Epidemiology Review CPH Examination

LCDR Lara Misegades, PhD, MS
Epidemiologist
HHS/ACF Office of Refugee Resettlement
lara.misegades@acf.hhs.gov

Epidemiology Principles on CPH Exam

1. General Knowledge
   - A. Definition of and Applications of Epidemiology
   - B. Concept of Risk for Disease
2. Measures of Disease Frequency
   - A. Incidence and Prevalence
   - B. Rates
   - C. Ratios
   - D. Proportions
   - E. Standardization
3. Measures of Association and Effect
   - A. Concepts
   - B. Comparisons
   - C. Interpretation and Communication
4. Infectious Disease & Outbreak Investigation
   - A. Infection and Transmission
   - B. Immunity
   - C. Outbreaks and Investigations
   - D. Disease Surveillance
5. Study Design
   - A. Observational
   - B. Experimental
   - C. Cross-Sectional
   - D. Case Control
   - E. Cohort Studies
   - F. Retrospective
   - G. Prospective
6. Causation and Validity
   - A. Validity
   - B. Bias
   - C. Confounding
   - D. Causal Criteria
7. Screening and Screening Policy
   - A. Screening Policy
   - B. Sensitivity
   - C. Specificity
   - D. Positive and Negative Predictive Value
   - E. Ethical Principles of Epidemiology

Epidemiology

- The study of the distribution and determinants of health and disease in populations, and the application of this study to the control health problems

<u>Applications:</u>

- Determine disease burden
- Compare disease occurrence between populations
- Describe natural history of the disease
- Identify causes and risk factors of disease
- Identify at-risk groups for targeted interventions
- Evaluate treatments and interventions
- Inform public health policy

MEASURES OF DISEASE FREQUENCY

Basic Parameters

- Count: simple measure of quantity
  Example: number of stillbirths at a hospital

- Ratio: numerator is not included in the denominator
  Example: number of stillbirths/number of live births

- Proportion: what fraction of population affected?
  - Numerator is included in the denominator

  Example: number of stillbirths/total number of births

- Rate: how fast the disease or outcome of interest occurs
  - Includes an explicit element of time
  - Change in one quantity per unit change in another

  Example: Number of stillbirths in a month

Measures of Disease Frequency

- Prevalence: measures *existing* cases of a disease or outcome at a particular point in time or over a period of time

- Incidence: measures *new* cases of a disease or outcome that develop over a period of time

Prevalence

$$= \frac{\text{\# of persons with disease in a population at a specific time}}{\text{Total population at that same time}}$$

- A “snapshot” of disease in a population at a given time
- A proportion; often expressed as a percentage
- Useful for assessing the health status of a population and planning health services

- <u>Point prevalence:</u> measures frequency of disease at a specific point in time (such as on a calendar day, or at birth, or at entry into a study)

- <u>Period prevalence:</u> the number of existing and new cases during a given period

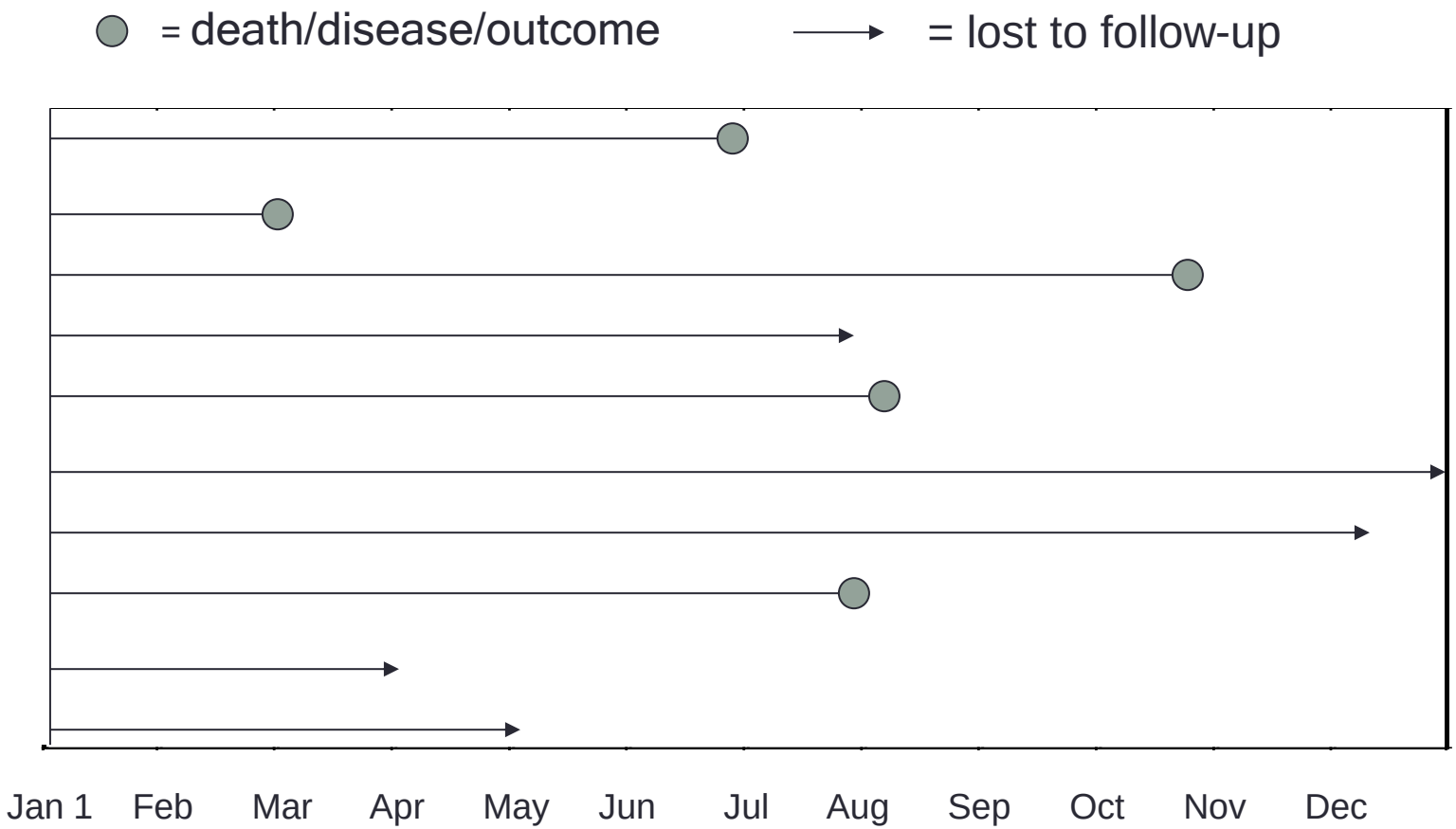
Cumulative Incidence (CI)

$$= \frac{\text{\# of new cases of disease during a specified period of time}}{\text{\# of disease-free persons at the beginning of the period of time}}$$

- An estimate of individual risk
- A proportion; can be expressed as a percentage
- Assumes entire population at risk is followed for specified period
- Includes statement about time

Example: 10,000 men with no history of myocardial infarction are observed for 6 months. 30 develop MI during the 6 month period. The CI is 30/10,000 = 0.003 (or 0.3%) in a 6 month period.

