Epidemiology

Measures of disease frequency and disease burden
“I’m studying epidemiology”:
3 responses

- You're studying what?”

- “Does that have something to do with skin?”

- “Uh-huh. And what else are you studying?”
What is epidemiology?

“The study of the distribution and determinants of health related states and events in populations, and the application of this study to control health problems”

John M. Last, *Dictionary of Epidemiology*
What for?

1. Provide the scientific basis to prevent disease & injury and promote health.

2. Determine relative importance to establish priorities for research & action.

3. Identify sections of the population at greatest risk to target interventions.

4. Evaluate effectiveness of programs in improving the health of the population.
What for? – more

5. Study **natural history** of disease from precursor states through clinical course

6. Conduct **surveillance** of disease and injury occurrence in populations

7. Investigate disease **outbreaks**

Measuring Disease Occurrence

• **Occurrence of disease** is the fundamental outcome measurement of epidemiology.

• **Occurrence of disease** is typically a binary (yes/no) outcome.
  – Note: Continuous changes related to disease, e.g., changes in blood pressure, are also relevant but not the focus of this course.

• **Occurrence of disease** involves *time*.
The Three Elements in Measures of Disease Incidence

• E = an event = a binary outcome (occurrence of disease)
• N = number of at-risk persons in the population under study
• T = time period during which the events are observed

Terminology is not standardized and is used carelessly even by those who know better. Key to understanding measures is to pay attention to how the 3 elements of number of events (E), number of persons at risk (N), and time (T) are used. Even the basic difference between prevalence and incidence is often ignored.
Incidence

\[ I = \frac{\text{New cases in a given period of time}}{\text{Exposed population in the same period of time}} \times k \]

- Also called absolute risk
- Only incidence can be used for etiology studies
An example population (N=200)

Incidence and prevalence
How can we quantify disease in populations?

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How can we quantify the frequency?
Incidence: **new cases per population (6/200)**

Incidence and prevalence
Prevalence

\[ P = \frac{\text{New and existing cases in a given point of time}}{\text{Exposed population in the same period of time}} \times k \]

- Prevalence: the proportion of a population at risk that is affected at a given time (point-prevalence)
- The impact of diseases on a population level (prevalence) is important when defining health care
1 new case, 1 death
(continued, 6 cases remain)
1 new case, 1 new death
2 new cases, no deaths
2 new cases, 1 new death
Prevalence (point) = \textbf{existing cases per population} (9 / 197)
Two Types of Prevalence

- **Point prevalence** - number of persons with a specific disease at one point in time divided by total number of persons in the population

- **Period prevalence** - number of persons with disease in a time interval (e.g., one year) divided by number of persons in the population
  - Prevalence at beginning of an interval plus any incident cases

- **Risk factor (exposure)** prevalence may also be important
USES OF INCIDENCE AND PREVALENCE

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, 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.
Problem: How would you measure breast cancer incidence in a cohort study (such as the Nurses Health Study)?

Disease incidence is the occurrence of new cases over time.

But how to account for the role of time?
Cohort study design

D = disease occurrence; arrow = losses to follow-up
Two Measures of Incidence

• The proportion of individuals who experience the event in a defined time period \(E/N\) during some time \(T\) = cumulative incidence = incidence proportion

• The number of events divided by the amount of person-time observed \(E/NT\) = incidence rate or density (not a proportion)
Cumulative Incidence

• Definition: The proportion of individuals who experience the event in a defined time period (E/N during some time T) = cumulative incidence

• Example: Diabetic Medications and Fracture: “The cumulative incidence of a first fracture among women reached 15.1% at 5 years with rosiglitazone, 7.3% with metformin, and 7.7% with glyburide.”
Incidence Rate

• Definition: The number of events divided by the amount of person-time observed (E/NT) = incidence rate or density (not a proportion)

• Same example, Diabetic Medications and Fracture, now presented as incidence rates: “The incidence of a first fracture among women was 2.74 per 100 person-years with rosiglitazone, 1.54 per 100 person-years with metformin, and 1.29 per 100 person-years with glyburide.”
Cumulative incidence

- The diagram to the left represents an observed population of 12 people (e.g. in a clinical trial).
- X – the occurrence of the disease
- A – start of observation
- B – end of observation
- CI = 7/12 = 58%
Cumulative incidence (CI)

- Has no dimension
- Value may vary between 0 and 1
- Specified in time (e.g. 5 years)
- All members of the given population should be observed until the occurrence of the event or until the end of the observational period

Survival rate (SR): 1-CI
Cumulative incidence rates used in medicine

- Absolute risk (incidence)
- (Case) Fatality rate is the ratio of death within a designated population of people with a particular condition, over a certain period of time.
- Five-year absolute survival rates describe the percentage of patients that are alive five years after their disease is diagnosed.
- Five-year relative survival rates describe the percentage of patients with a disease that are alive five years after their disease is diagnosed divided by the percentage of the general population of corresponding sex and age that are alive after five years.
- Attack rate cumulative incidence of infection in a group of people observed over a period of time during an epidemic, usually in relation to foodborne disease.
Incidence rate ("incidence density")

\[
\text{Number of new cases} \div \text{Avg population at risk } \times \text{ Time interval}
\]

\[
\text{Number of new cases} = \ldots \text{Population-time}
\]
Incidence rate

The diagram to the left represents an observed population of 5 people from 1990 to 2000 (90-0).

- X – the occurrence of the disease
- A-E – Individuals observed
- — length of observation

Total observed period: 35.5 years

Incidence rate = 2 / 35.5 person-years = 0.0056 / person year = 56 / 1000 person-years
Incidence rate (density)

- Rate at which new cases of a disease occur in a population given that the population is both studied and at risk for varying length of time

- Person-time: the number of disease-free time (e.g. years) contributed by each individual in the study

- Value may vary between 0 and infinite
WHO HFA Database

- [http://data.euro.who.int/hfadb/](http://data.euro.who.int/hfadb/)

Indicators
- Mortality
- Morbidity
- Risk factors

Analysis by time and by country
EXERCISE

• Check the changes of cardiovascular death in Hungary!

• Compare the incidence of lung cancer among European countries in a 10-year long period!

• Observe the changes in smoking habits during the same period!