

# Segment 1: Fundamentals of Causal Inference

## Section 02: The “Classical” Paradigm for Causal Inference

# A Useful Distinction Between Causal Inference Paradigms

1. The Classical Paradigm: Judgment of causality based on criteria about the relationship between a potential cause and an observed effect.
  - ▶ We observe that smoking is associated with lung cancer. What would we need to know about this association in order to determine that smoking *causes* lung cancer?
2. Potential Outcomes Paradigm: Comparison of outcomes under different actions.
  - ▶ What would be the difference in lung cancer status if somebody did vs. did not smoke?

**Required reading:** Glass TA, Goodman SN, Hernan MA, and Samet JS (2013). Causal Inference in Public Health, *Annual Reviews of Public Health* 34, pp. 61-75.

## “Classical” Paradigm: Bradford Hill Criteria

**Example:** There is an apparent association between cigarette smoking and the occurrence of lung cancer.

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**Example:** There is an apparent association between cigarette smoking and the occurrence of lung cancer.

1. **Strength:** the larger the association, the more likely that it is causal
2. **Consistency/reproducibility of findings in different studies/places/samples/etc.**
3. **Specificity:** Is there a very specific population with no other likely explanation
4. **Temporality:** Effect must occur after the cause
5. **Biological gradient:** Greater exposure → greater effect
6. **Plausibility of mechanism**
7. **Coherence**
8. **Analogous with other similar agents and diseases**
9. **Experimental evidence:** introduction of presumed causal agent

# Practice of the Classical Paradigm

- ▶ An association between a nominal cause (e.g., smoking) and an effect (e.g., lung cancer) is observed
  - ▶ Possibly in many different research studies
  - ▶ Possibly in many different populations and conditions
  - ▶ Possibly with a variety of statistical models/analyses
- ▶ The Bradford Hill criteria are applied to the association
  - ▶ Observed data
  - ▶ Biological/physical/mechanistic knowledge
  - ▶ Other considerations
- ▶ A judgment is made about the strength of belief that the observed association is *causal*

# Example of the Classical Paradigm in Practice

Causality is viewed as the end of a *continuum of evidence*

- ▶ Many research studies document an relationship between exposure to fine particulate air pollution (PM2.5) and respiratory health
- ▶ To inform federal regulations, the U.S. Environmental Protection Agency conducts an *Integrated Science Assessment* summarizing all of the evidence of the relationship between PM2.5 and respiratory health
- ▶ The body of evidence is classified as either “likely,” “suggestive,” “inadequate,” or “not likely” to suggest a causal relationship between pollution and health

*A growing body of evidence...supports the general conclusion that PM2.5...are **likely causally related** to cardiovascular and respiratory mortality and morbidity - EPA Integrated Science Assessment 2009 (emphasis added)*

# Causal Inference in Public Health

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