Cumulative Incidence



10 people at risk 5 get disease during year

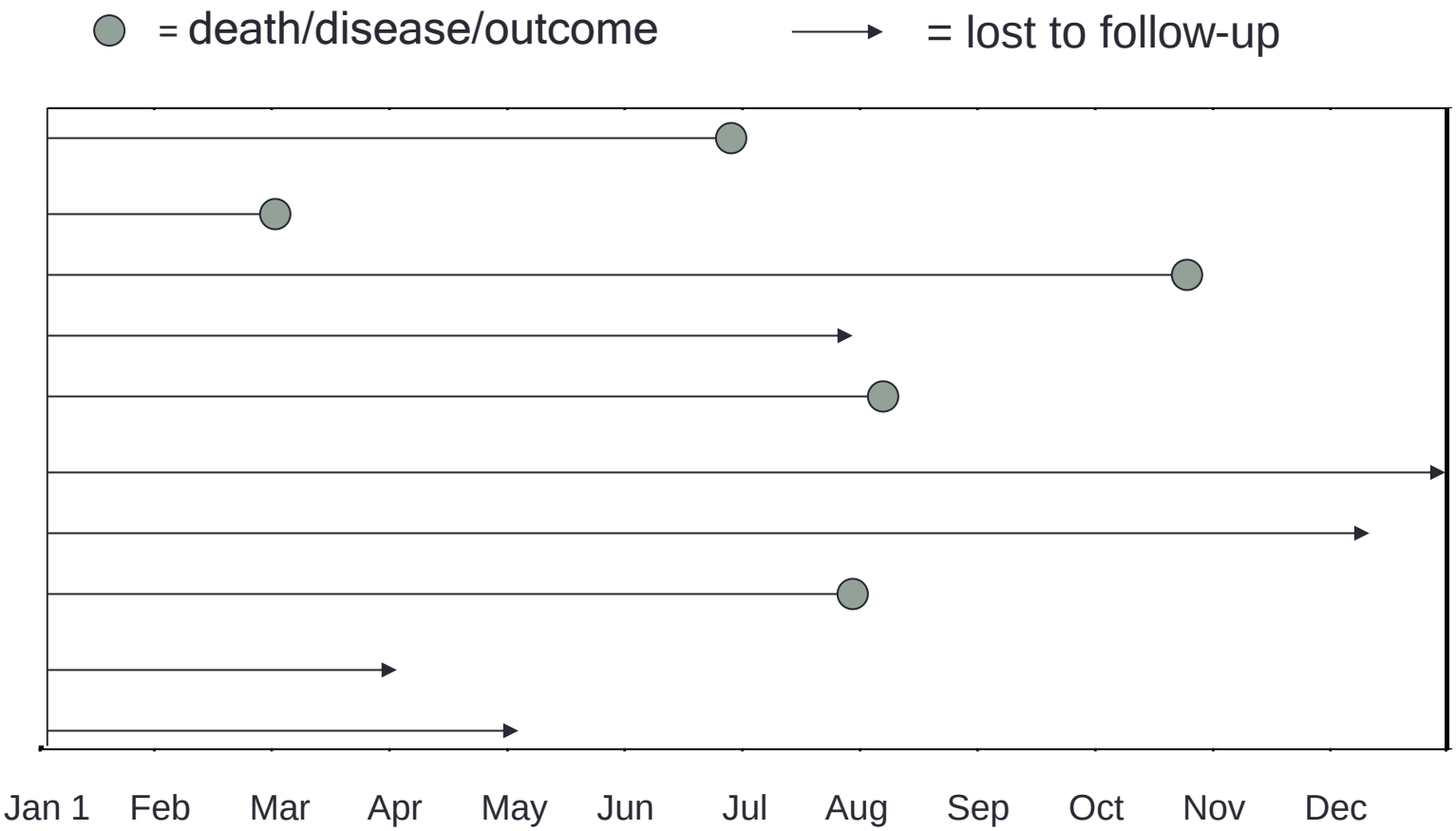
5/10 = 0.5 x 100 = 50 per 100 persons at risk

Incidence Density (ID)

$$= \frac{\text{\# of new cases of disease during a specified period of time}}{\text{Summed person-time of observation (e.g., person-days, person-years)}}$$

- A true rate with units of cases/person-time
- Measures how quickly new cases develop
- Denominator expressed as person-time
  - Sum of the time persons remained under observation and free of disease
  - More precise denominator than cumulative incidence; adjusts for persons who are lost to follow-up and time at risk

Incidence Density



5 persons get outcome person-time = 69 person-months

ID = 5/69 = 7.25 events per 100 person-months (0.87/person-year)

Other Measures of Disease Frequency

- Birth rate =
  (live births)/(midyear population)
- Fertility rate =
  (live births)/(females aged 15-44 yrs at midyear)
- Infant mortality rate =
  (deaths < 1 year)/(live births)
- Neonatal mortality rate =
  (deaths < 28 days)/(live births)
- Postneonatal mortality rate =
  (deaths 28 days-1 yr)/(live births)
- Fetal death rate =
  (fetal deaths > 20 wks)/(live births+fetal deaths)
- Crude mortality rate =
  (deaths)/(midyear population)
- Cause-specific mortality rate =
  (deaths from cause A)/(midyear population)
- Proportionate mortality =
  (deaths from cause A)/(all deaths)
- Case fatality rate =
  (persons with disease A who die)/(persons with disease A)

Standardization of Rates

- Standardization (or adjustment) of rates is necessary to compare rates between populations with different population compositions (e.g., age, race, gender)

- Unless adjustment is made for the differing factors, population comparisons may be meaningless

- Age adjustment techniques
  - Direct standardization (more commonly used): age-specific disease rates from the populations of interest are applied to the number of people in each age group of a standard population (e.g., US population)
  - Indirect standardization: age-specific disease rates from a standard population are applied to the number of people in each age group for the populations of interest

http://www.cdc.gov/nchs/tutorials/nhanes/nhanesanalyses/agestandardization/info1.htm

STUDY DESIGN

Part I

Types of Epidemiologic Studies

Descriptive epidemiology:

- Describe population health events and characteristics
- Compile and analyze data by person, place, and time
- Examples: analysis of surveillance data; surveys (e.g., of health status, exposures, behaviors)

Analytic epidemiology:

- Evaluate suspected exposure/outcome relationships
- Often involves testing hypotheses
- Examples:
  - Observational studies (cross-sectional, case-control, cohort, ecological)
  - Experimental studies (intervention/clinical trials)

Public Health Surveillance

The ongoing, systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health*

Applications:

- Case detection
- Describe distribution and trends of health events
- Hypothesis generation
- Evaluate prevention and control measures
- Inform public health policies and planning
- Outbreak detection (i.e., detect increase in disease above the normal background occurrence)

* http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5013a1.htm

Types of Surveillance

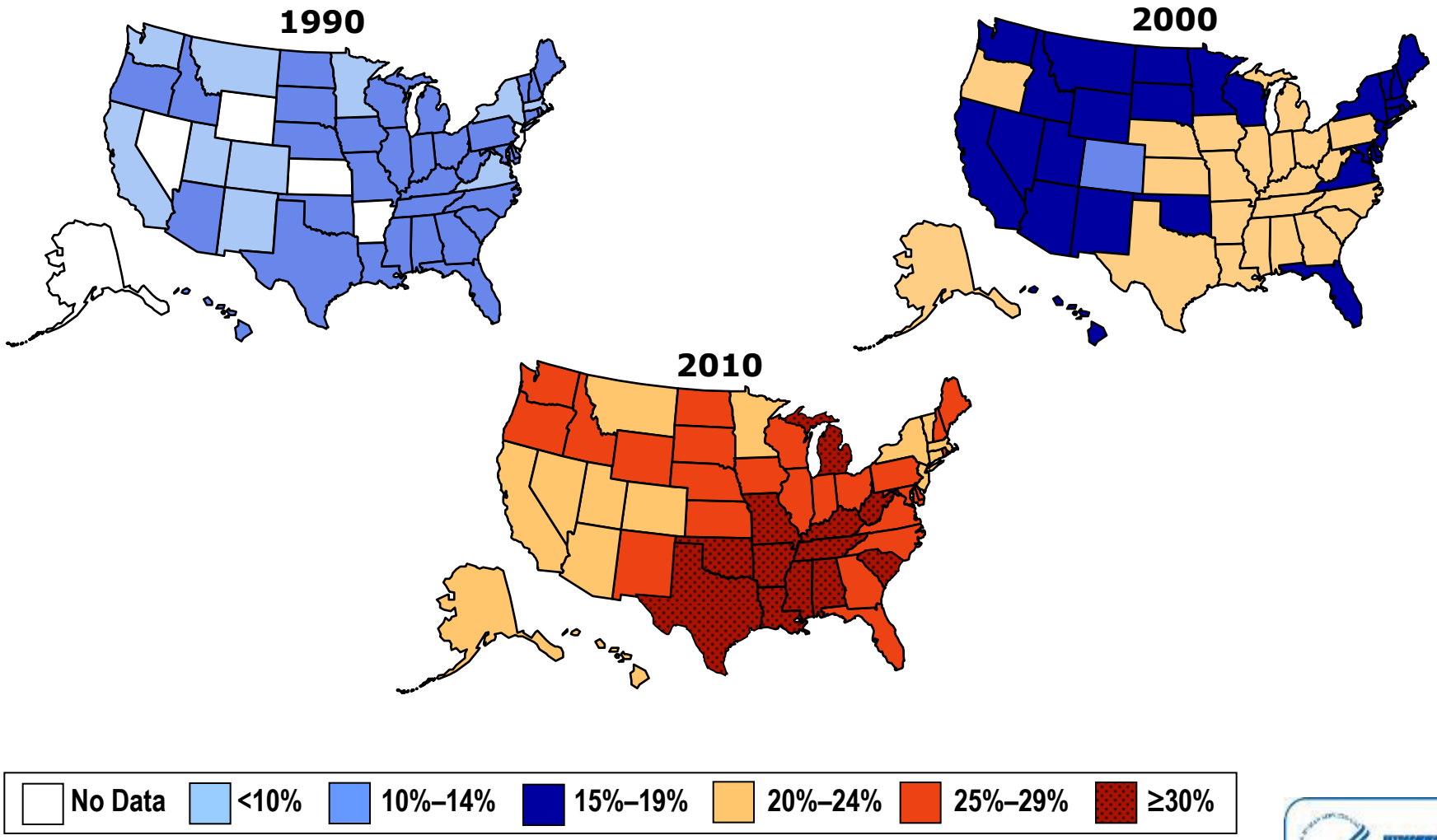
- Passive
  - Routine reporting of health events by healthcare providers or laboratories; inexpensive, not comprehensive
- Active
  - Seek out cases of disease; expensive, more comprehensive
- Sentinel
  - Intensive collection of case data from part of the population (e.g., active surveillance at specific hospitals to track specified disease)

