessments
• But: intra-urban spatial variability
  – ‘hot spots’, esp. relevant to motor vehicle emission
Black carbon in 2 New York City communities differing by traffic density and socio-economic level (data of P.L. Kinney)

![Graph showing daily mean Black Carbon and Organic Carbon concentrations for 1/13/03-2/20/03]
Conclusion of WHO AQG Environmental equity chapter

‘At present…insufficient data exist to incorporate these emerging findings (on SEP and air pollution) quantitatively into the setting of air guidelines of general applicability.’

2015 review had the same basic conclusion—and new recommendations

Recommendations


Conduct studies using individual and neighborhood SEP measures together

Address spatial autocorrelation when evaluating whether inequities/injustices exist at small area units

Further explore reasons for heterogeneity in SEP/air pollution health effects associations
One solution: Community-based participatory research

- Questions designed jointly to address local problems
- Detroit Urban Research Center and affiliate projects
  Michigan professors present air pollution/asthma results at public hearings on important local policy issues

http://www.detroiturc.org/
Policy applications-Detroit

Map 4: Prioritized Tree Planting Areas to Enhance Vehicular Air Pollution Removal

Legend
- 2010 Block Group Boundaries
- Detroit City Council Districts
- Value:
  - Very Low Priority
  - Low Priority
  - Medium Priority
  - High Priority
  - Very High Priority

http://caphedetroit.sph.umich.edu/wp-content/uploads/2016/02/NIEHS-Grantees-Meeting-Presentation-1-12-16-FINAL.pdf
Conclusions/Questions

• Heterogeneity in SEP and traffic pollution associations
• How can observed environmental inequities be translated to policy?
• What type of research would be useful for guiding specific policies?
Conclusions/Questions (2)

- Select SEP indicators relevant for policy decisions and interventions
  - “understanding whether differences in risk are more strongly driven by geography, demographics, or other factors (e.g., behaviors, co-exposures) is important in designing optimal interventions.”


Select indicators in conjunction with local stakeholders

Clougherty et al 2014 The Role of Non-Chemical Stressors in Mediating Socioeconomic Susceptibility to Environmental Chemicals Curr Envir Health Rpt (2014) 1:302–313
Conclusions/Questions (3)

• Goals for research
  – Comparability across regions
  – Applicability within a local area

• SEP index versus single variables
  – Capturing complexity, addressing correlations and cumulative risk
  – Communicating potential interventions on specific constructs

• Include multiple disciplines and sectors in design and conduct of research
Thank you!

marieo@umich.edu