Measuring Occurrence of Disease

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“We owe all the great advances in knowledge to those who endeavor to find out how much there is of anything.”

- James Maxwell

(physicist 1831-1879)

Human Disease

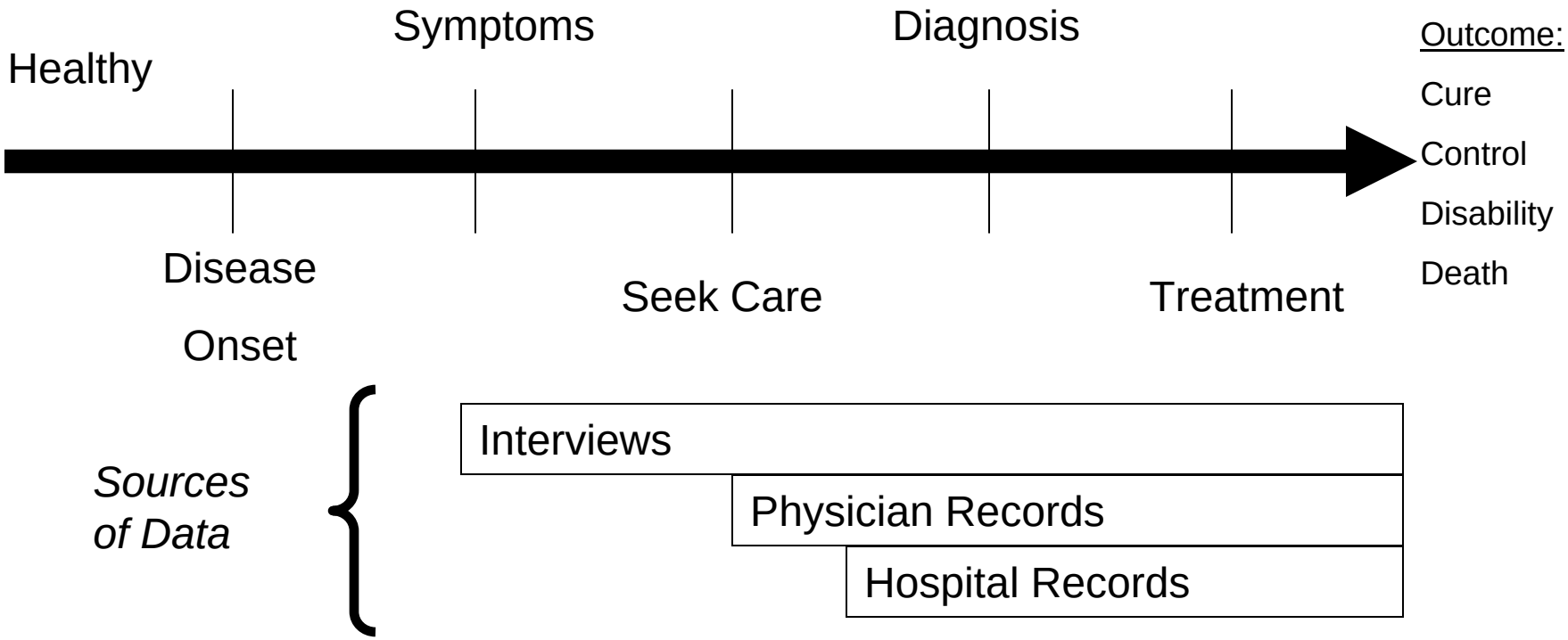
- To examine the transmission of disease in human populations, we need to measure:
  - Frequency of disease occurrence
  - Deaths from the disease

- RATES - help express the extent of morbidity (debilitation) and mortality resulting from a disease

Overview

- Measures of Morbidity
  - Incidence
  - Prevalence
- Measures of Mortality
  - Mortality rates
  - Case-fatality rates
  - Proportionate mortality
  - Years of Potential life lost
  - Problems with Mortality Data

Time Frame for Development of Disease



Epidemiologic Calculations

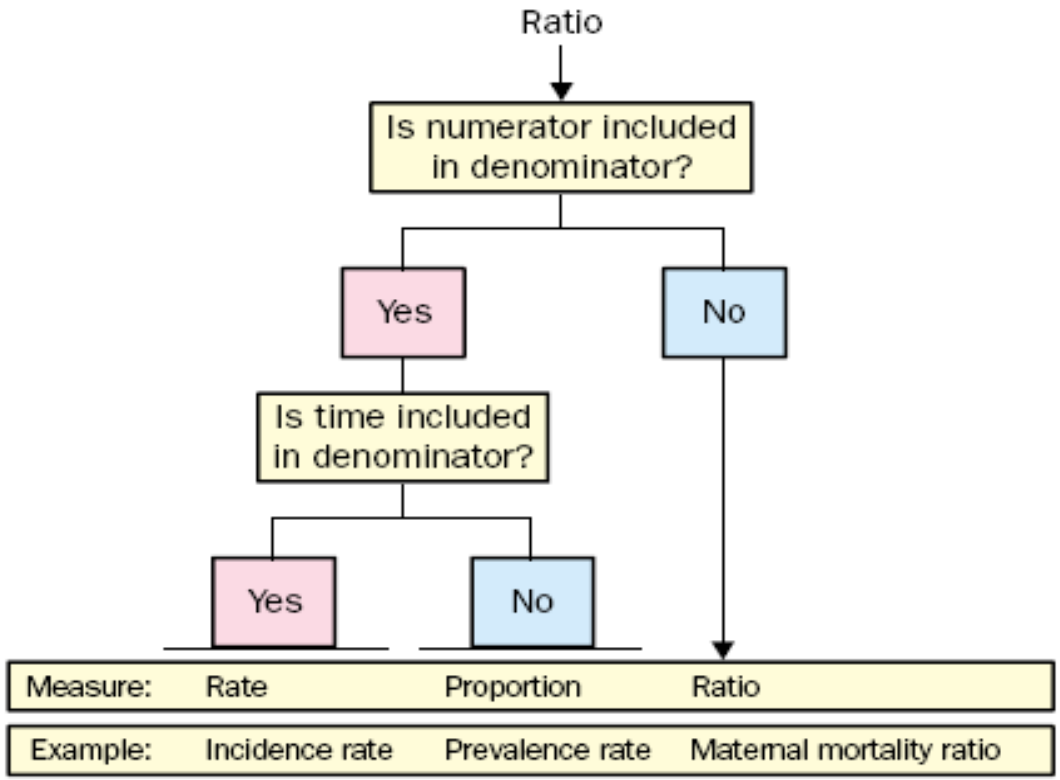


Figure 3: **Algorithm for distinguishing rates, proportions, and ratios**

Grimes & Schulz, 2002 (www)

Incidence

- The number of NEW cases of a disease that occur during a specified time frame in a population at risk for the disease.

Incidence per 1,000 =

$$\frac{\text{\# of new cases of a disease occurring in the population during a specified time period}}{\text{\# of persons at risk of developing the disease during that time period}} \times 1{,}000$$

Incidence (2)

- Because incidence is a measure of events (i.e. transition from no disease to disease), incidence is a *measure of risk*.

- This risk can be looked at in any population
  - Particular age groups
  - Genders
  - Occupational groups
  - Etc.

Incidence (3)

- Denominator -
  - Must be only persons at potential risk, (e.g. males could not be included in a measure of incidence of uterine cancer.)
  - Must know that all individuals in denominator have been followed up for the entire *time period specified.* Choice of time period is arbitrary (days, weeks, months, years).

