Designing Popu
Health Stud

March 31 and April 2 202

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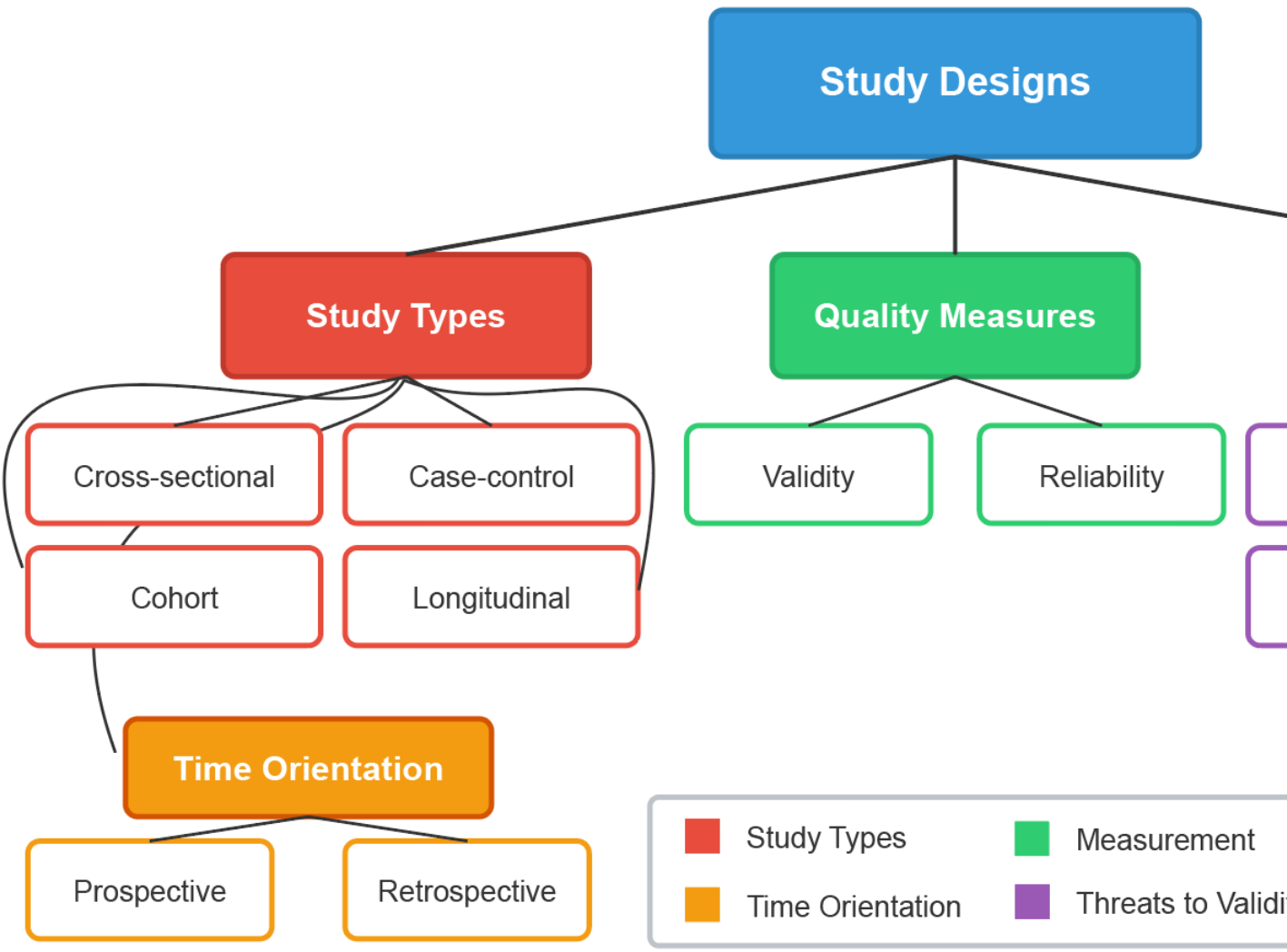

Study Designs
Study Types
Quality Measures
Cross-sectional
Case-control
Cohort
Longitudinal
Validity
Reliability
Time Orientation
Prospective
Retrospective
Study Types
Measurement
Time Orientation
Threats to Validi

Chapter Overview

- Research design fundamentals in epidemiology a
- Measurement validity and reliability
- Error and bias in population health research
- Study design approaches:
  - Cross-sectional
  - Case-control
  - Cohort
  - Experimental
- Qualitative methods and their integration with q
- Ethical considerations in population health resea

1 A Matter of Measureme

Primary vs. Secondary Data

Primary data:

- Data collected specifically for the purpose

Secondary data:

- Data collected for other purposes but reor
reanalyzed.

