Introduction

Arvid Sjölander

Department of Medical Epidemiology and Biostatistics
Karolinska Institutet

A short course on concepts and methods in Causal Inference

Definition of epidemiology

*Epidemiology is the science that studies the patterns, **causes, and effects** of health and disease conditions in defined populations.*

Wikipedia, 2015

Statistical association

- Any attempt to discover a causal effect often starts by observing a **statistical association**
- A 'statistical association' between two factors means that they 'tend to appear together'
  - lung cancer is more common among smokers than among non-smokers
  - sickness is more common in hospitals than outside hospitals

Association vs causation

- However, **association does not imply a causation**
- *Apart from a true causal effect, what could possibly explain the association between*
  - *smoking and lung cancer?*
  - *hospitals and sickness?*

The Bradford Hill criteria for causation (1965)

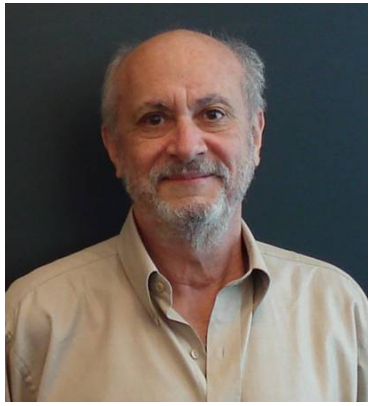
- Strength of association
- Consistency
- Specificity
- Temporality
- Dose-response relationship
- Plausibility
- Coherence
- Experimental evidence
- Analogy

Definition of causal effect

- The Bradford Hill criteria is a checklist of important considerations to make, when trying to infer causality
- The criteria do not **define** a causal effect
  - a causal effect may satisfy all or none of the criteria (apart from temporality, which is absolute)
- So what is the definition of a 'causal effect'?

Brief history of causal inference, 70's

- Donald Rubin developed a formal definition of causal effects
  - **potential outcomes**
  - **counterfactuals**



Brief history of causal inference, 80's

- James Robins discovered - and solved - some important problems with longitudinal studies, from a causal inference perspective
  - **Marginal Structural Models** (MSMs)
  - **Structural Nested Models** (SNMs)

Brief history of causal inference, 90's

- Judea Pearl developed **Directed Acyclic Graphs** (DAGs)
  - simplify interpretation and communication in causal inference
  - useful for covariate selection in observational studies

Outline

- Association vs causation
- Estimation of causal effects
- Directed Acyclic Graphs (DAGs)
- Multiple exposures
- Regression models

Before we start...

- Causal inference has been an intense research field over the last 20 years
  - countless papers and several books
- This is a brief introduction course
  - we will only have time to scratch the surface