Biostatistics
Epidemiological Measures
Ratio, Proportion, Rate

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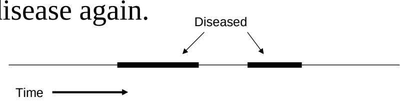
Basic Concepts in Epidemiology

- What is Epidemiology?
  IT IS NOT THE STUDY OF THE SKIN!!
  It is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to control of health problems.

How do diseases evolve in individuals over time?

- Disease states:
  - Many diseases afflict an individual over time.
  - Some are recurrent – person is diseased for a while, then recovers, but may experience the disease again.



  - Examples: Urinary tract infection, depression, fracture of radius

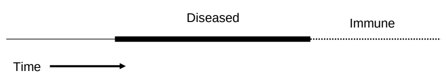
How do diseases evolve in individuals over time?

- Disease states:
  - Some are non-recurrent – an individual can develop the disease at most once
    - Diseases may be irreversible

    - Examples: Alzheimer's Disease, Osteoarthritis, Coronary Heart Disease

How do diseases evolve in individuals over time?

- Disease states:
  - Some are non-recurrent – an individual can develop the disease at most once
    - Recovery may occur with development of permanent immunity.



    - Examples: Measles, Appendicitis

How do diseases evolve in individuals over time?

General Model:

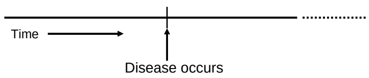
- Above patterns of disease behavior can be regarded as special cases of a more general model.
- At any given time, an individual can be in one of three states:
  1. Diseased: Currently afflicted.
  2. Susceptible: not currently afflicted, but capable of developing the disease in the next moment of time.
  3. Immune: not currently afflicted, and incapable of developing the disease in the next moment (and possible longer).

How do diseases evolve in individuals over time?

General Model:
- Examples:
  - Uterine cancer – men are immune.
  - Benign prostatic hypertrophy – women are immune.
  - Measles – those who become ill (or immunized) develop protective antibodies.
  - Polio – oral vaccines confer immunity.
- "At-risk"
  - Susceptible individuals are termed "at-risk" (there may be wide variability in risk among them, however).
  - Immune and diseased individuals are termed "not at-risk" – they have no chance of developing the disease anew in the next moment of time.

How do diseases evolve in individuals over time?

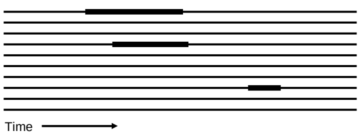
- Disease events:
  - Some diseases are most naturally regarded as instantaneous occurrences at a particular point in time. Unlike states, they have negligible durations. Examples:
    - Rupture of aortic aneurysm.
    - Spontaneous abortion.
    - Fall in an elderly person.



Diseases in Populations

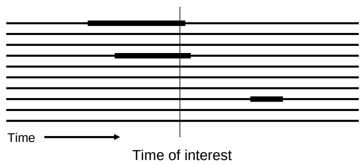
- Populations are groups of individuals. Their disease experience can be considered collectively on a common time scale.

  Example: Urinary tract infection in a population of 10 people.



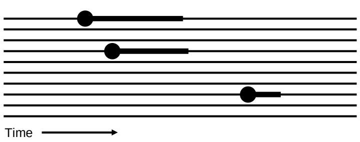
Diseases in Populations

- At any given time, population members may be in different states:



Diseases in Populations

- Over time, onset of disease in susceptible persons may occur at different times.



Diseases in Populations

How are populations "defined"?
- By specifying criteria for membership. These criteria may include:
  - Geographic boundaries within which individuals must reside.
  - Membership in a predefined group.
  - Specification of a time or time period of interest.
  - Examples:
    - Residents of Salt Lake City, UT on January 1, 2005.
    - Attendees of a certain church picnic.
    - All alumni of the U of U School of Medicine as of January 1, 2005.