Examples:

- Health insurance claims data
- Employment records
- National health surveys

2 Primary vs. Secondary

- **Primary data**
  - Collected specifically for a new study
  - Controlled by the researcher
  - Tailored to answer specific research questions
- **Secondary data**
  - Pre-existing data collected for another purpose
  - Often large-scale and readily available
  - May require cleaning or transformation

While primary data offers control and preci
data can save time and resources.

3 Levels of Measurement

Level	Description	Example
Nominal	Categories with no ranking	Blood type, Sex
Ordinal	Ordered categories	Health self-rating: excelle good, fair, poor
Interval	Equal units, no true zero	Temperature in °C
Ratio	Equal units with true zero	Weight, Blood pressure

Understanding measurement levels is crucial for selecting app analyses. *A variable can always be reduced to a lower level of m* categorical), *but not elevated* (categorical to continuous).

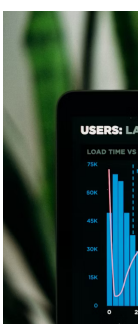
4 Ecological Studies and

- **Unit of analysis:** Group (e.g., city-level data)
- **Examples:**
  - Community fluoride levels and dental caries
  - Countries' smoking rates and lung cancer rates
- **Ecological fallacy:** Attributing group-level associations to individuals
- **Example:**
  - Classrooms with more women had higher average grades
  - But individual-level analysis showed men had higher grades in each classroom

Classroom A
F 70
F 70
F 70
F 75
F 70
F 80
F 80
F 80
M 95
M 100
Class Mean
F 74, M 98, FM 79

5 Variables and Levels of Measurement

- **Categorical variables:**
  - *Dichotomous* (e.g., male/female)
  - *Polytomous* (e.g., blood type)
  - *Nominal* (no implied order)
  - *Ordinal* (ranked, e.g., “good” > “fair”)
- **Continuous variables:**
  - *Interval scale* (e.g., temperature in Celsius)
  - *Ratio scale* (e.g., body weight, height)



Note: Continuous variables can be converted to categorical, but not vice versa.

6 Types of Research Desi

Key concepts to distinguish studies:

- **Purpose**: Descriptive vs. analytical
- **Investigator control**: Observational vs. intervent
- **Directionality**: Forward vs. backward
- **Sample selection**: Based on exposure, disease, c
- **Timing**: Prospective vs. retrospective

Study Types: - Cross-sectional - Case-contr
cohort - Prospective cohort - Randomized c

7 Basic Terminology: Exp
Disease

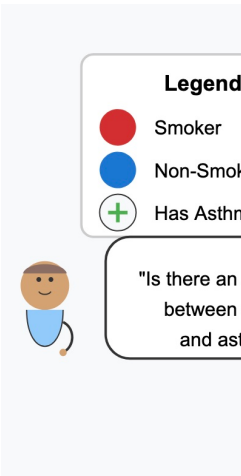
- **E** = “Exposure”
  - Risk factor (e.g., smoking, occupational hazard)
  - Intervention (e.g., drug, prevention program)
- **D** = “Disease” or outcome
  - Disease, injury, death
  - Any health-related outcome
- $\mathbf{E_0}$ and $\mathbf{D_0}$ = Absence of exposure/disease
- $\mathbf{E_1}$ and $\mathbf{D_1}$ = Presence of exposure/disease

8 Study Designs Summar

Study Type	Purpose	Control	Directionality	S S
Cross-sectional	Descriptive/ Analytical	Observational	Concurrent	R s
Case-control	Analytical	Observational	Backward	B d
Retrospective cohort	Analytical	Observational	Forward	B e
Prospective cohort	Analytical	Observational	Forward	B e
Randomized control trial	Analytical	Interventional	Forward	B e

9 Cross-Sectional Studie

- Also called **prevalence studies**
- Exposure and outcome assessed **simultaneously**
- Can be descriptive or analytical
- Provides a “snapshot” of a population
- Relatively quick and inexpensive



Limitations:

- Cannot establish temporal sequence
- Only includes survivors of disease
- Not suitable for rare diseases

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10 In-class exercise

11 Case-Control Analysis

- Cannot directly compute relative risk
- Use **odds ratio (OR)** as an estimate:

$$OR = \frac{ad}{bc}$$

- In a 2×2 table:

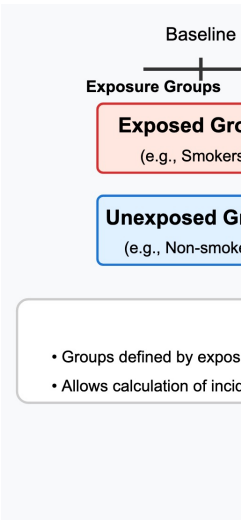
	D_1	D_0
E_1	a	b
E_0	c	d

- When disease is rare, OR ≈ RR

What

12 Cohort Studies

- Start with **exposure status** (E_1 and E_0)
- Follow forward to observe outcome
- Two types:
  - **Prospective**: Start now, follow into future
  - **Retrospective**: Look back at historical exposure
- Can study multiple outcomes
- Directly computes incidence and relative risk