Incidence (4)

- Cumulative Incidence:
  - Incidence calculated using a period of time in which all persons in the selected population are considered to be at risk for the outcome.

- Incidence Rate:
  - Denominator is the sum of the different times each individual was at risk (often expressed as *person-years*)

Prevalence

- Number of affected persons present in the population at a specific time divided by the number of persons in the population at the time.

Prevalence per 1,000 =

$$\frac{\text{\# of cases of a disease present in the population at a specified time}}{\text{\# of persons in the population at that specified time}} \times 1{,}000$$

Prevalence vs. Incidence

- Prevalence – does not consider WHEN the disease started or how long (duration) the disease has existed.
  - A slice through the population at a certain time point
  - Because the numerator includes persons with the disease for various lengths of time, prevalence is NOT a measure of risk.
  - Risk can only be determined using INCIDENCDE.

Point vs. Period Prevalence

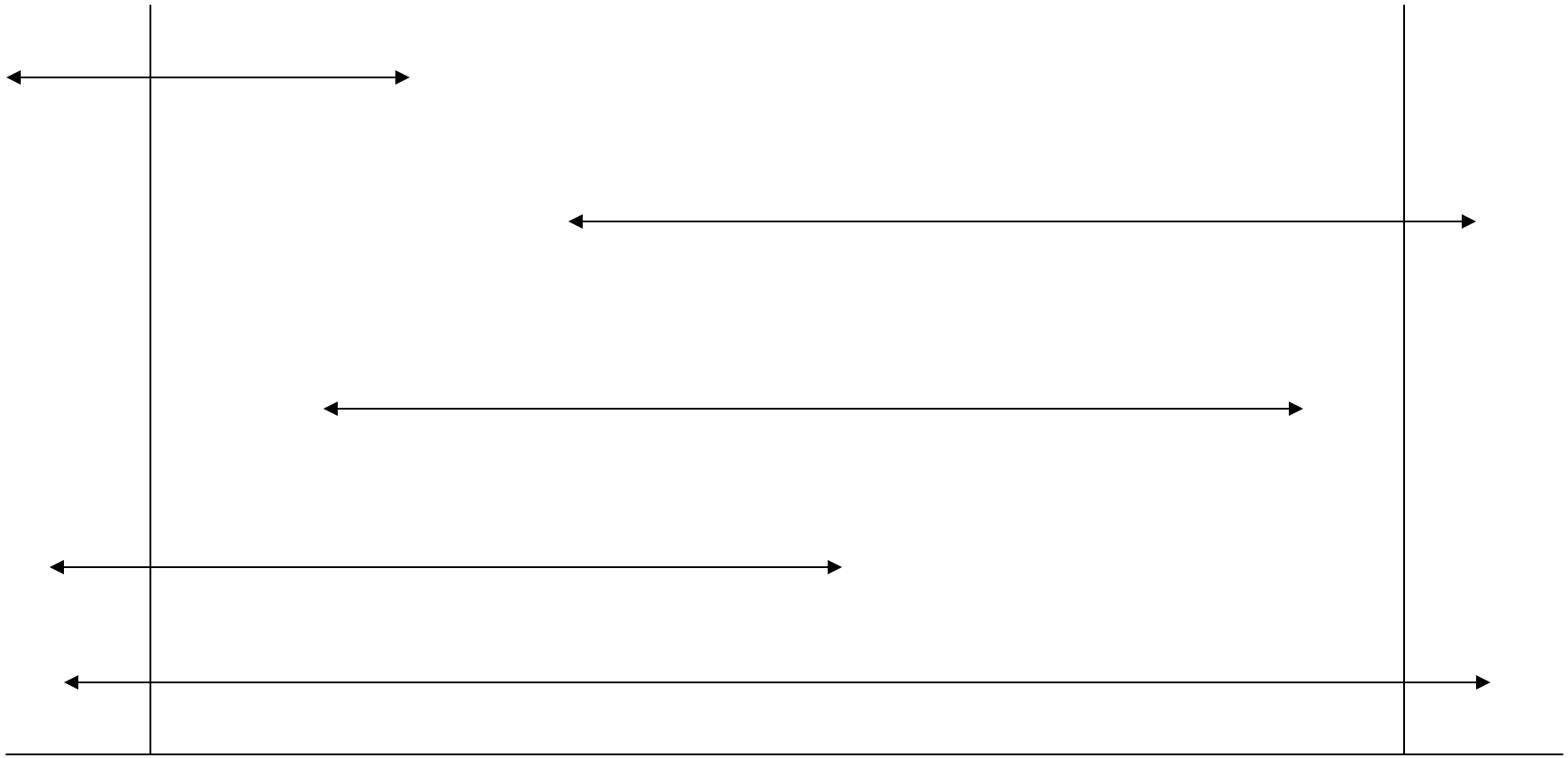
- Point Prevalence: The prevalence of the disease at a point in time.

- Period Prevalence: How many people have had the disease at any time during a certain period, e.g. during a single calendar year.
  - Some may have had dz before and died *during* that period
  - Some may have developed the dz during that period
  - Bottom line: every person in numerator had the dz at some point during the time period.

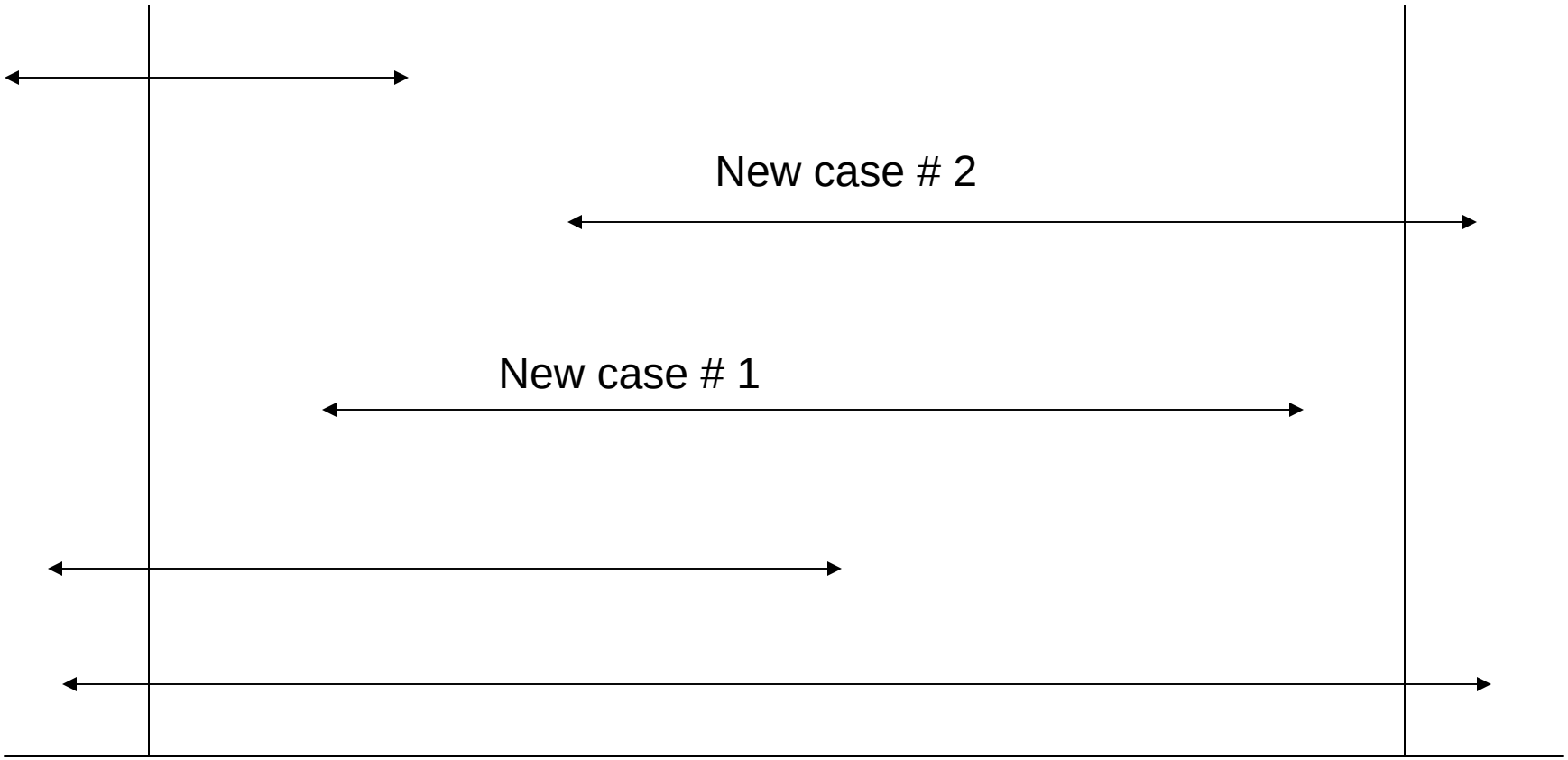
Examples of Point and Period Prevalence and Cumulative Incidence

