Bias and confounding

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Learning objectives

- **By the end of this lecture, the students will be able to:**

1. Discriminate between different types of bias and confounders.
2. Identify the drawbacks of introducing bias and confounders in the research.
3. Understand methods to overcome bias and confounders.

What does bias mean?

Bias occurs when there is a systematic difference between the results from a study and the true situation.

Bias may be introduced at all stages of the research process, from study design, to analysis and publication.

Bias can create a fake association (i.e., overestimation or underestimation of an effect).

Types of bias

- There are many forms of bias which may be categorized as:

A. Selection bias.

B. Information bias.

C. Funding bias.

D. Publication bias.

E. Confounding bias.

A. Selection bias

- Selection bias occurs when patients included in the study are not representative of the population to which the results will be applied,

- ***For example:***

Patients who agree to participate in a study may differ from those who do not agree to participate (this form of bias is a particular problem in retrospective studies, where patients who have died are excluded from the study).

Selection bias includes the following:

- ***Ascertainment bias*** may occur when the sample included in a study is not randomly selected from the population.

- ***For example:***

When doctors are interested in the genetics of a particular medical condition, they collect information on the patients in their clinic, rather than using a random sample from the population.

- ***Attrition bias*** arises when those who are lost to follow-up in a longitudinal study differ from those who are not lost to follow-up.

- **Response bias** is caused by differences in characteristics between those who choose or volunteer to participate in a study and those who do not.
- **Survivorship bias** occurs when a study includes only those subjects who have "survived" long enough to receive certain intervention.
- This can lead to systematically distorted results, because those who died were unable to receive the intervention.

For example,

- Imagine a long-term cohort of cancer patients being studied from 2010–2020.
- A new targeted drug becomes available in **2015**.
- Researchers compare survival between patients who received the new drug and those who did not.
- Patients who lived until 2015 could receive the drug, but patients who died before 2015 obviously could not.
- If survival is measured from 2010, it will look like the drug-treated group lives longer, but much of that “extra survival” occurred **before** they even received the drug.

B. Information Bias

- Arises when there are systematic errors in measuring exposure or outcome.

For example

- Participants may underreport behaviors such as smoking or alcohol use (recall bias), or medical records may contain incorrect diagnoses.
- Information bias can distort the association between exposure and outcome, leading to either **overestimation** or **underestimation** of true effects.

Information bias includes the following:

I. Central Tendency Bias

- Arises when using a Likert scale (comprising a small number of graded alternative responses such as very poor, poor, no opinion, good, excellent), where responders tend to move towards the mid-point of the scale (usually ‘no opinion’ or ‘just right’).
- As a result, data become clustered around the center of the scale.
- This bias can distort study findings, especially in assessments of satisfaction, performance, or attitudes.

II. Measurement Bias

- Measurement bias occurs when the instruments or procedures used to collect data distort the results in one direction.

For example

- Using a miscalibrated blood pressure cuff that consistently reads higher values can lead to an overestimation of hypertension prevalence.

III. Misclassification Bias

- Arises when individuals are **incorrectly categorized** with respect to their exposure or outcome variables.

For example:

- A person **with a disease** is mistakenly recorded as **disease-free**.
- A person **exposed** to a risk factor is recorded as **unexposed**.

Causes:

1. **Inaccurate measurement tools** (faulty test, poor questionnaire design)
2. **Recall errors** by participants
3. **Data entry errors**
4. **Observer bias** during assessment

IV. Observer Bias

- Occurs when one observer tends to under-report (or over-report) a particular variable; also called **assessment bias**.

V. Reporting Bias

- Occurs when participants give answers in the direction they perceive is of interest to the researcher or under-report socially unacceptable or embarrassing behaviors (e.g., alcohol consumption or sexually transmitted diseases).

C. Funding Bias

- **Funding bias occurs when the *source of financial support* for a study influences its design, methods, analysis, or reporting in a way that favors the sponsor's interests.**

What does it mean?

When a company, organization, or group funds research, there is a risk, intentional or unintentional, that:

- The study is designed to produce favorable outcomes.
- Unfavorable results are suppressed or not published.
- Data analysis is interpreted in a sponsor-friendly way.
- Only certain comparisons are chosen to increase the chance of positive findings.

D. Publication Bias

- **Publication bias refers to the tendency for studies with favorable results to be published more often and more quickly than those with unfavorable results.**

Why does it happen?

Publication bias occurs because:

- Journals prefer positive findings.
- Researchers may not submit negative results (“file-drawer effect”).
- Sponsors may discourage publication of unfavorable data.
- Peer reviewers may view null results as less valuable.

E. Confounding: What is it?

- **Confounding** occurs when we find a **FAKE** association between a potential risk factor and a disease outcome or miss a real association between them because we have failed to adjust for any confounding variables.
- **A confounding variable** or **confounder** is **associated with both** the exposure and the outcome.

For Example,

- We may be interested in studying the effect of smoking status on the incidence of coronary heart disease (CHD) in men.
- However, we know that alcohol consumption is associated with the development of CHD, and that alcohol consumption and smoking are also related to each other (i.e., men who consume alcohol are more likely to smoke than men who do not drink alcohol).
- Thus, in this study, unless we adjust for it, the effect of alcohol consumption may confound an apparent relationship between smoking and the incidence of CHD.