Followi
from ex

13 Cohort Analysis

- **Relative Risk (RR)** quantifies association between exposure and outcome:

$$RR = \frac{a/(a+b)}{c/(c+d)}$$

- In a 2×2 table:

	D_1	D_0
E_1	a	b
E_0	c	d

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14 Randomized Controlle(
(RCTs)

- **Gold standard** for assessing causal relationships
- Participants randomly allocated to intervention (E_1) or control (E_0)
- Minimizes confounding and bias through:
  - Randomization
  - Blinding (single, double)
- Can be conducted at individual or group level

Phases o

- **Phase I:** sample)
- **Phase II:** effects
- **Phase III** monitor
- **Phase IV**

Randomiz
known an

15 Validity and Reliability

Measurement Validity

- **Face validity**: Appears reasonable on the surface
- **Content validity**: Covers full scope of concept
- **Construct validity**: Reflects theoretical concept
- **Criterion validity**: Correlates with external standard
- **Concurrent validity**: Correlates with present condition
- **Predictive validity**: Forecasts future outcome

Study Validit

- **Internal vali** sample
- **External vali** other popula

Reliability

- **Test-retest**: S
- **Inter-observe**
- **Intra-observe** over time

16 Reliability vs. Validity

- **Reliability** = consistency of measurement
- **Validity** = accuracy of what is intended to be measured
- A tool can be reliable but not valid
- A tool cannot be valid if it is not reliable

Unrelia

Relia

Target
reliab

17 Types of Error

Random Error

- Caused by chance or sampling variation
- Affects **precision**
- Can be reduced by increasing sample size
- Produces unpredictable fluctuations

Systemati

- Consistent, to flaws in
- Affects **vali**
- Not reduce size
- Must be ad

18 Major Types of Bias

Selection Bias | Information Bias | Confoundin

- Systematic differences between those selected a
- Examples:
  - Low response rate
- Healthy worker effect
- Volunteer bias
- Berkson's bias (hospital sampling)
  - Loss to follow-up
  - Survivor bias

19 Controlling for Confou

At Design Stage

1. **Randomization**
    - Evenly distributes confounders across groups
2. **Restriction**
    - Limit study to specific subgroup
3. **Matching**
    - Pair participants with similar characteristics

At Analysis

4. **Stratifica**
    - Analyze strata
    - Mantel-H estimate
5. **Multivari**
    - Include covariat
    - Logistic

20 Effect Modification (Int

- Occurs when the effect of exposure differs across levels of a third variable
- **Not the same as confounding**
- Can be additive or multiplicative
- **Additive Model:**

$$RREM = RRE + RRM - 1$$

- **Multiplicative Model:**

$$RREM = RRE \times RRM$$

- Interpretation:
  - If RREM > expected → **synergism**
  - If RREM < expected → **antagonism**

Exa

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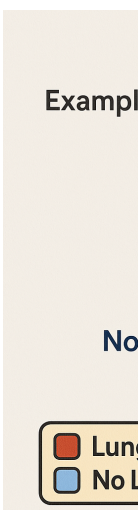
risk



21 Qualitative Methods

- Originates from the social sciences
- Explores perceptions, beliefs, experiences
- Often used to:
  - Understand lived experiences
  - Explore context and meaning
  - Inform survey and tool development
- **Common techniques:**
  - In-depth interviews
  - Focus groups
  - Participant observation
  - Document analysis

Mixed m
qualita
quantit

22 Types of Qualitative Me

Observation | Interviews | Document Analysis

- **Participant observation**: Researcher immersed i
- Captures real behavior and interactions
- Varies in degree of participation

23 Integrating Qualitative & Quantitative Methods

Ways to integrate qualitative methods:

1. **Pre-study**: To develop hypotheses or instruments
2. **During study**: To explain unexpected results
3. **Post-study**: To interpret and validate findings
4. **Standalone**: As an alternative or complement to quantitative

Com
give

Example: Regional Health Needs Assessment

- **Quantitative**: Epidemiologic data, service access
- **Qualitative**: Focus groups with residents, interviews with key informants

24 Ethical Considerations

Four Ethical Principles:

1. **Autonomy** – Respect for individuals
2. **Beneficence** – Maximize benefits
3. **Non-maleficence** – Do no harm
4. **Justice** – Fair treatment and burden distribution

Research I

- Informed co
- Confidentia
- Data securi
- Vulnerable
- Institutiona
- Research in transparen

25 Key Takeaways

- Choose the study design that best answers your research question
- Recognize and control for bias and confounding
- Understand the role of validity and reliability
- Combine methods when appropriate
- Always prioritize ethics and participant rights

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