Question	**Type of Measure**
Do you currently have hypertension?	Point prevalence
Have you had hypertension during the past (n) years?	Period prevalence
Have you *been* diagnosed with hypertension in the last year?	Incidence

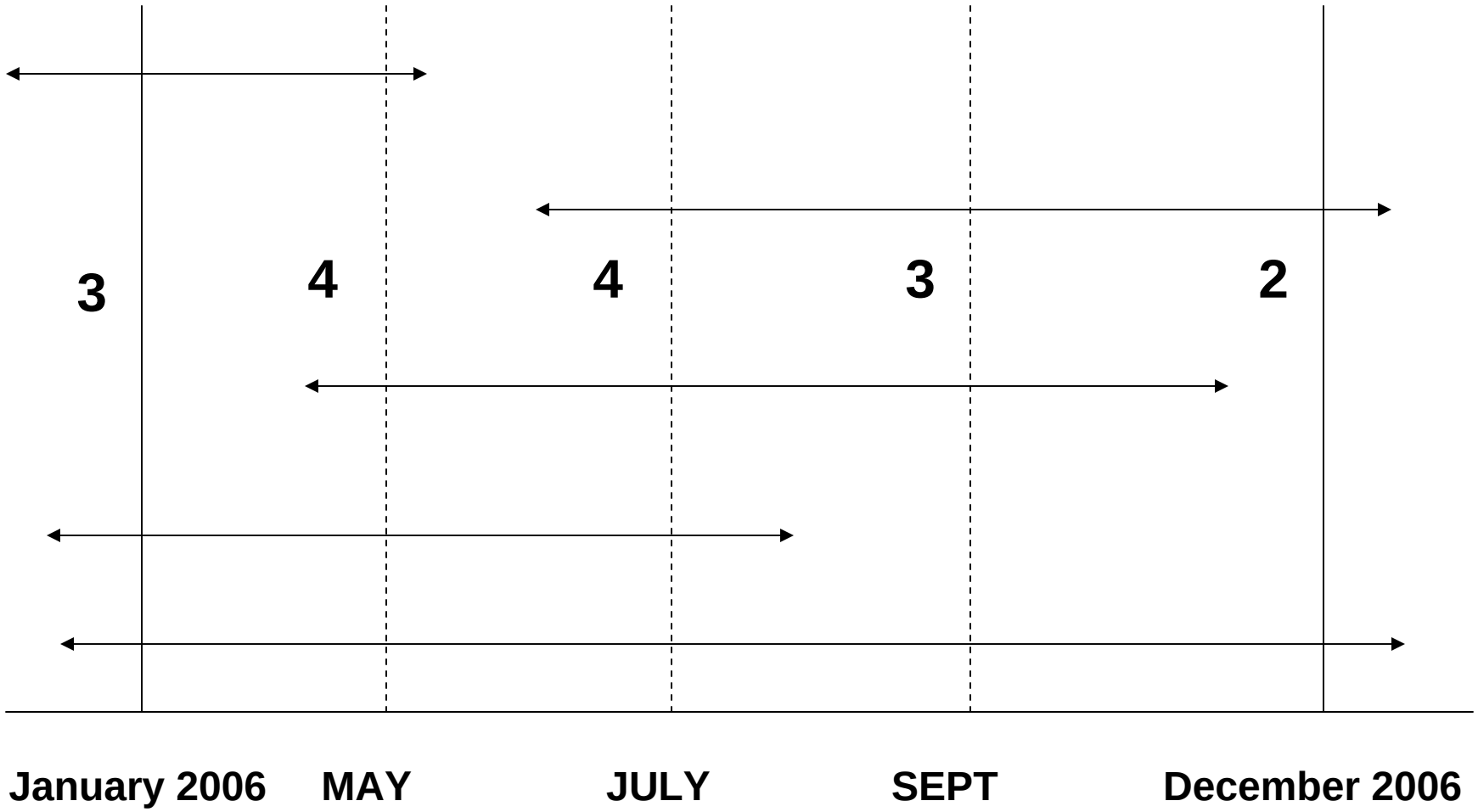
Incidence vs. Prevalence



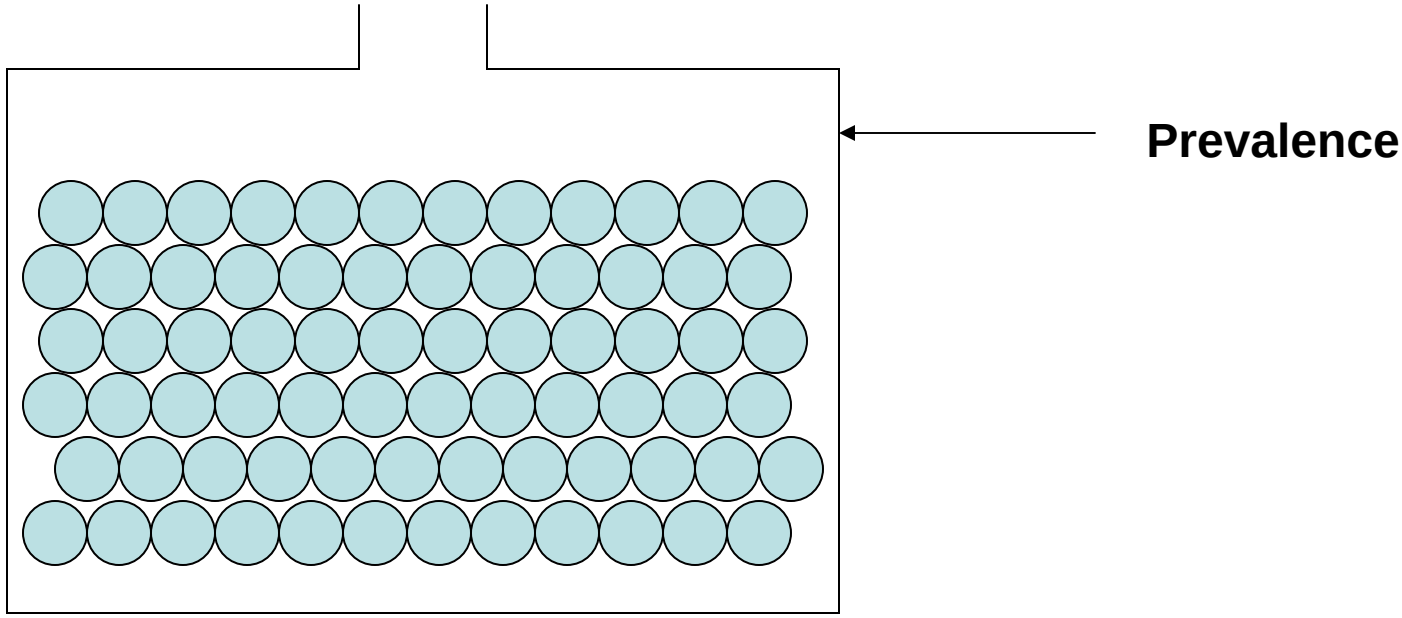
What is the numerator for <u>incidence</u> in 2006?