***** A good surveillance system is: timely, representative, sensitive, and specific.

Obesity Trends* Among U.S. Adults

BRFSS, 1990, 2000, 2010

(*BMI ≥30, or about 30 lbs. overweight for 5' 4" person)



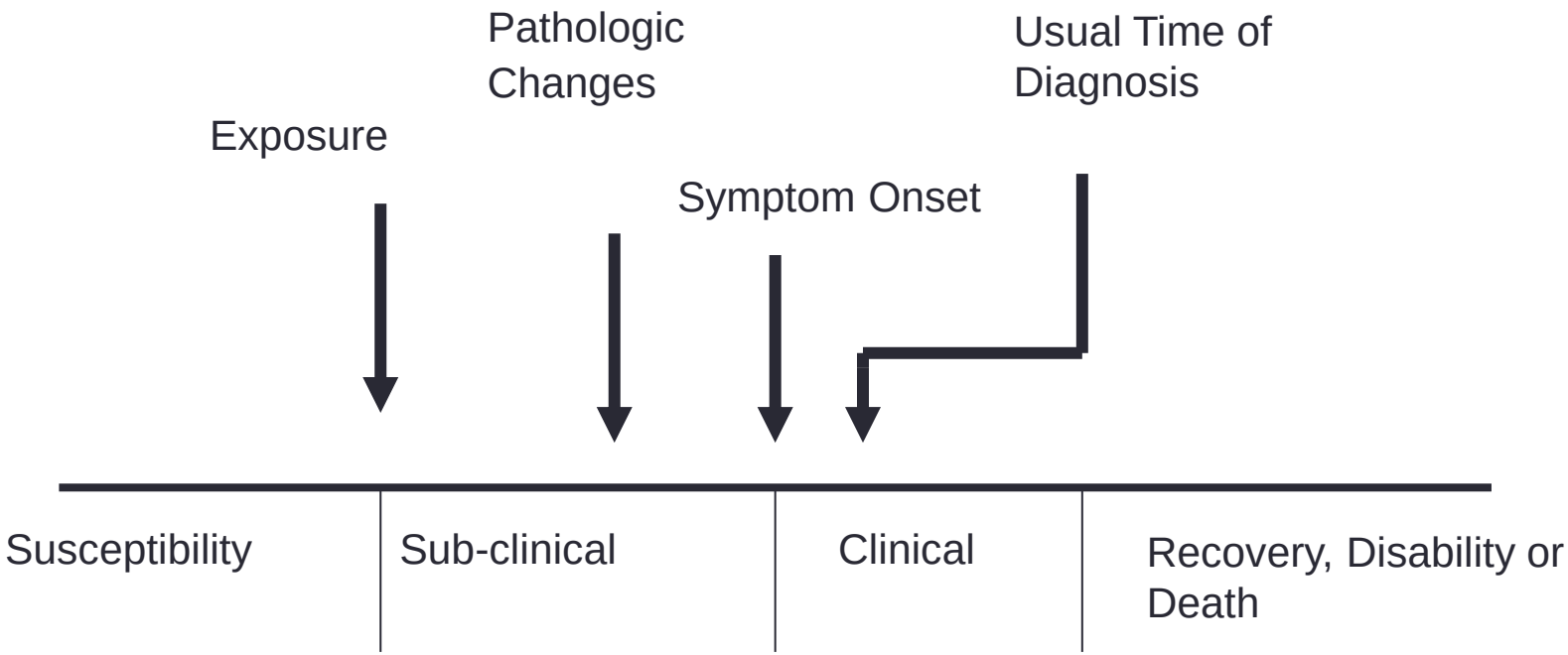
Source: Behavioral Risk Factor Surveillance System, CDC.

Examples of US Surveillance Systems

- Nationally Notifiable Diseases
- Vital Statistics (birth or death certificates)
- Disease Registries
- Health Surveys
- Ambulatory Systems
- Linked vital statistics with health insurance data
- Sentinel Systems (example: NIOSH Sentinel Event Notification System for Occupational Risks (SENSOR)

INFECTIOUS DISEASE AND OUTBREAK INVESTIGATIONS

Natural History of Disease



carrier
immunity, active
immunity, herd
immunity, passive

incubation period
infection
latency period

Page et al, 1995
http://www.cdc.gov/OPHSS/CSELS/DSEPD/SS1978/Glossary.html#I

Infectious Disease Patterns

- Endemic: *usual occurrence* of a disease within a given geographic area
- Epidemic: the occurrence of a group of similar illnesses in a given community that is *in excess* of normal expected disease levels
- Pandemic: *worldwide* epidemic
- Common-source outbreak: all persons exposed to the same agent; can be point-source (occurs in a short period) or intermittent (longer period)
- Propagated outbreak: results from person-to-person transmission
- Mixed epidemic: features of both common-source and propagated outbreaks

http://www.cdc.gov/ophss/csels/dsepd/ss1978/lesson1/section11.html

Infectious Disease Transmission Modes

Direct

- Direct contact (touch, kissing, sex)
- Respiratory droplets/secretions (cough, sneeze)

Indirect

- Airborne (droplet nuclei, dust)
- Vector-borne (mosquitoes, fleas, ticks)
- Vehicle-borne (food, water, fomites)

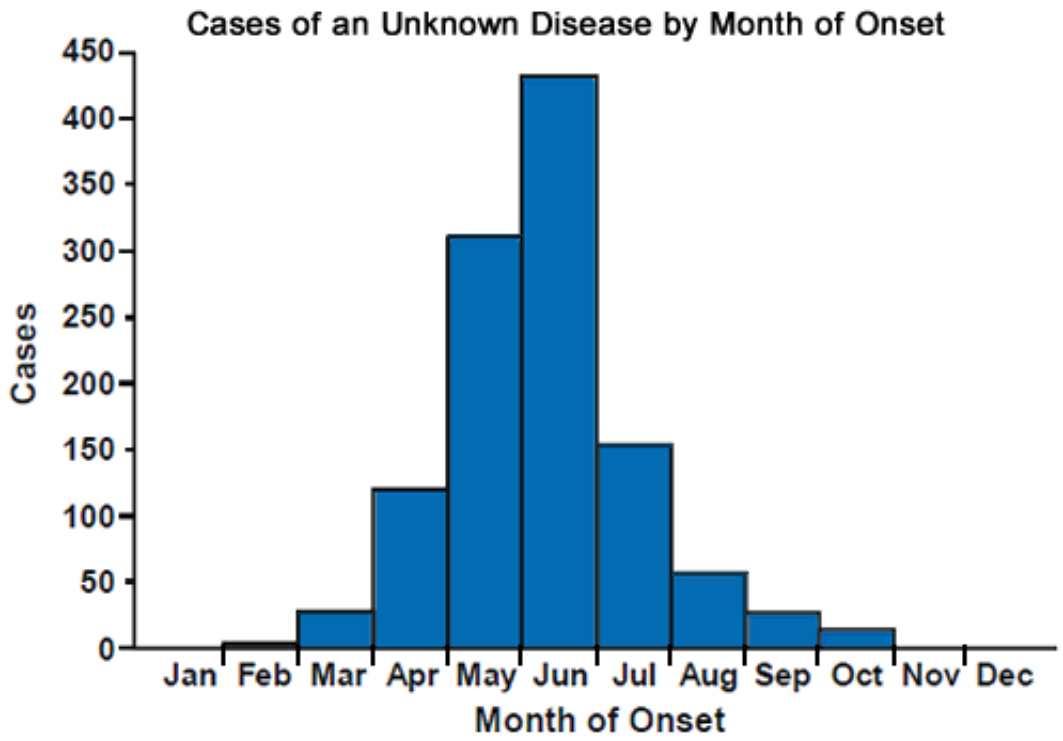
Outbreak Investigation Steps

1. Prepare for field work
2. Establish the existence of an outbreak
3. Verify the diagnosis
4. Construct a working case definition
5. Find cases systematically and record information
6. Perform descriptive epidemiology
7. Develop hypotheses
8. Evaluate hypotheses epidemiologically
9. As necessary, reconsider, refine, and re-evaluate hypotheses
10. Compare and reconcile with laboratory and/or environmental studies
11. Implement control and prevention measures
12. Initiate or maintain surveillance
13. Communicate findings

http://www.cdc.gov/ophss/csels/dsepd/ss1978/lesson6/section2.html

Epi Curve

- Display of the onset of illness among cases associated with an outbreak



http://www.cdc.gov/training/quicklearns/createepi/

Selected Outbreak Measures of Disease

Attack rate =

$$\frac{\text{\# of people at risk who develop disease A}}{\text{Total \# of people at risk}}$$

Secondary attack rate (person-to-person transmission) =

$$\frac{\text{\# of people who got sick from the index case}}{\text{Total \# of people exposed to the index case}}$$

Exposure-specific attack rate =

$$\frac{\text{\# of people who at a certain food and became ill}}{\text{Total \# of people who ate that food}}$$

Case fatality rate =

$$\frac{\text{\# of people with disease A who die}}{\text{Total \# of people with disease A}}$$

STUDY DESIGN

Part II

Components of Analytic Studies

- Same components used in all analytic designs
- Designs differ by objective, timing of measurement, role of investigator, unit of analysis
- Each design has strengths, weaknesses.