Methods to Control Bias and Confounders

1. During Study Design
2. During Data Collection
3. During Data Analysis

1. During Study Design

- **Randomization:**
  - •Randomly assign participants to exposure or treatment groups.
- **Restriction:**
  - •Limit study participants to a specific category of a confounding variable.
  - •Example: include only non-smokers or only females.
- **Matching:**
  - •Select control groups with similar characteristics (e.g., age, sex) as the case groups.
  - •Commonly used in case–control studies.

- **Blinding (Masking):**
  - Keep participants, investigators, biostatisticians, and sponsors unaware of exposure or treatment status.
- **Standardization of Procedures:**
  - Use uniform instruments, questionnaires, and protocols for all participants.
  - This reduces measurement variability and interviewer bias.

2. During Data Collection

- **Use of validated tools:**
  - Employ standardized, pretested instruments to ensure accuracy.
- **Training and calibration:**
  - Train and calibrate examiners to maintain consistency.
- **Reducing recall bias:**
  - Use objective data sources (e.g., medical records) or shorten recall periods.
- **Blinded data collection:**
  - Ensure data collectors do not know participants' exposure or outcome status.

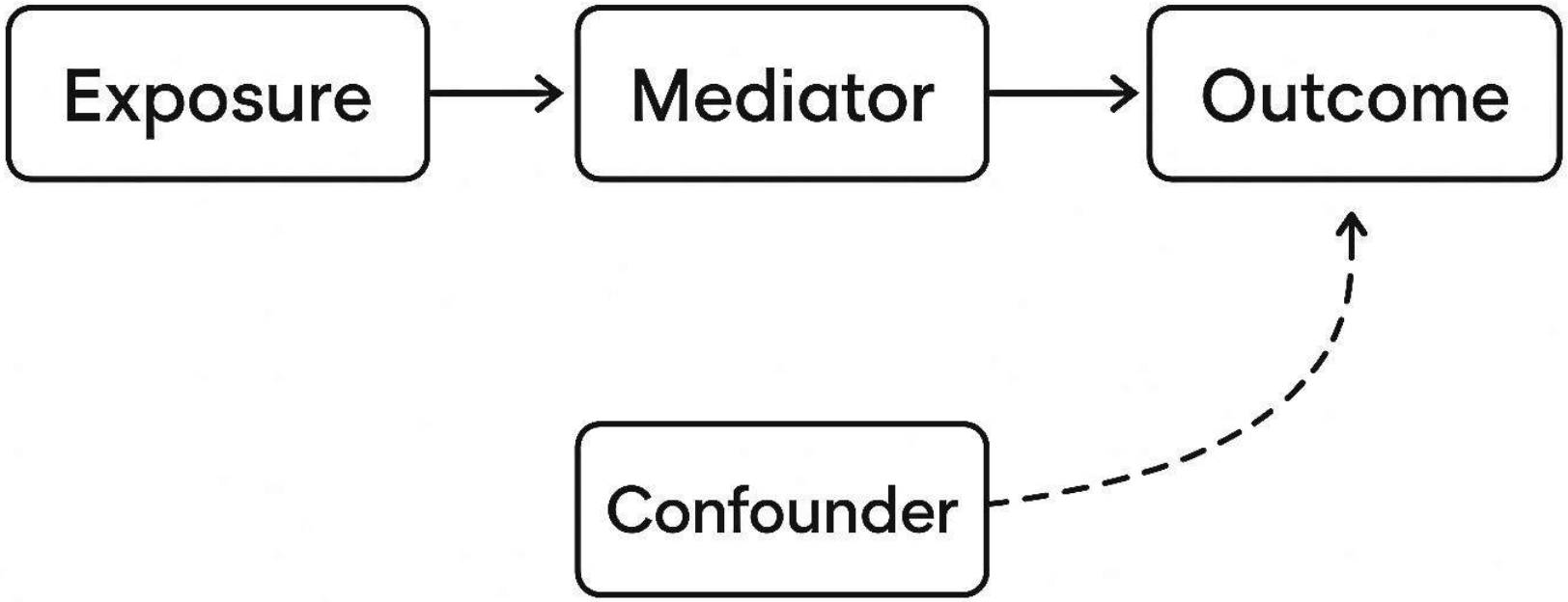
3. During Data Analysis

- **Stratification:**
  - Analyze results within subgroups of a confounding variable (e.g., by age or sex).
- **Multivariable analysis:**
  - Use statistical models such as logistic or linear regression to adjust for several confounders simultaneously.

The causal pathway and confounding

- The **causal pathway** is the chain of events that, in sequence, lead to an outcome.
- The causal pathway helps us consider opportunities for disease prevention.
- We should not confuse mediators, which are part of the causal chain and confounders, which are not part of it.
- ***For Example:*** **multiple births → preterm delivery → neonatal cerebral damage in cerebral palsy**
- We should **not adjust** for variables that lie **on the causal pathway** between exposure and outcome.

The causal pathway and confounding



Thanks