What is the numerator for point prevalence in 2006?



Relationship between Prevalence and Incidence



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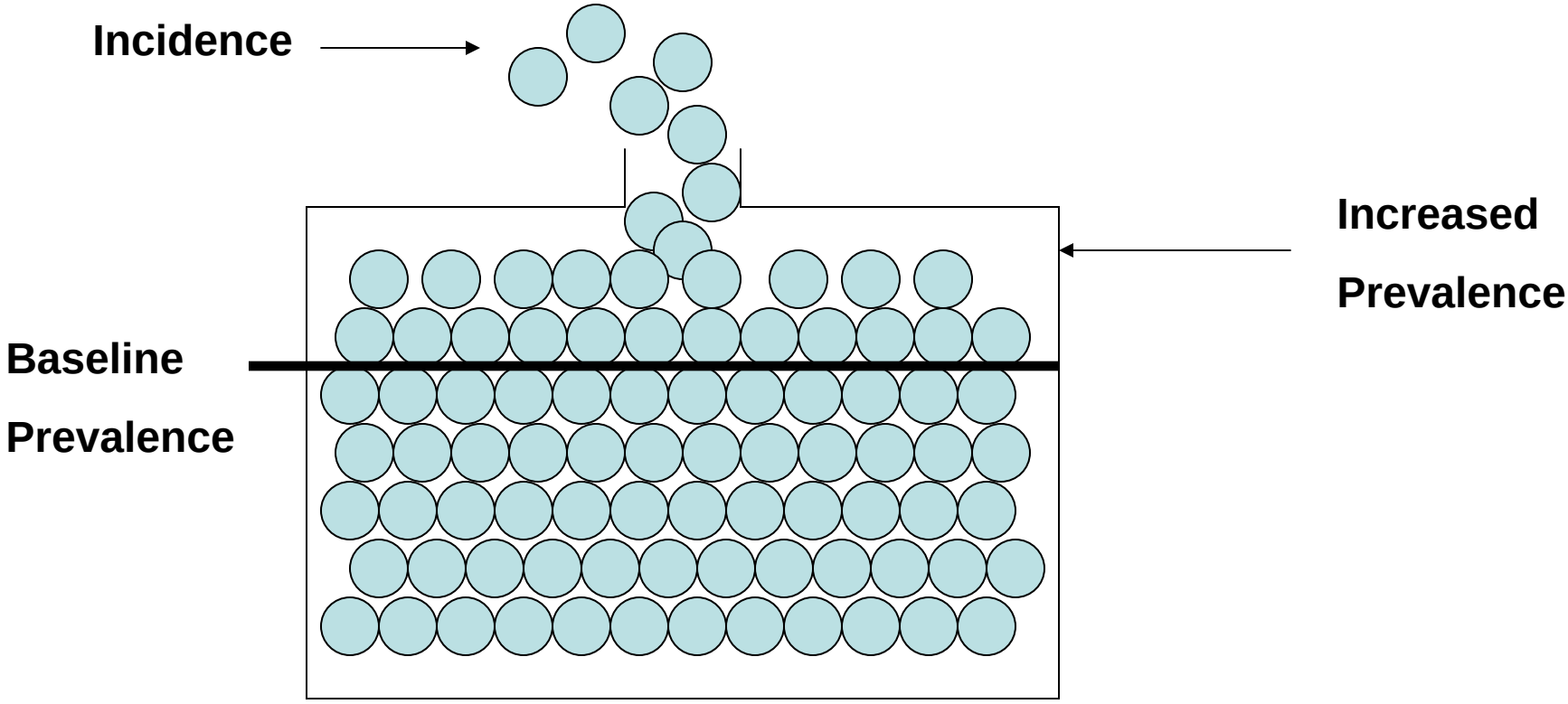