1. Study hypothesis
2. Defined study population
3. Information on study outcome(s)
4. Information on study exposure(s)
5. Assessment of the exposure-outcome association
6. Conclusion

Observational Studies: Timing of Data Collection

Study designs differ by the timing of exposure and outcome measurements

- Cross-Sectional: exposure and outcome are measured at the same time
- Prospective: exposures are measured *before* the outcome events occur
- Retrospective: exposures are measured *after* the outcome events occur

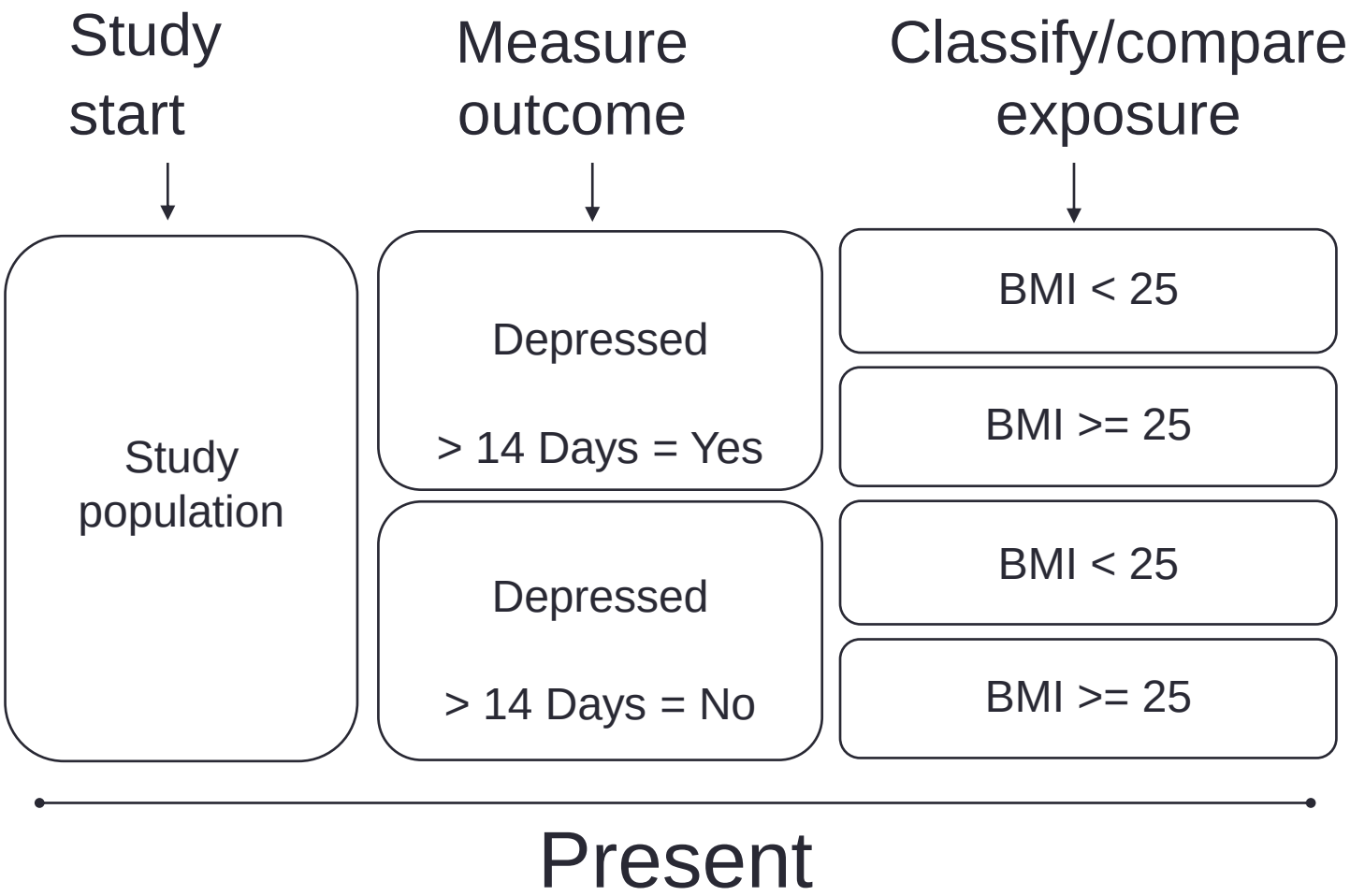
Cross-Sectional Design

- Often used to study prevalence of disease
- Exposure and disease measured concurrently
- Includes all persons in (or a sample of) the population at the time of the assessment

Advantages	Disadvantages
Can be good for hypothesis generation	Not ideal for etiologic research
Efficient, as exposure and outcome are assessed at same time	Cannot distinguish between existing (prevalent) outcomes and new (incident) outcomes

Cross-Sectional Design

Are depression and obesity associated?

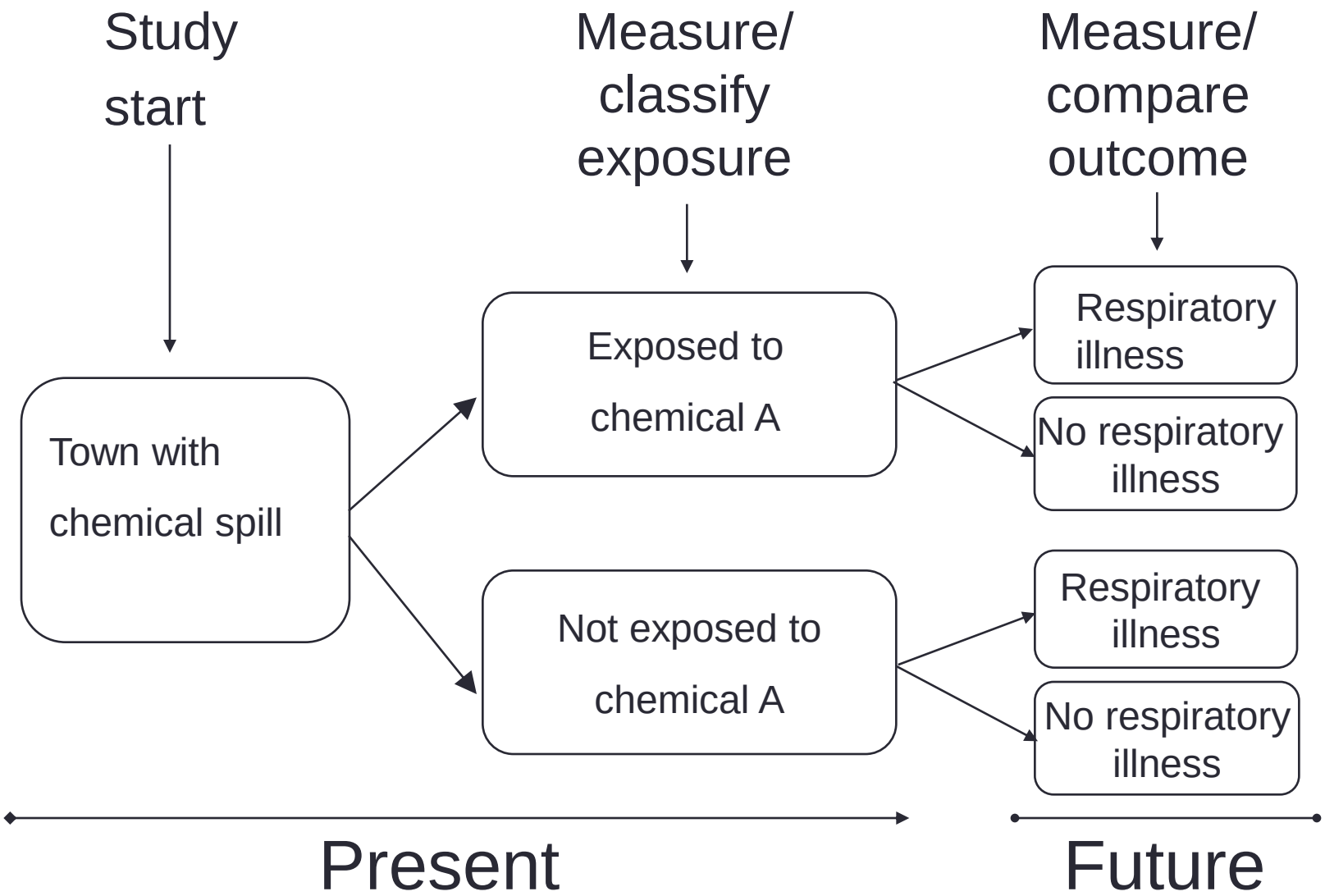


Cohort Design

- Defined cohort is classified into groups (exposed/non-exposed) and followed for outcome of interest
- Participants must be free of the outcome at study start and have the potential to develop the outcome of interest

