Measures of Disease Frequency

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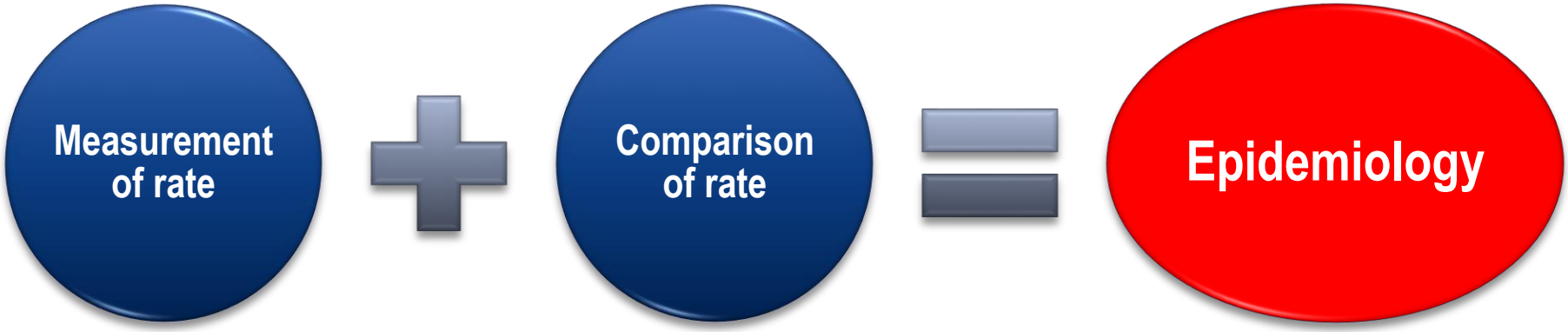
Learning Objectives:

1. Understand counts, ratios, proportions, and rates.
2. Define, calculate, and interpret incidence.
3. Understand the use of person-time denominators.
4. Distinguish between cumulative incidence and incidence rate.
5. Define, calculate, and interpret prevalence.

Learning Objectives (cont.):

7. Distinguish between point and period prevalence.
8. List special types of incidence and prevalence measures.
9. Describe the interrelationship between incidence, prevalence, and duration of disease.
10. Differentiate the use of incidence and prevalence measures.

Quantitative Measures of Health Status



Measures of health status convey information about the occurrence of disease. They include:

- Counts
- Proportions
- Ratios
- Rates

Counts

- Simplest / most frequently performed measure in epidemiology
- Refers to the number of cases of a disease or other health phenomenon being studied
- Useful for allocation of health resources (at the policy level of MOH)
- Limited usefulness for epidemiologic purposes without knowing size of the source population.

Counts – Limited Interpretation

Location	New Cases of Disease	Reporting Period	Population
City A	20	1998	100
City B	100	1998	1000

Annual Rate of Occurrence

City A: 20 / 100 = 0.2

City B: 100 / 1000 = 0.1

Proportions

- Persons included in the numerator are always included in the denominator:

$$\text{Proportion:} \quad \frac{A}{A + B}$$

- In epidemiology, tells us the fraction of the population that is affected.

Proportions - Example

A	B	Total (A + B)
# persons with hypertension	# persons without hypertension	Total study population
1,400	9,650	11,050

P (hypertensive) = A / (A + B) = (1,400 / 11,050)
= 0.127 = 12.7%

Proportions-the role of constant

- Numerical value of a proportion: 0 to 1
- Linked to probability theory (i.e. risk of developing disease)
- For ease of usage, can multiply a proportion by 100 to get a percentage. Or use another power of 10 multiplier (constant)

Ratios

- Like a proportion, is a fraction, BUT without a specified relationship between the numerator and denominator

- Example: Occurrence of Major Depression

Female cases = 240 240

---------- = ------ = 2:1 female to male

Male cases = 120 120

Rates

- A proportion in which TIME forms part of the definition

- Epidemiologic rates contain the following elements:

  - disease frequency (in the numerator)
  - unit size of population
  - time period during which an event occurs