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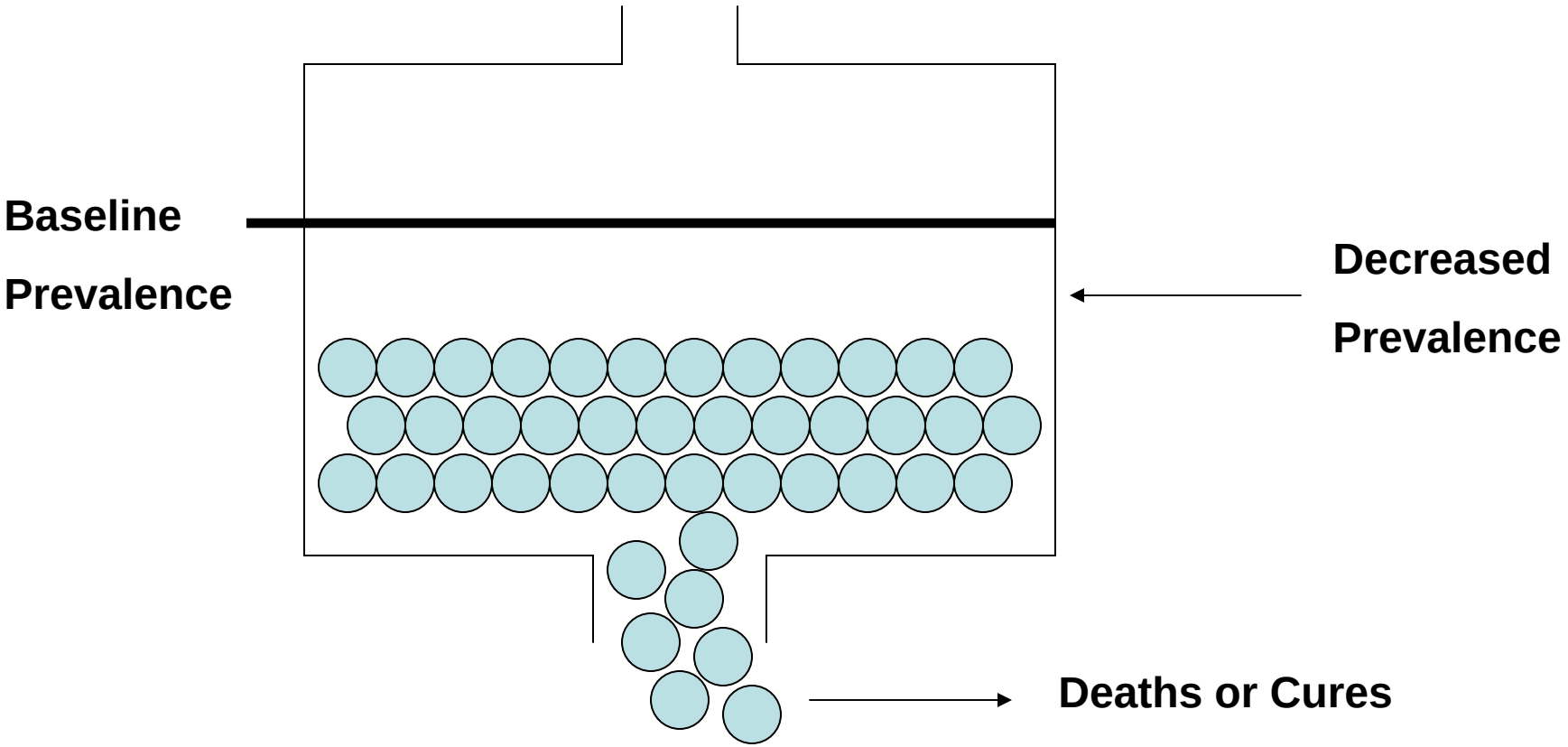
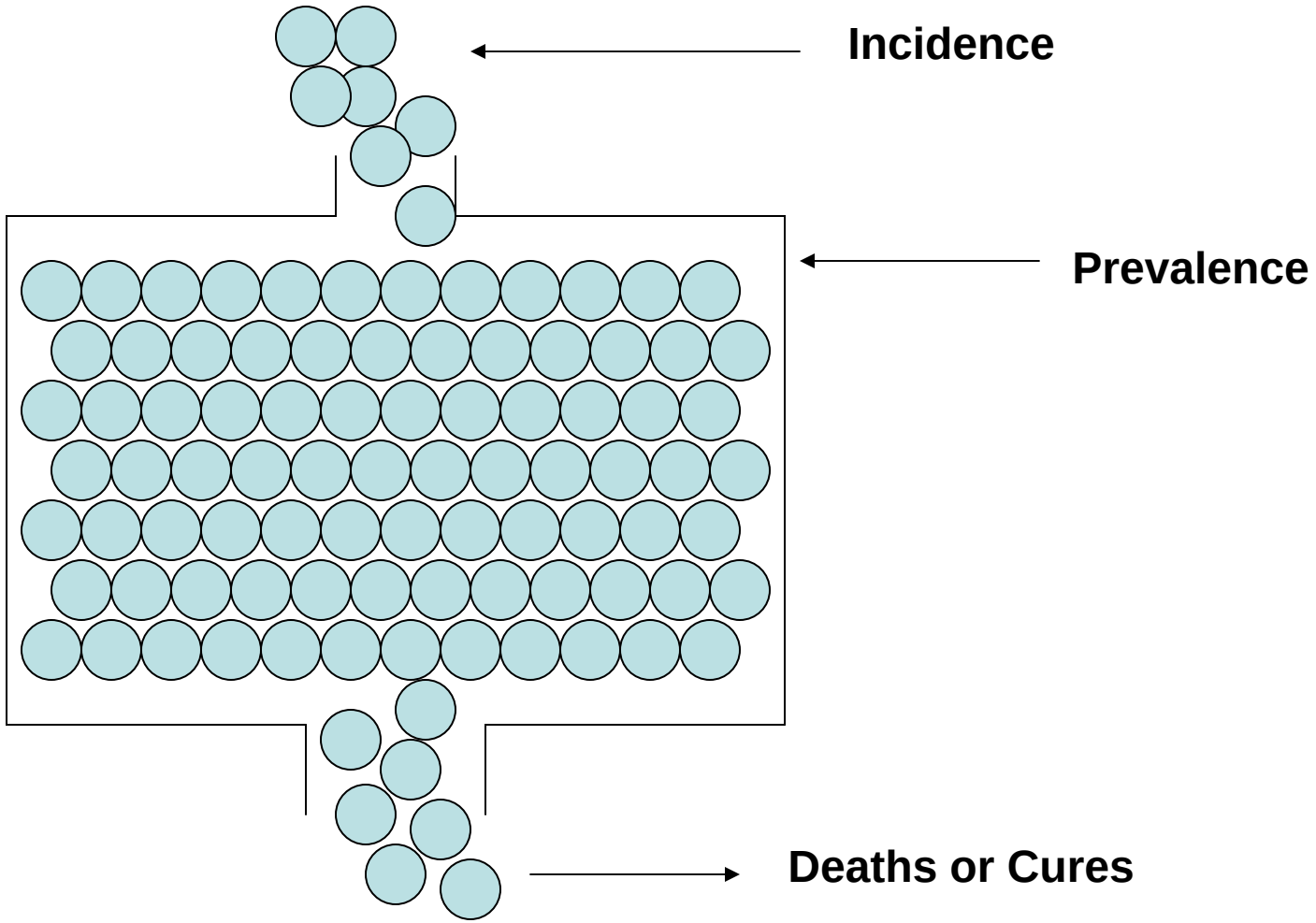


True Dynamic



Dynamic Interplay (example)

- New method of detecting or treating disease

- What happens to prevalence?
  - Increases – more people diagnosed or living longer with disease

Why?

- Why measure prevalence?
  - Public health planning (burden of disease) or policy

- Why measure incidence?
  - To tell us something about the etiology or cause of a disease
  - To explore the relationship between a risk factor (exposure) and the risk of disease