Advantages	Disadvantages
Temporality is known; provides better evidence for a cause-effect relationship than other observational designs	Can take a long time for results
Can study natural history of disease	Often expensive
Efficient for rare exposures	Not good for rare outcomes (would require large sample size)
Able to evaluate multiple outcomes	Participants lost to follow-up

Prospective Cohort Design



Retrospective Cohort

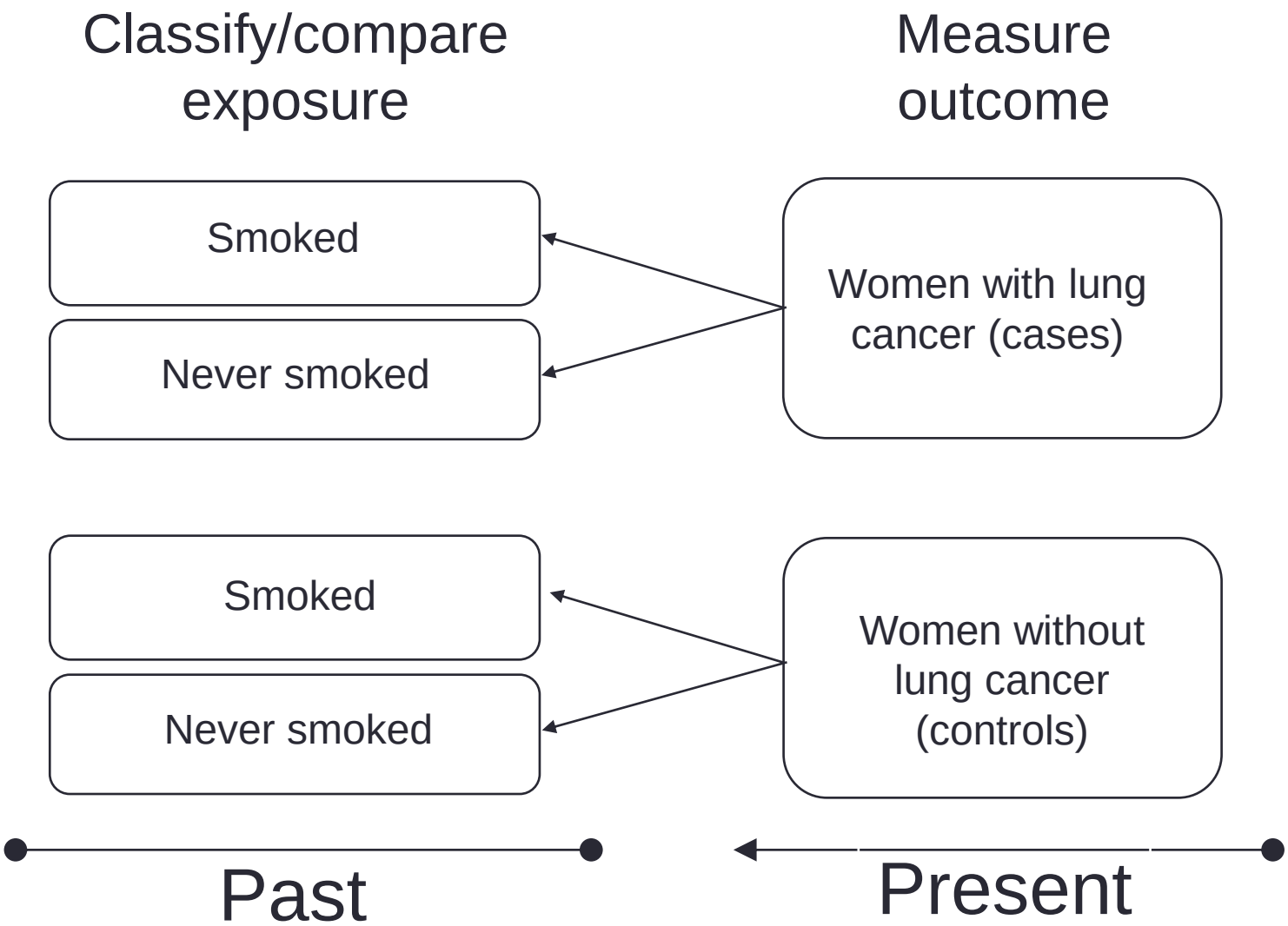
- Are conceived in retrospect and use existing data
- Study population is identified from past data and classified as exposed or not exposed
- Disease status is determined at present time; there is no follow-up or future measurement

Case Control Design

- Study groups are selected based on the presence (case) or absence (control) of outcome of interest
- Controls are selected as a representative sample of the population that gave rise to the cases
- Past exposure is assessed for both groups

Advantages	Disadvantages
Efficient design for rare diseases	Challenge to select appropriate controls
Able to evaluate multiple exposures	Susceptible to recall bias (cases may recall exposures differently than controls)
Relatively fast and inexpensive	Not able to assess cause-effect

Case Control Design



Ecological Design

- Information on exposure and/or outcome is available on a group or population level, not an individual level
- Study group can be countries, states, counties, census tracts

Advantages	Disadvantages
Grouped data (e.g., neighborhood poverty, air pollution) may reflect best exposure	The people with the outcome may not be the ones with exposure (ecological fallacy)
Useful for hypothesis generation	Groups usually differ in many ways in addition to the exposure studied
Often inexpensive	Group level data can vary in quality

Environmental Health: A Global Access Science Source

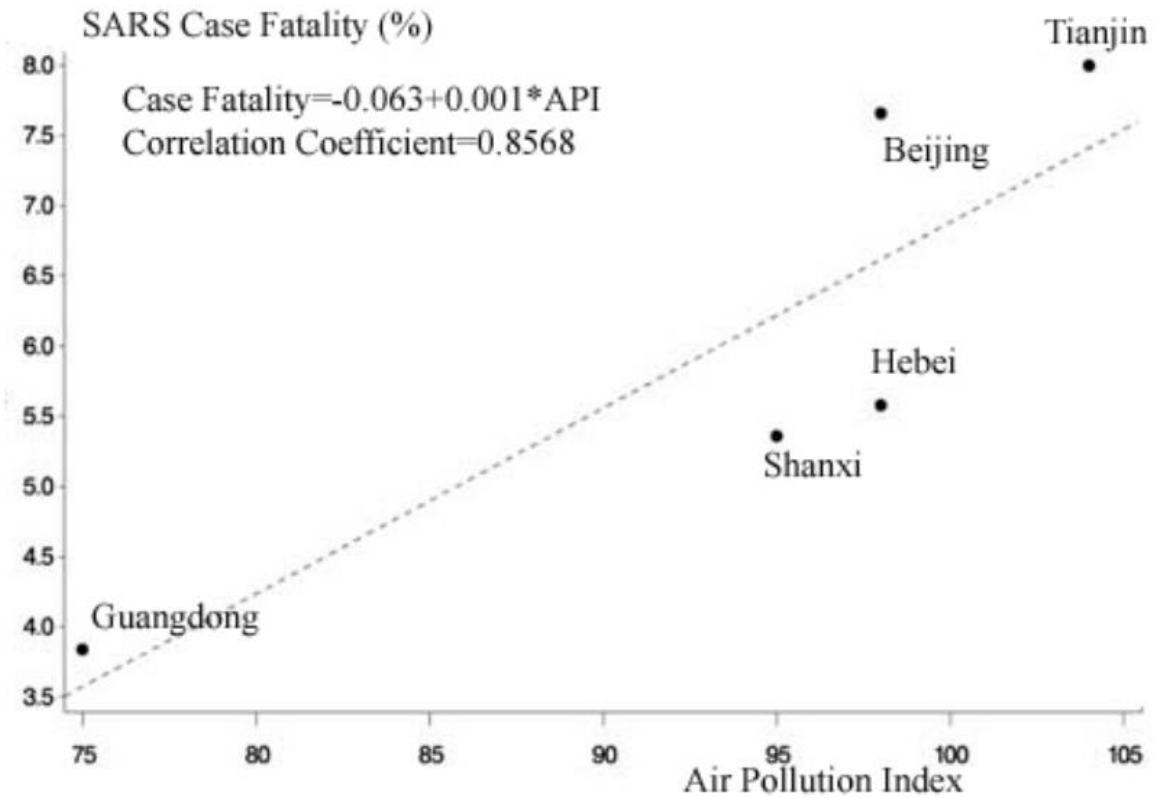
BioMed Central

Research

Open Access

Air pollution and case fatality of SARS in the People's Republic of China: an ecologic study