Two common types of rates

A) Events related to the population

- Mortality rate
- Morbidity rate
- Age-specific rates of disease
- Birth rates
- Infant mortality rates
- Perinatal mortality rates
- Neonatal mortality rates

B) Events related to total number of events

- Case-specific fatality rates
- Operative mortality
- Still births

Rates – Example

Calculate crude annual death rate in the US:

$$\text{Crude death rate} = \frac{\text{Annual death count}}{\text{Reference population (during midpoint of year)}} \times \text{constant}$$

Death count in U.S. during 1990: 2,148,463

U.S. population on June 30, 1990: 248,709,873

$$\text{Crude death rate} = \frac{2{,}148{,}463}{248{,}709{,}873} \times 1{,}000 = 8.6 \text{ per } 1{,}000$$

Classification of rates:

There are 2 major types of rates used in epidemiology:

1. Prevalence rate
2. Incidence rate

Prevalence rate

Provides a snap shot of disease or health event. There are 2 types of prevalence rates:

1. Point prevalence rate: Proportion of individuals in a specified population at risk who have the disease of interest at a given point in time.
2. Period prevalence rate: Proportion of individuals in a specified population at risk who have the disease of interest over a specified period of time.

Incidence rate

Incidence rate is the basic measure of risk. Like prevalence is of 2 types:

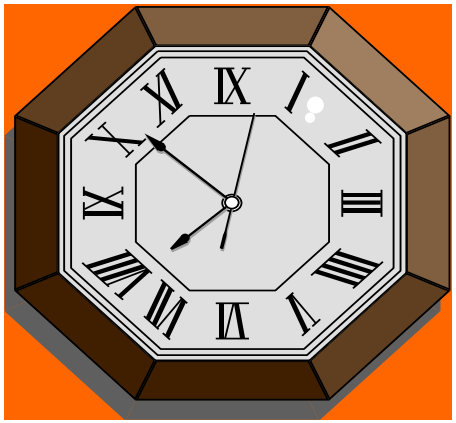
1. Cumulative incidence rate: Number of new cases of disease occurring over a specified period of time in a population at risk (disease-free or condition-free) at the beginning of the interval.
2. Incidence density: Number of new cases of disease occurring over a specified period of time in a population at risk throughout the interval.

The numerator (number of new cases or events) does not differ between the two types of incidence rate. However, the denominator differs in incidence density because it takes account:

- Subjects lost to follow up during the time frame (migration, death, lost interest in the study)
- Subjects who had the disease (like influenza) once and will not have it again in the same season (not at risk any more).
- Subjects who came to observation after the start of study.

Incidence Density

$$\text{Incidence Density} = \frac{\text{No. new cases of disease during a given period}}{\text{Total ``person-time'' of observation}}$$



Since the number of cases is divided by a measure of time of observation, rather than people, this helps address the problem of *losses to follow up*.

Person-Time

Person	Follow-up Time on Study	Person Yrs.
1	<---------->	2
2	<----------Died	2
3	<----------Event	1
4	<---------->	3
5	<---------->	2

1995 Jan. 1996 Jan. 1997 Jan. 1998 Jan.

Study Period: 3 Years
Study Participants: 5
Person Years of Observation: 10
Average Duration of Follow-Up: 2.0 Years

Incidence Rate-Calculation

$$\text{Incidence Density} = \frac{1 \text{ case}}{10 \text{ years}} = 1 \text{ case /10 person-years}$$

Where as,

$$\text{Cumulative Incidence} = \frac{1 \text{ case}}{5 \text{ persons}} = 0.20 = 20.0\%$$

Incidence Vs prevalence comparison

1. Incidence is generally used for acutely acquired diseases, prevalence is used for more permanent states, conditions or attributes of ill-health.
2. Incidence is more important when thinking of etiology of the disorder (since it measures the risk), prevalence when thinking of societal burden of the disorder including the costs and resources consumed as a result of the disorder.
3. Incidence always requires a duration, prevalence may or may not.
4. Incidence generally requires an initial disease-free interval before counting starts.