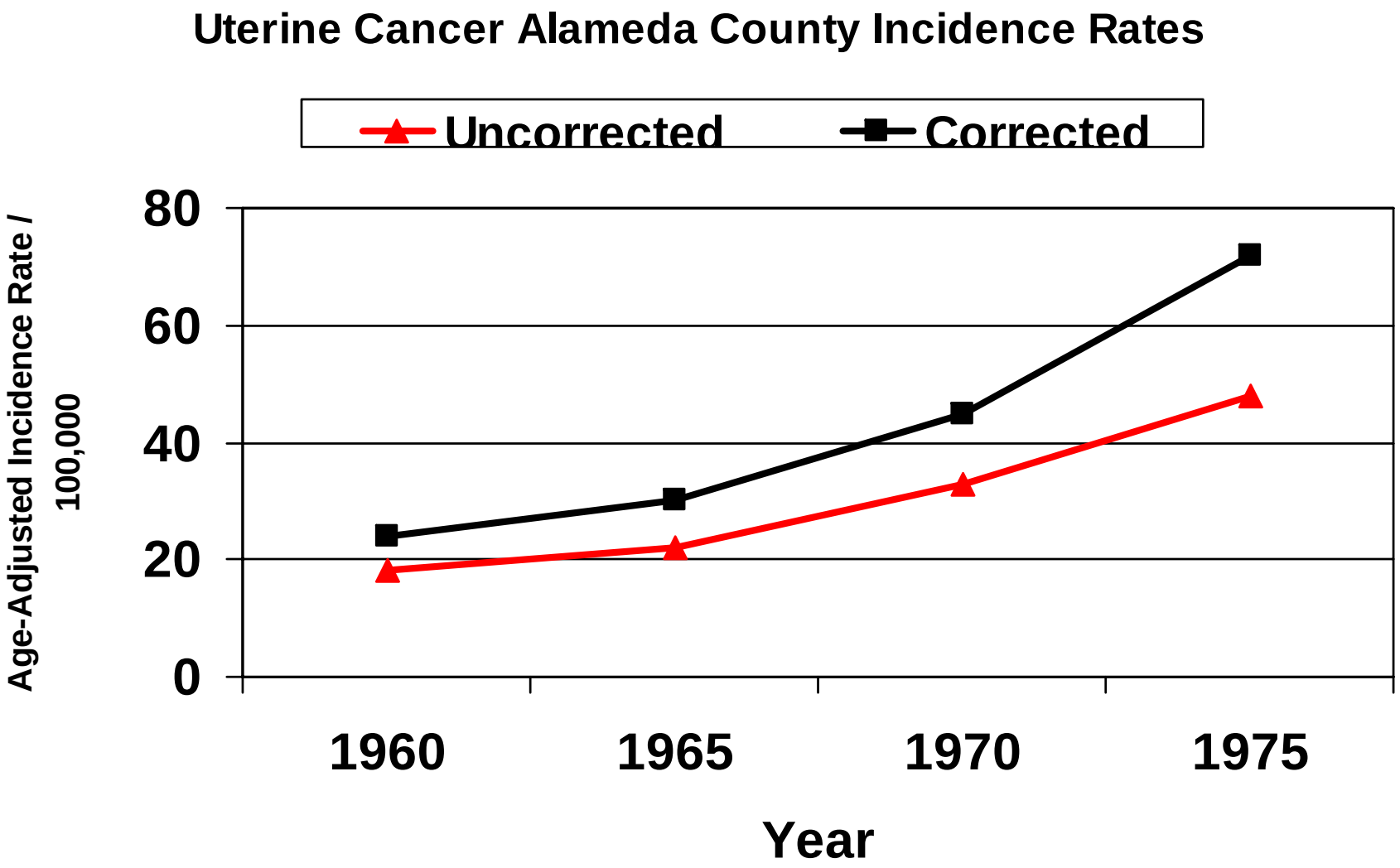
Problems with Numerators

1. Defining who has the disease.
   - What is the cut-point for having high blood pressure? Who decides?

2. How do we find the cases?
   - Can conduct a study to specifically find the cases or use regularly available data.

Problems with the Denominator

1. Selective undercounting of certain groups in a population
   - Young males in ethnic minority groups often missed
   - Difficulty defining race or ethnicity (e.g. language, country of origin, heritage, parents ?)
2. Defining “at risk”
   - E.g. uterine cancer risk – including or excluding persons who had hysterectomies



Why is "corrected" higher? **Answer:** Because persons not at risk removed from denomiator = those who had hysterectomy and couldn't develop cancer

Relation between Prevalence and Incidence

Prevalence = Incidence X Duration of Disease

P = I X D

Hypothetical Example

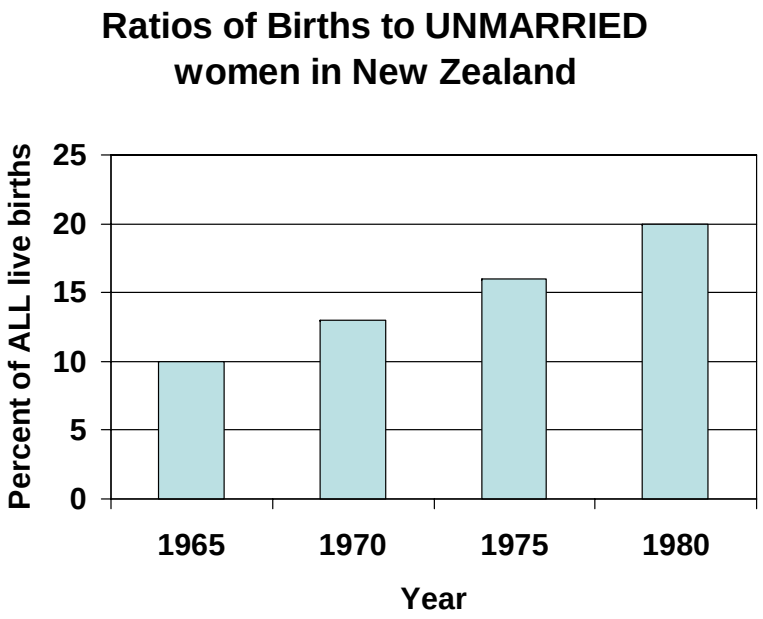
Stress Test = A test that increases heart rate to determine if changes in heart function or changes in ECG occur. Positive test indicates chance of CAD.

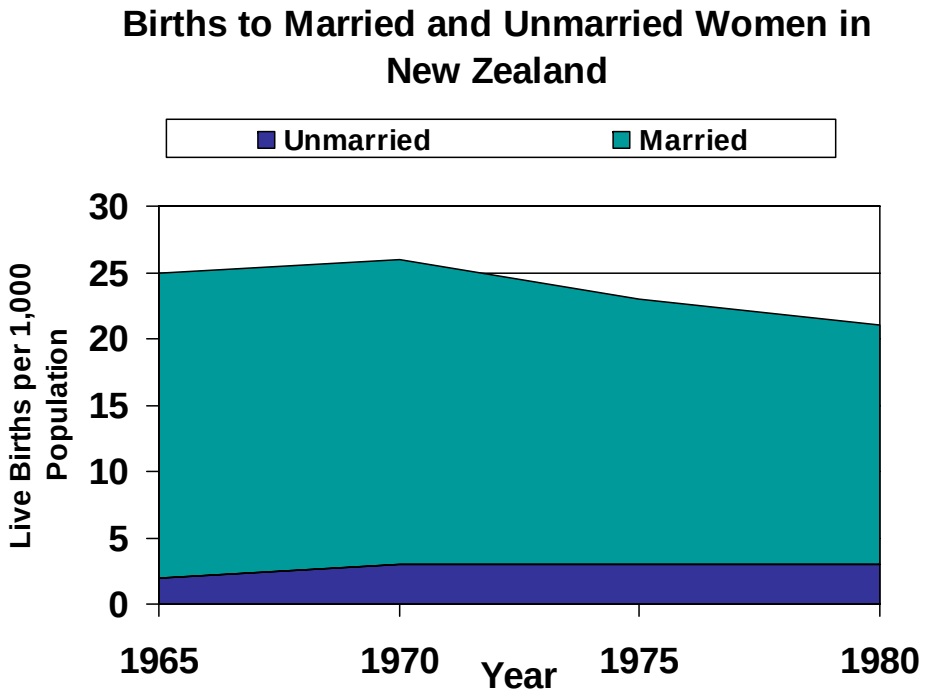
Screened Population	**No. with Positive Stress Test**	**Point Prevalence per 1,000**	**Incidence (occurrences per yr)**	**Duration (yr)**
1, 000 Hitown	100	100	*4*	*25*
1,000 Lotown	60	60	*20*	*3*
Prevalence = Incidence X Duration				

Question: Which town is at higher risk of developing the disease?

Answer: Lotown. The higher number (100) in Hitown reflect a longer duration of the disease, not an increase in the risk of developing the disease.