Yan Cui[1], Zuo-Feng Zhang*[1], John Froines[2], Jinkou Zhao[3], Hua Wang[3], Shun-Zhang Yu[4] and Roger Detels[1]

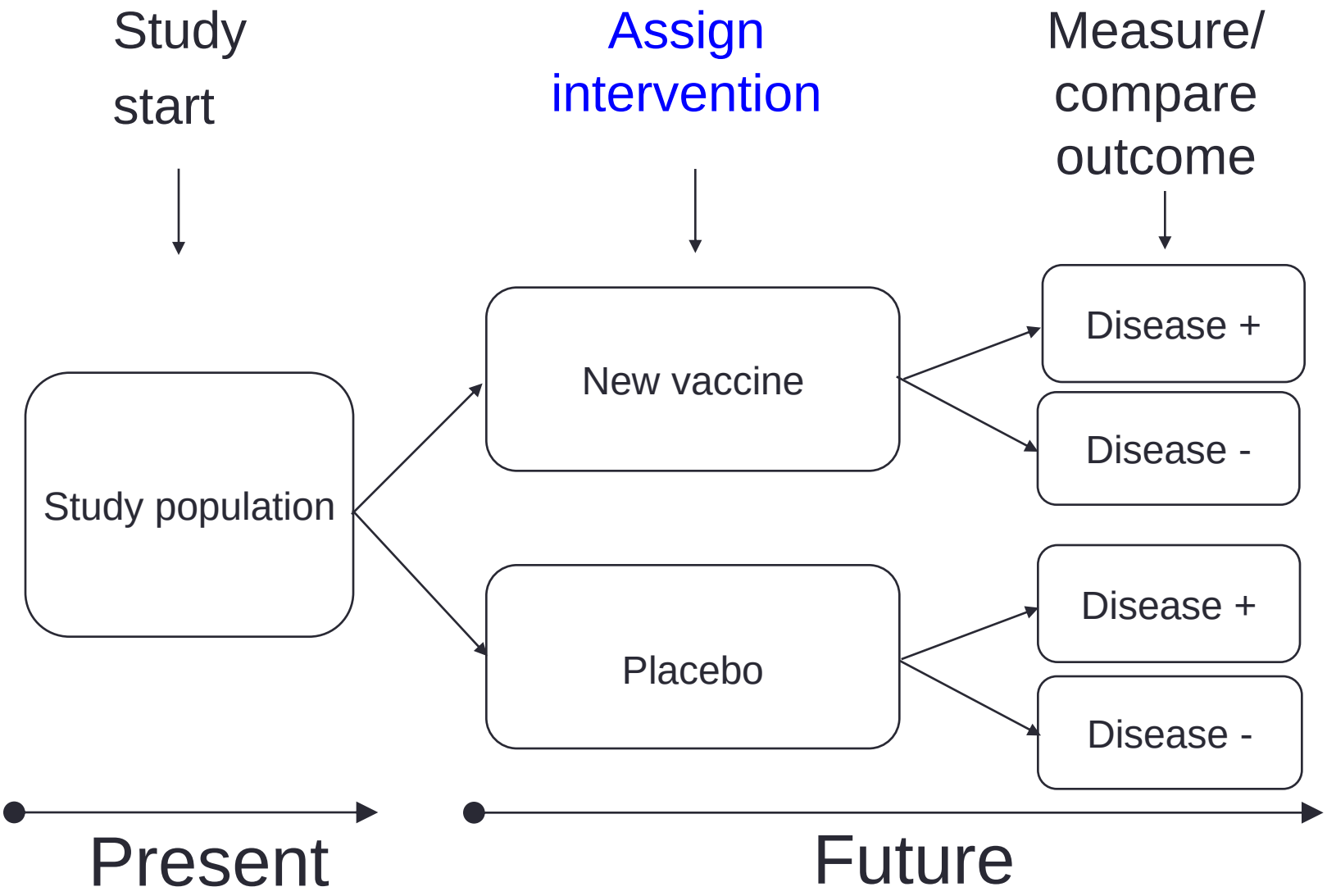


Role of Investigator

- Cross sectional, case control and cohort studies are observational; investigator observes exposures

- Another approach is experimental; investigator intervenes or “assigns” exposure for participants

Experimental Design



Experimental Design

- Treatments/interventions may be randomly assigned (randomized controlled trial)
- “Blinding” used if knowing treatment assignment could influence results
  - Single blind: study participant does not know assigned treatment
  - Double blind: participant and investigator do not know assigned treatment

Advantages	Disadvantages
Good for hypothesis testing	Often expensive
Can minimize bias	Ethical constraints

Study Design: Terminology

	Alternate Study Names
Cross-Sectional	survey, prevalence
Cohort	prospective, prospective cohort, retrospective cohort, longitudinal, follow-up, incidence
Case Control	retrospective
Nested Case Control	case-cohort study
Experimental	randomized controlled trial, field trial, community trial, intervention trial
Ecological	correlation

Study Components: Terminology

Study group	sample, study population, cases/controls
Information	characteristics, factors, variables, parameters
Outcome	disease, endpoint, dependent variable
Exposure	predictor, independent variable, risk factor
>1 exposure	covariables, covariates, confounders, cofactors
Association	relationship, correlation

MEASURES OF ASSOCIATION AND EFFECT

Measures of Effect – Big Picture

- Compares measures of disease in Group 1 vs. Group 2 (e.g., exposed vs. unexposed)

- Ratio = $\frac{\text{Measure of disease in Group 1}}{\text{Measure of disease in Group 2}}$

- Difference = Measure of disease in Group 1 - Measure of disease in Group 2

Relative Risk

- Relative risk is intended to measure the magnitude of an association between exposure and disease
- The risk (cumulative incidence, incidence density, or odds) of disease in the exposed is compared as a ratio to the same measure in the non-exposed
- Relative risk is a generic term; preferable to explicitly state the measure of effect

Relative Risk in a Cohort Study

- In a cohort study, we calculate relative risk using:
  - Incidence of disease in 'exposed'
  - Incidence of disease in not 'exposed'

- Cumulative Incidence Ratio

$$= \frac{\text{cumulative incidence for exposed}}{\text{cumulative incidence for unexposed}}$$

- Incidence Density Ratio

$$= \frac{\text{incidence density for exposed (person-time)}}{\text{incidence density for unexposed}}$$

Relative Risk

	Disease +	Disease -	Total
Exposed	A	B	A+B
Not exposed	C	D	C+D
Total	A+C	B+D	N

$$RR = \frac{\text{Risk in the exposed}}{\text{Risk in the unexposed}} = \frac{A/(A+B)}{C/(C+D)}$$

Risk Difference (Attributable Risk)

- The number of cases of disease among the exposed that can be attributed to the exposure

- In other words, the number of cases of disease among the exposed that would not occur if the exposure was eliminated.

RD = Risk in the exposed - Risk in the unexposed

= A/(A+B) - C/(C+D)

What about a Case Control Study?

- In a case control study we have:
  - diseased people (cases)
  - non-diseased people (controls)

- We cannot directly calculate incidence for each group, therefore cannot directly calculate a relative risk

Odds

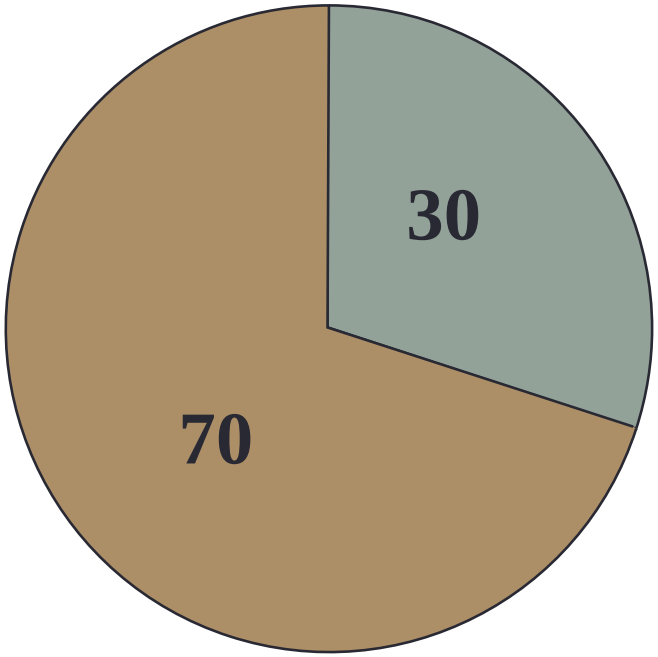
- Odds = $\frac{\text{number of times event occurred}}{\text{number of times event did not occur}}$

  = $\frac{\text{probability of event occurring (p)}}{\text{probability of event not occurring (1-p)}}$

- Odds vary from 0 (nobody has the event) to infinity (everyone has the event)

Risk vs. Odds

In a 35-year prospective cohort study of pack/day smokers, 30 out of 100 developed cancer.



