

# Demystifying Causal Inference In Air Pollution Epidemiology

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**Background:** The promise of identifying causal relationships between, for example, air pollution exposure and human health, has rightly generated ample enthusiasm in air pollution research. However, confusion remains as to what exactly makes a method a causal one, how exactly such methods differ from traditional approaches, and where evidence derived from causal methods fits with the large body of research on the relationships between air pollution and health.

**Workshop Objective:** To promote literacy among the general air pollution community on issues related to inferring causal relationships in observational air pollution research. To provide a framework for the general consumer of air pollution research to understand and assess the increasing amount of work being labeled as “causal.”

**Target Audience:** The general informed consumer of air pollution research. Expertise in statistical methods and/or econometrics is not required, but participants are expected to have familiarity with the epidemiological literature pertaining to air pollution and health.

**Description of Workshop:** This workshop will provide a broad overview of inferring causal relationships in air pollution studies. The focus is not instruction on specific statistical methods, but rather the description of a foundational perspective on methods for causal inference that underlie a large body of air pollution research. Frequent and interactive use of familiar examples will help illustrate how a potential-outcomes perspective on causal inference can shed light on different types of research studies and designs, regardless of whether such studies are explicitly labeled as “causal.” Participants should leave this workshop with: a) improved ability to determine what makes a particular research study “causal,” b) a framework with which to evaluate the assumptions underlying the causal validity of a particular result, c) improved ability to place the evidence from causal studies in proper context with the vast literature on the relationships between pollution exposure and human health.

## **Requested background reading:**

- Glass et al. (2013). Causal inference in public health. *Annual Review of Public Health* 34.
- Zigler and Dominici (2014). Point: Clarifying Policy Evidence With Potential-Outcomes Thinking - Beyond Exposure-Response Estimation in Air Pollution Epidemiology. *American Journal of Epidemiology* 180(12).

# Outline

## I. Introduction: Causal Inference: What it is (and what it is not)

- i. Introduction of familiar “causal” questions that will be used to anchor workshop discussion
- ii. What causal inference is: A general analytic perspective
- iii. What causal inference is not: A specific method or a magic silver bullet
- iv. “Classical” paradigm for causal inference and biologic causality
- v. “Potential Outcomes” paradigm for causal inference and consequences of (possibly hypothetical) actions

## II. Framing Observational Studies as Approximate Randomized Experiments

- i. Prelude: Why randomized experiments are the “gold standard” for causal inference
- ii. The experimental paradigm for observational data: “Designing” a hypothetical experiment that defines a causal effect
- iii. “Analyzing” the hypothetical experiment to estimate the causal effect
- iv. Key assumptions for causal validity
- v. An overview of some relevant methods
  - Methods for observed confounding adjustment
  - Methods for unmeasured confounding

————— Break —————

## III. Rapid Fire Examples

Discussion (with audience participation via Q/A sheet distributed during the break) of several familiar studies from the literature, all from a causal inference perspective. Examples will involve studies that have been explicitly labeled as “causal” as well as those that have not, including (among others) a causal evaluation of the Six Cities Study.

## IV. Putting it All Together: Illustrative Case Study: Causal effects of PM<sub>2.5</sub> Nonattainment Designations

## V. Questions/Open Discussion