Overview of Ozone Epidemiology

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EPA's Causal Determinations

Health Outcome	Short-term Exposure		Long-term Exposure	
	2008 Review	2015 Review	2008 Review	2015 Review
Respiratory effects (including mortality)	Causal	Causal	Suggestive	**Likely to be causal**
All-cause mortality	Suggestive	**Likely to be causal**	Little evidence	**Suggestive**
Cardiovascular effects (including mortality)	Suggestive	**Likely to be causal**	No conclusion	**Suggestive**

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Administrator's Proposed Conclusions – Epidemiology Studies

Exposure	Administrator's Conclusion	Elsewhere in Proposed Rule	Uncertainties
Short Term	Small, reversible changes in lung function and inflammation, respiratory ED visits, HA, all-cause mortality	• Administrator "places relatively less weight on epidemiology-based risk estimates" • Heterogeneity across locations • Exposure measurement error • Shape of C-R functions in lower portions of ambient distributions	Exp measurement error, modeling specifications, and confounders (*e.g.,* co-pollutants, temperature, flu epidemics)
Long Term	Respiratory morbidity and mortality "likely" to be causal	• Only one "well-designed" long-term mortality study (Jerrett *et al.*, 2009) • Uncertainty about threshold	Exp measurement error and confounders (*e.g.,* smoking, SES)

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Ozone Epidemiology Study Designs

- Short-term exposure (hours, days, or weeks)
  - Time-series studies
  - Case-crossover studies
  - Panel studies
- Long-term exposure (months, years)
  - Longitudinal cohort studies
- One time point
  - Cross-sectional studies

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Time-series Studies

- Aggregate estimates of exposure and health

  - Central site monitors and existing databases

- **Population-average** rates of acute health events

  - Hospital admissions (HA), emergency department (ED) visits, death rates

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Case-crossover Studies

- **_Individual-level_** exposure estimates
  - Central site monitors often used
  - Case period *vs.* control period
- **_Individual-level_** acute health events
  - Administrative data often used: hospital admissions (HA), emergency department (ED) visits
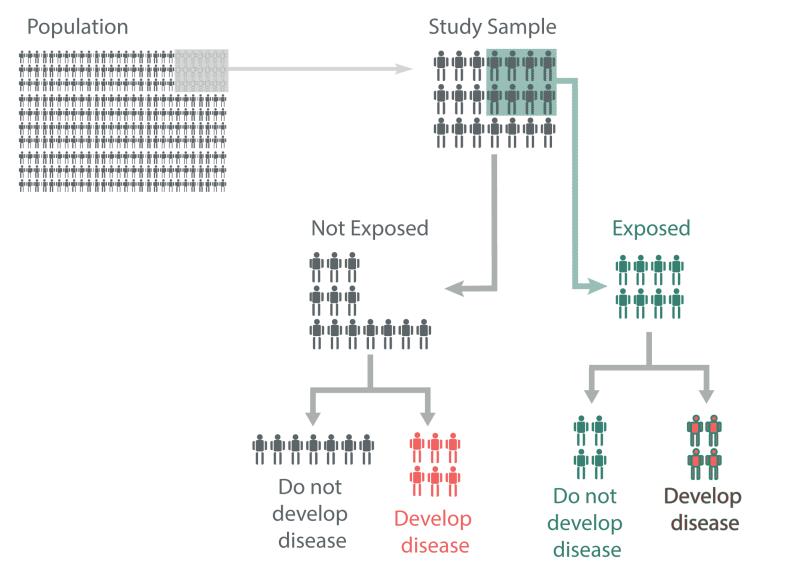
Panel Studies

- Repeatedly assess health status of **individual subjects**

- Time-varying ozone exposure

  - Central-site monitoring or personal exposure

- Commonly used to investigate lung function and asthma symptoms

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Longitudinal Cohort Studies

Cross-sectional Studies

- Exposure status and disease status are measured at one point in time or over a short period. No follow-up.

- Comparison of disease prevalence among exposed and non-exposed (*e.g.,* asthma prevalence)

December 12, 2010

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Strengths of Ozone Epidemiology Studies

- Can assess health status in a large population over many years

- Can capture temporal ozone concentration variability

- Can make individual-level causal inference

- Can control for temporal trends

- Can deal with time-invariant subject characteristics

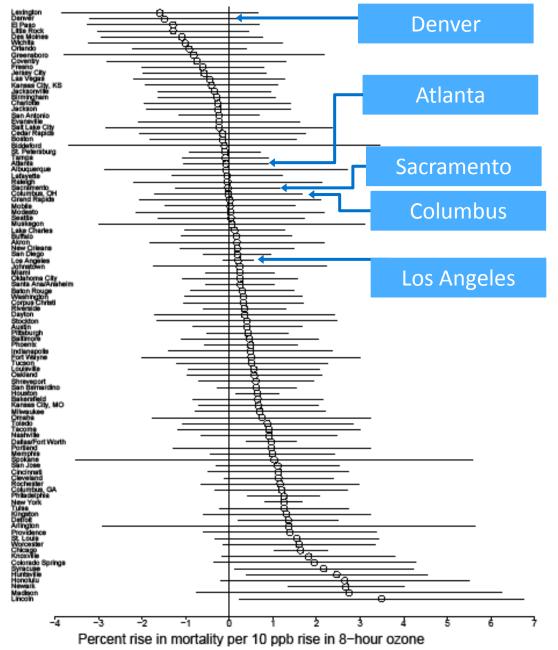GRADIENT

Limitations in Ozone Epidemiology Studies

- Ecological fallacy

- Confounding

- Prevalence measures (vs. incidence)

- Low compliance (panel studies)

- Exposure measurement error

- Disease measurement error

- Model misspecification

- Model selection bias

- Publication bias

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Heterogeneity

8-HOUR OZONE-MORTALITY COEFFICIENTS
RAW ESTIMATES AND 95% CONFIDENCE INTERVALS

Denver

Atlanta

Sacramento

Columbus

Los Angeles

Percent rise in mortality per 10 ppb rise in 8−hour ozone

Smith *et al.* (2009)