Risk = 30/100 = 0.30

Odds = 30/70 = 0.43

Odds Ratio (Case Control Study)

	Case (have disease)	Control (no disease)
Exposed	a	b
Not exposed	c	d

Exposure OR = $\frac{\text{odds of exposure in cases}}{\text{odds of exposure in controls}}$

= a:c/b:d

= ad/bc

Disease OR = $\frac{\text{odds of disease among exposed}}{\text{odds of disease among not exposed}}$

= a:b/c:d

= ad/bc

* If the disease is rare and sample is unbiased, the odds ratio is an estimate of the relative risk

Odds Ratio (Case Control Study)

	E. coli [Case]	E. coli [Control]
Ate pork	a = 70	b = 20
Did not eat pork	c = 1	d = 25
	a+c = 71	b+d = 40

- Odds of having E. coli if ate pork: a/c = 70/1 = 70
- Odds of having E. coli if did not eat pork: b/d = 20/25 = 0.8
- Ratio of the two odds: $\frac{a/c}{b/d} = \frac{70}{0.8} = 87.5$

- Shortcut: ad/bc = (70*25) / (1*20) = 87.5

Summary of Measures of Effect by Study Design

Study Design	Type of data	Measures of Effect
Cross-Sectional	Count	Prevalence Ratio Odds Ratio (can be calculated)
Case Control	Count	Odds Ratio
Cohort	Count	Cumulative Incidence Ratio (Risk Ratio) Odds Ratio (can be calculated)
Cohort	Person-time	Incidence Density Ratio (Rate Ratio)

Interpreting Magnitude and Direction of Relative Risk and Odds Ratio

- RR = 1 or OR = 1
  - No association
- RR > 1 or OR >1
  - Exposed group has more disease than non-exposed
  - Suggests exposure is a risk factor
- RR < 1 or OR < 1
  - Exposed group has less disease than non-exposed
  - Suggests exposure is a protective factor

Sample Interpretations

- OR = 87.5: E. coli cases had 87.5 times the odds of having eaten pork than those who were not sick with E. coli (controls)
- OR = 1: There are the same odds of eating pork whether or not a person was sick with E. coli
- RR = 0.6: Those who regularly took low dose aspirin had 0.6 times the risk of myocardial infarction compared to the those who did not take aspirin
- RR = 10: Those who worked 55 hours or more per week had 1.3 times the risk of stroke compared with those working a standard 35- to 40- hour week

CAUSATION & VALIDITY

Why worry about causal inference?

- Association between exposure and outcome does not prove a causal relationship

- Causal inference: process of evaluating all available knowledge of the association between a particular exposure and an outcome

Causal Criteria (Bradford Hill Criteria)

- Strength of Association: larger the association implies potentially important effect
- Temporality: the exposure must precede the outcome in time
- Consistency: different studies (designs and subjects) find similar measures of association
- Biological Plausibility: exposure-outcome association makes biological sense (limited by state of knowledge at present)
- Experimental Evidence: a well-conducted experimental trial is strong evidence for causality
- Dose-Response (Biological Gradient): risk of outcome increases in a step-wise fashion with increase in exposure
- Coherence: the exposure-outcome association does not conflict with existing knowledge of the natural history of the outcome
- Analogy: the exposure-outcome association is similar to another association in the literature
- Specificity: one exposure is associated with one outcome (strengthens causality, but is not necessary)

Validity

The degree to which a study reaches the right conclusion

- Internal validity: refers to the design, methods, analysis and results of an individual study. Did the study do what it intended to do?

- External validity: refers to whether internally valid findings are also generalizable beyond the study population. Do the study results apply in the real world?

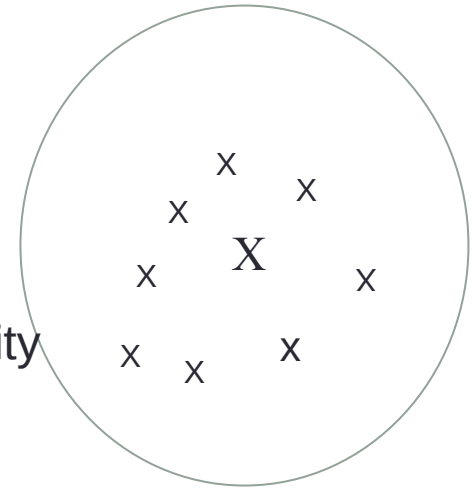
Why worry about error?

- Epidemiological studies attempt to approximate what is going on in the real world by assessing relationship between exposure and outcome in a sample of people
- Error is inevitable because we can never study everyone and we can never measure exposure and outcome perfectly
- Difference between truth and approximation = error

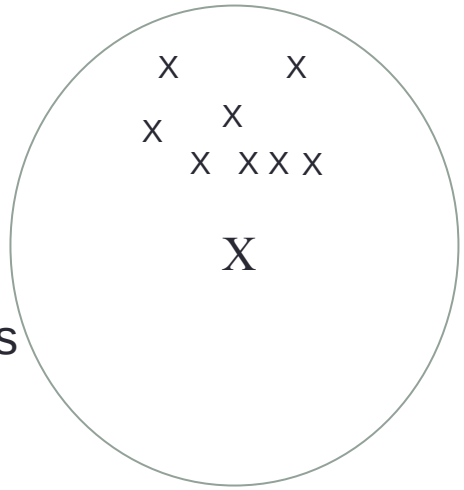
Types of Error

- Random variability: deviates from the truth (X) due to chance: no particular direction of error
- Bias: A systematic difference from the truth (X) in a particular direction

Random/variability



Systematic/bias



Strategies for Reducing Random Variability

<u>Sampling Variability</u>

- Draw random sample from population base
- Aim for high response rate
- Large study population

<u>Measurement Error</u>

- Standardize collection of measurements
- Collect repeat measures

Sources of Bias

- Selection bias: systematic error that occurs while identifying study population or in follow-up (self-selection, non-response, loss to follow-up, inappropriate comparison group)
  - between cases and controls in a case-control study
  - between exposed and non-exposed in a cohort study

- Information bias: systematic differences in the measurement of exposure, outcome, or other variables;
  - participant as source: recall bias, surrogate bias, non-response bias
  - investigator as source: interviewer bias
  - misclassification bias; exposure or disease status is incorrectly classified (may be non-differential or differential across study groups)

Strategies for Reducing Bias

Selection Bias

- Repeated attempts to enroll and follow everyone
- Provide incentives
- Collect data on non-respondents
- Same strategies as for sampling variability

Information Bias

- Collect information identically for all study participants
- Blind participant, observer
- Calibrate instruments
- Same strategies for measurement error

Confounding

- Occurs when another variable (confounder) influences the relationship between the exposure of interest and the outcome.
- Distorts the true relationship between exposure and outcome
- Refers to associations that are real, but do not indicate a causal link between exposure and outcome

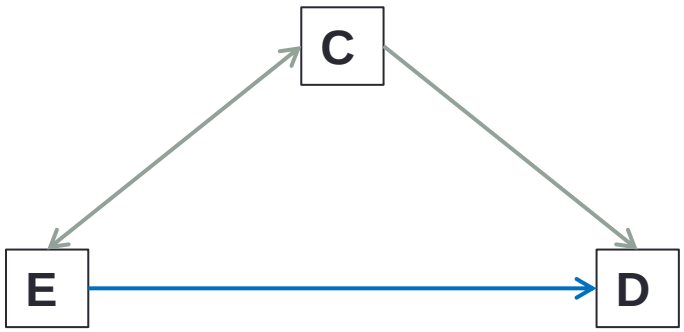
Confounding

A confounding variable:

- is associated with both the exposure and the outcome
- when not considered, makes the exposure and outcome look related when they are not.