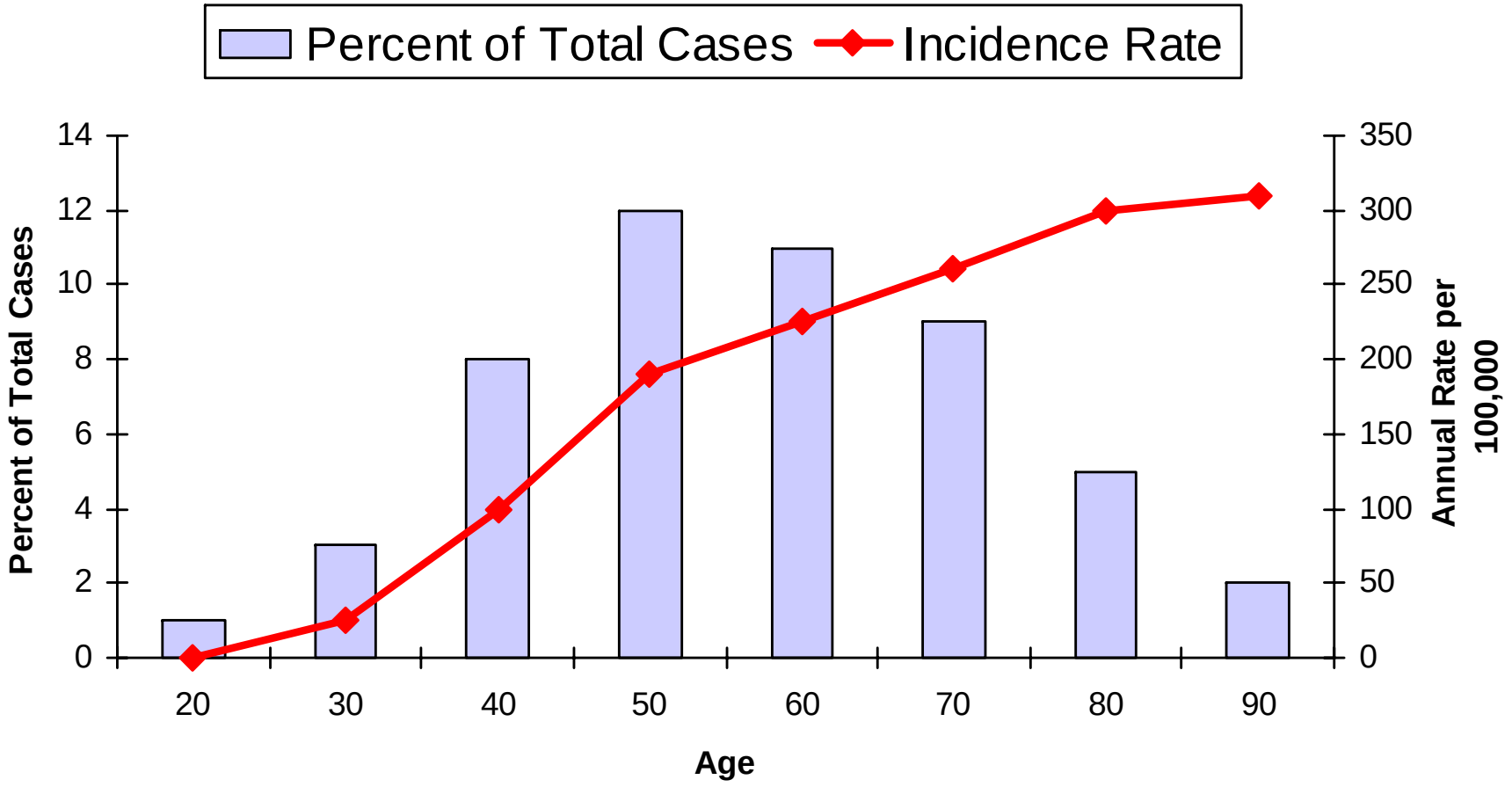
Proportions and Rates





******************Proportions (ratios) are NOT Rates**************************

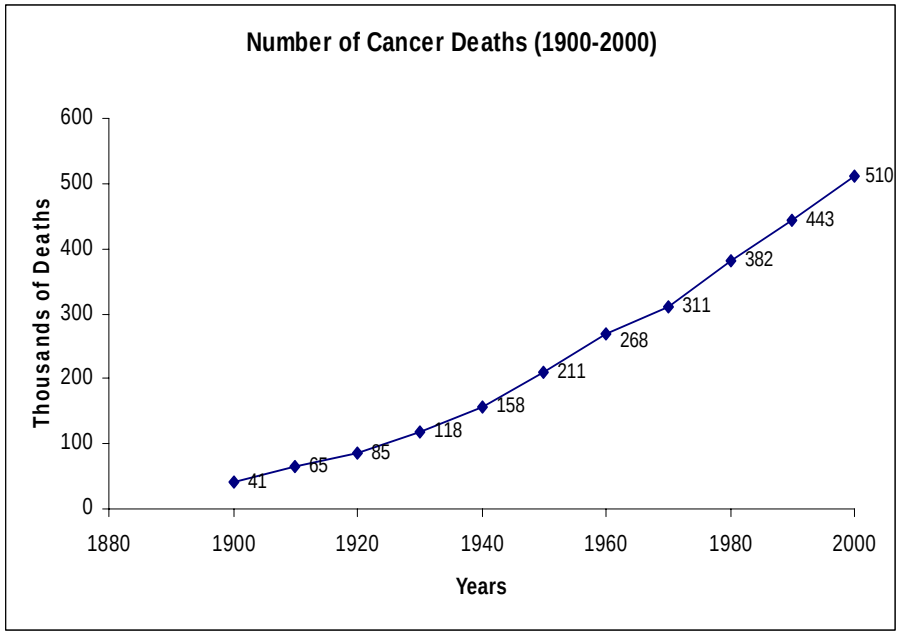
Breast Cancer Incidence Rates and Distribution of Cases by Age



Measures of Mortality

- How is mortality expressed in quantitative terms?
  - Annual mortality rate from ALL causes
  - Disease (or cause) – specific mortality rates
  - Age-specific mortality rates

Mortality Statistics



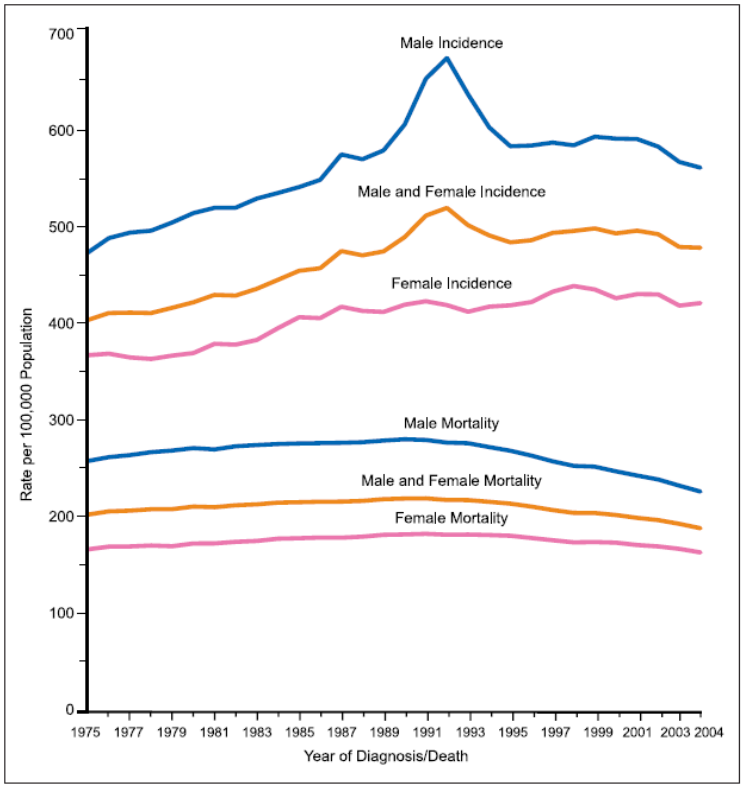


FIGURE 2 Annual Age-adjusted Cancer Incidence and Death Rates* for All Sites by Sex, United States, 1975 to 2004.
*Rates are age-adjusted to the 2000 US standard population. Incidence rates are adjusted for delays in reporting.
Source: Incidence—Surveillance, Epidemiology, and End Results (SEER) program, (www.seer.cancer.gov). Delay-Adjusted Incidence database: "SEER Incidence Delay-Adjusted Rates, 9 Registries, 1975–2004." National Cancer Institute, DCCPS, Surveillance Research Program, Statistical Research and Applications Branch, released April 2007, based on the November 2006 SEER data submission. Mortality—US Mortality Data, 1960 to 2004, National Center for Health Statistics, Centers for Disease Control and Prevention, 2006.