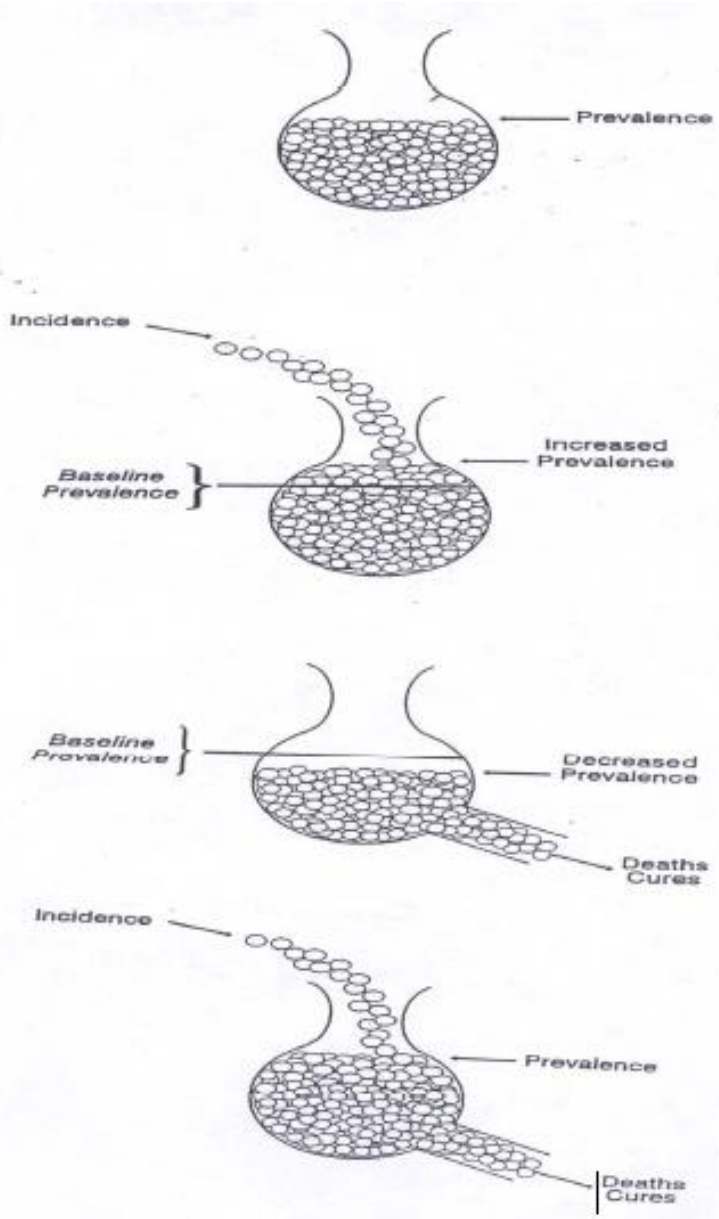
How are incidence and prevalence related?

WHEN (the steady state is in effect). Incidence rate (I) and duration of disease (D) has been constant over time.

$$I \times D = P / (1 - P)$$

$$P = (I \times D) / (1 + (I \times D))$$

If the prevalence (P) of disease is low (i.e. < 0.10) then $P = I \times D$



Why is incidence preferred over prevalence when studying the etiology of disease?

Because, in the formula: **P = I x D**

D is related to :
- The subject's health condition
- Access to care
- Availability of treatment
- Social support
- The severity of disease

So prevalent cases reflect factors related to the incidence of disease (Etiological factors), AND factors related to the duration of disease (Prognostic factors). Thus, they are not adequate for studies trying to elucidate Disease Etiology.

Test your knowledge

- What disease has a high incidence and low prevalence?
- What conditions have a high prevalence and low incidence?
- What condition has low incidence and low prevalence?
- What condition has high incidence and high prevalence?

References

- Lecture Notes in Epidemiology and Public Health Medicine, 5th edition. Farmer R, Lawrenson R. Blackwell Publishing, 2004.
- Oxford Textbook of Public health, 4th edition. Detels R, McEwen J, Beaglehole R, Tanaka H. Oxford Medical Publications, 2002.