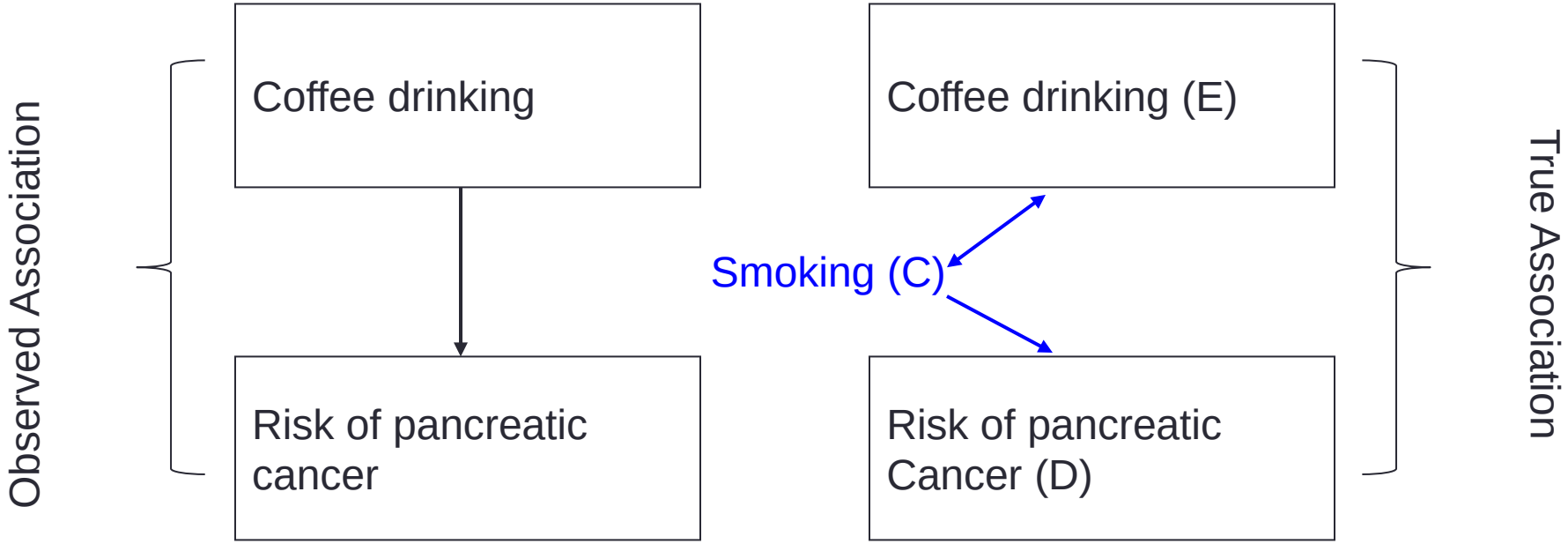
Criteria for Confounding

1. Potential confounder (C) is independent predictor of outcome (D)
2. Potential confounder associated with exposure (E)
3. The variable is not on the causal path in the true relationship between the exposure and outcome



The Association Between Coffee Drinking & Pancreatic Cancer

- A study found that cases with pancreatic cancer reported higher consumption of coffee than controls.
- However, the true risk factor was smoking; coffee appeared to be related because smokers drank more coffee than nonsmokers. Smoking is a confounder of the exposure-disease association.



Control of Confounding

When	Method
Before the study	Randomization (clinical trials)
Before the study	Matching (make cases and controls similar with respect to the confounder; match on age, race, etc.)
Before the study and/or during data analysis	Restriction (limit to individuals who are similar with respect to confounders)
During data analysis	Standardization (e.g., age adjustment)
During data analysis	Stratification (examine E-D relationship within different strata of the confounder)
During data analysis	Adjustment (multivariable analysis)

SCREENING

Diagnostic vs. Screening Test

- Diagnostic: used to determine the presence/absence of a disease when a subject shows signs or symptoms
- Screening: used to identify asymptomatic individuals who may have the disease
- A diagnostic test may be performed after a positive screening test to establish a definitive diagnosis

Criteria for Screening Program

- Disease being screened should:
  - Be an important public health problem
  - Be prevalent
  - Have a long pre-clinical phase
  - Have effective intervention which would improve outcome if diagnosed early
- Test being used should:
  - Have favorable sensitivity, specificity and predictive values
  - Be economical
  - Not be unduly hazardous or uncomfortable

Common Screening Tests

- Pap smear for cervical dysplasia or cervical cancer
- Fasting blood sugar – diabetes
- Blood pressure – hypertension
- Mammography – breast cancer
- PSA for prostate cancer
- Fecal occult blood for colon cancer
- Ocular pressure for glaucoma
- PKU screening for children

Screening

TEST	DISEASE: Present	DISEASE: Absent
Positive	True + (A)	False + (B)
Negative	False - (C)	True - (D)

- Sensitivity = P(Test$^+$|Disease$^+$) = A / (A+C)
  - *High sensitivity means few cases missed*
- Specificity = P(Test $^-$|Disease$^-$) = D / (B+D)
  - *High specificity means few non-cases misclassified*
- Predictive-value positive (PVP) = A / (A+B)
- Predictive-value negative (PVN) = D / (C+D)

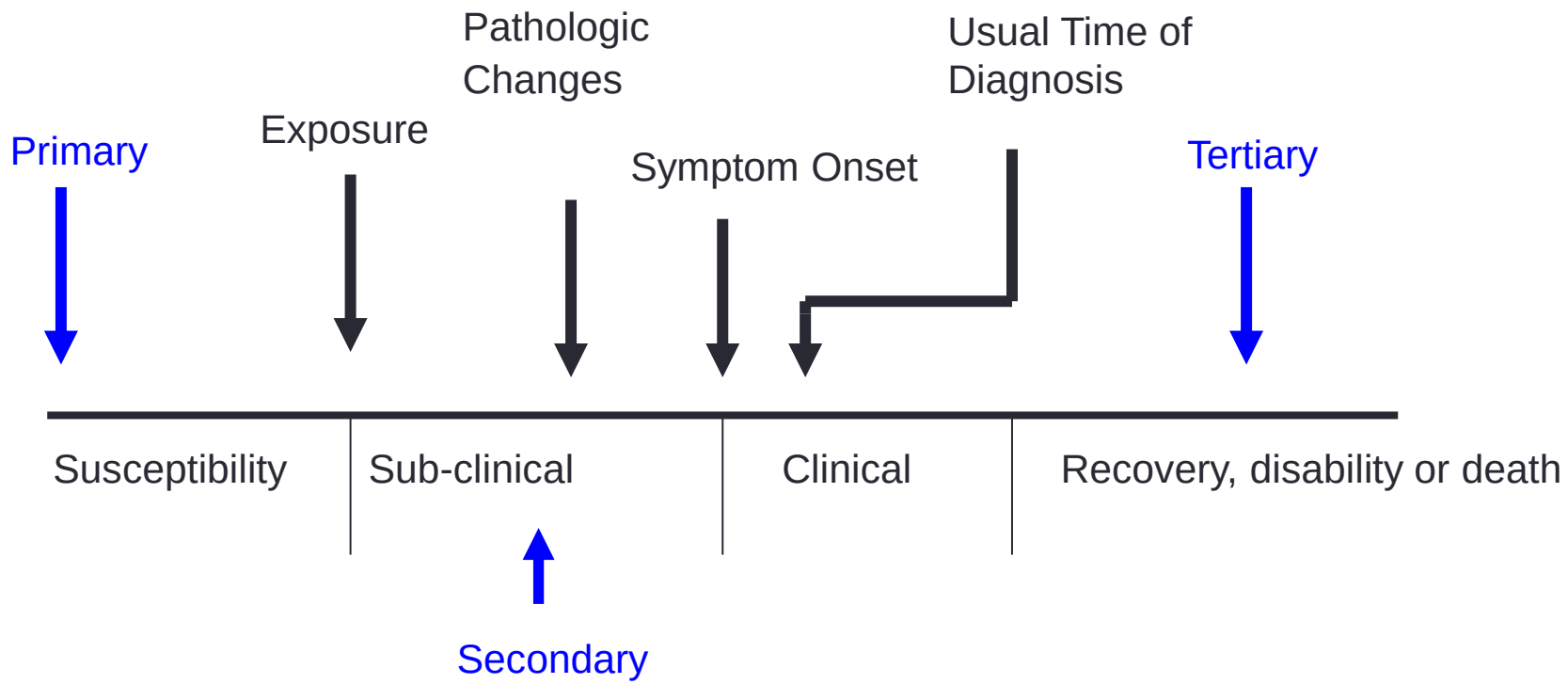
Predictive Values of Screening Tests

- PVP = the probability that persons with a positive screening test truly have the disease
- PVN = the probability that persons with a negative screening test truly don't have the disease

  - Are influenced by the disease prevalence in screened population (whereas sensitivity and specificity are characteristics of the test)
  - Indicate the usefulness of a test in specific populations; in a high prevalence setting, it is more likely that persons who test positive truly have disease (increased PVP, decreased PVN)

Disease Prevention Levels

- Primary: avoid exposure; prevent disease from occurring (e.g., immunization)
- Secondary: modify severity of disease (e.g., **screen** to find early disease and treat before it becomes established)
- Tertiary: treat established disease to avoid complications



Page et al, 1995

Ethical Principles in Epidemiology

- **Beneficence**: participant benefits proportionate to risks
- **Justice**: benefits and burdens fairly distributed among population

<u>Application to public health and research:</u>

- Study results intended to improve population health
- Equitable selection of participants for studies
- Protect vulnerable populations (e.g., children, prisoners, pregnant women)
- Obtain informed consent (assure voluntary participation)
- Safety, privacy, confidentiality
- Access to data; who owns the data?
- Conflict of interest (related to funding or the investigator)
- Communicating findings to the public

Online Learning Modules

- CDC Principles of Epidemiology:
  http://www.cdc.gov/ophss/csels/dsepd/ss1978/

- Schools of Public Health:
- http://sphweb.bumc.bu.edu/otlt/MPH-Modules/Menu/index.html
- https://himmelfarb.gwu.edu/tutorials/studydesign101/
- https://practice.sph.umich.edu/micphp/epicentral/index.php