Annual mortality rate for ALL causes (per 1,000 population) =

$$\frac{\text{Total no. of deaths from all causes in 1 year}}{\text{No. of persons in the population at midyear}} \times 1{,}000$$

NOTE: Because the population changes over time, the number of persons in the population at midyear is generally used as an approximation.

Annual mortality rate from lung cancer (per 1,000 population) =

$$\frac{\text{Total no. of deaths from lung cancer per year}}{\text{No. of persons in the population at midyear}} \times 1{,}000$$

NOTE: Because the population changes over time, the number of persons in the population at midyear is generally used as an approximation.

Case-Fatality Rates

Case Fatality Rate (percent) =

$$\frac{\text{No. of individuals dying during a specified period of time after disease onset or diagnosis}}{\text{No. of individuals with the specified disease}} \times 100$$

What percent of people diagnosed as having a certain disease die within a specified time period after diagnosis?

Comparison of Morality Rate and a Case-Fatality Rate

Assume a population of 100,000 people of whom 20 are sick with disease “X” and in 1 year, 18 die from disease “X”.

The mortality rate in that year from disease “X” =

$$\frac{18}{100{,}000} = .00018 = .018\%$$

The case-fatality rate in from disease “X” =

$$\frac{18}{20} = .9 = 90\%$$

Proportionate Mortality

Proportionate Mortality from CVD in the U.S. in 1995 (percent) =

$$\frac{\text{No. of deaths from CVD in the U.S. in 1995}}{\text{Total Deaths in the U.S. in 1995}} \times 100$$

Of all the deaths in the U.S., what proportion were due to CVD?

Comparison of Mortality Rate and Proportionate Morality (part I):

	Community A	Community B
Mortality rate from ALL causes	30 / 1,000	15 / 1,000
Proportionate Mortality from heart disease	10%	20%
Mortality rate from heart disease	3 / 1,000	3 / 1,000

All cause mortality in community A is twice that of community B.

10% of deaths in community A and 20% of deaths in community B are due to heart disease. ***Is the RISK twice as high in community B?***

Mortality Rates are identical. ***Proportionate mortality does not tell us about RISK.***

Comparison of Mortality Rate and Proportionate Morality (part II):

	Community A	Community B
Mortality rate from ALL causes	20 / 1,000	10 / 1,000
Proportionate Mortality from heart disease	30%	30%
Mortality rate from heart disease	6 / 1,000	3 / 1,000

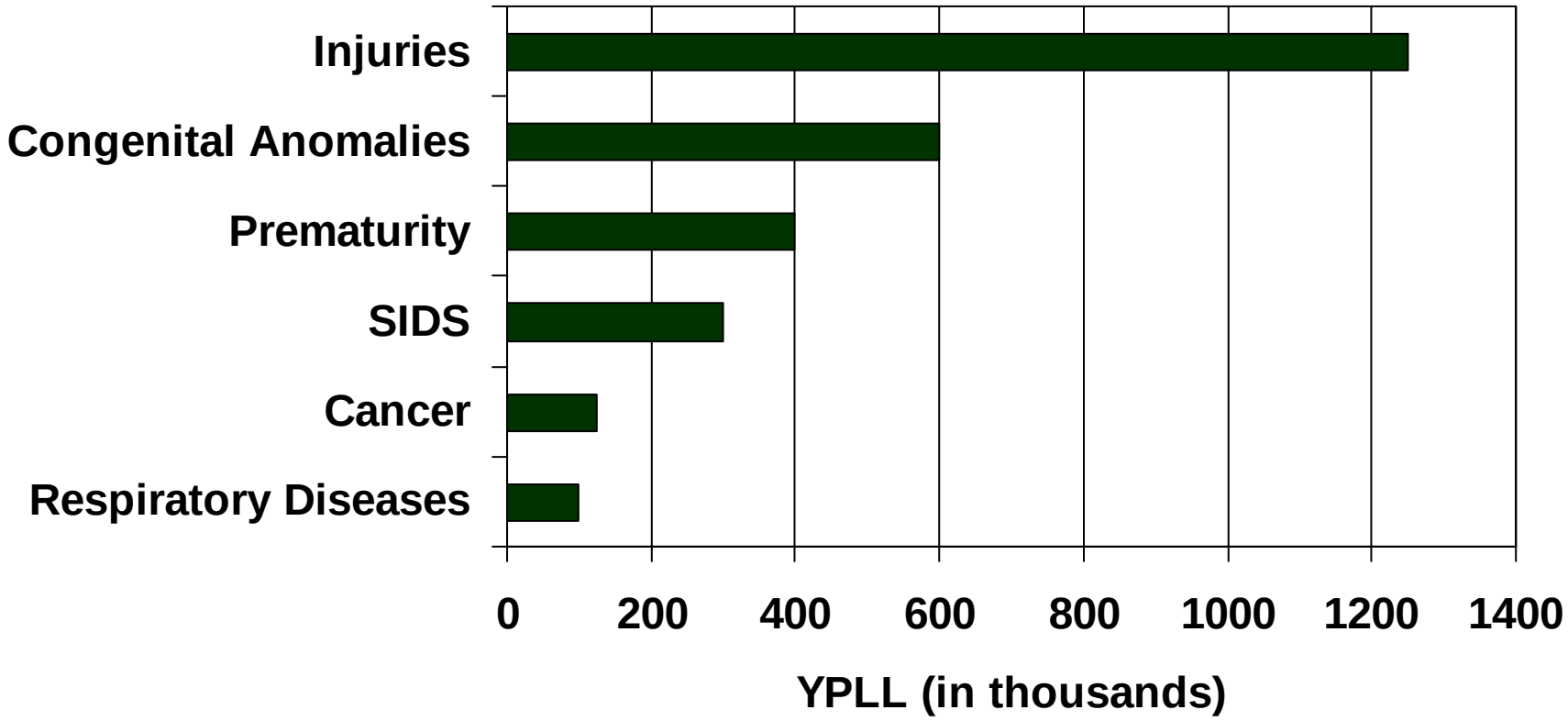
If the ALL cause mortality rates differ, cause-specific mortality rates can differ significantly even when the proportionate mortality is the same.

Proportionate mortality can give us a quick look at the major causes of death, but cannot tell us the RISK of dying from a disease; we need mortality RATE for that.

Years of Potential Life Lost (YPLL)

- Recognizes that death occurring in the same person at a younger age clearly involves a greater loss of future productive years than were it to occur at an older age.

YPLL before age 65 years among children younger than 20.



Problems with Mortality Data

- Mortality data obtained from death certificates
- No training in filling out death certificates for doctors
- Changes occur in how diseases are defined
- Changes in how deaths from diseases are classified
- Countries vary widely in the quality of death certificate data

Why use mortality?

1. Index of severity of dz from both clinical and public health perspectives
2. Can use mortality rate as a reflection of incidence rate.
   - Best used as risk index under 2 conditions:
     - High case-fatality rate of disease
     - Short duration of disease