Diseases in Populations

- In a population that is observed over time, membership in the population may or may not change.
  - If no changes in membership occur, it is called a Closed Population (or "fixed cohort"). Examples:
    - Persons involved in a foodborne illness outbreak that occurs over a short period of time.
    - Clinical trials participants whose mortality experience is followed for the duration of the trial, with no losses to follow-up.

Diseases in Populations

- If membership of the population changes during the observation period, it is called an Open Population (or "dynamic population").
  - People may join – e.g., births, in-migration.
  - People may leave – e.g., deaths, out-migrants.
  - Examples:
    - Population of Salt Lake City during 2004.
    - Employees of the state government during 2000-2004.
    - Enrollees of Intermountain Health Care during 2000-2004.

Measurements in Epidemiology

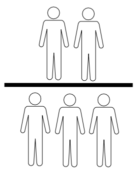
- Define and use
  - Ratio
  - Proportion
  - Odds
  - Rate

Measurements in Epidemiology

- Define and use
  - Prevalence
  - Incidence
    - Cumulative incidence (CI), Incidence proportion
    - Attack rate (AR)
    - Incidence density (ID), Incidence rate

Measurements in Epidemiology

- **Count** - The number of individuals with the outcome of interest
- **Proportion** - The number of individuals within a defined group with the outcome of interest divided by the number of individuals enumerated in the population
- **Rate** - The number of individuals within a defined group with the outcome of interest divided by the number of individuals enumerated in the population who are followed for a specified period of time
- **Ratio** - One number divided by another number

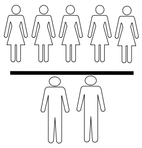


- Ratio
- Proportion
- Rate

What, who is in the denominator ? ???

Ratio

- **The quotient of 2 numbers**
- **Numerator NOT necessarily INCLUDED in the denominator**
- **Allows to compare quantities of different nature**



= 5 / 2 = 2.5 / 1

Ratio, Examples

- \# beds per doctor
  - 850 beds/10 doctors
  - R = 85 beds for 1 doctor
- \# participants per facilitator
- \# inhabitants per latrine

- Sex ratio: Male / Female
  Female / Male
- Odds ratio
- Rate ratio

Ratios

- **Used when denominator of a population is hard to define**
- **Infant mortality ratio**

$$\frac{\textbf{\# of Infant deaths at a defined stage of gestation}}{\textbf{\# of live births}}$$

- **Maternal mortality ratio**

maternal deaths/live births

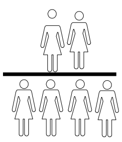
Proportions: An Example

Suppose someone says: “Seven children in the city have developed leukemia in the last year.”

- Is seven too many?
- It depends on the size of the city!
- The proportion of children with leukemia gives more information than the number of children with leukemia.

Proportion

- **The quotient of 2 numbers**
- **Numerator NECESSARELY INCLUDED in the denominator**
- **Quantities have to be of same nature**
- **Proportion always ranges between 0 and 1**
- **Percentage = proportion x 100**



$$\frac{2}{4} = 0.5 = 50\%$$

Proportion, Examples

- Proportion of male in 8 classes
  - 101 students, 9 male
  - Proportion of male student = 0.09
  - Percentage of male student = 9%

Proportions

- Numbers by themselves may be misleading: they are on different scales and need to be reduced to a standard basis in order to compare them.
- We most frequently use proportions: that is, the fraction of items that satisfy some property, such as having a disease or being exposed to a dangerous chemical.
- "Proportions" are the same thing as fractions or percentages. In every case you need to know what you are taking a proportion of: that is, what is the DENOMINATOR in the proportion.

$p = \frac{x}{n}$ and $percent = \frac{x}{n}(100)$

Proportions and Probabilities

- We often interpret proportions as probabilities. If the **proportion** with a disease is 1/10 then we also say that the **probability** of getting the disease is 1/10, or 1 in 10.
- Proportions are usually quoted for **samples** - probabilities are usually quoted for **populations.**

Uses of Proportion

As a descriptive statistic:

- The proportion of women in college.
- The percent of economy cars.

As a measure of morbidity

- Disease prevalence
- Disease incidence
- Mortality rate (death rate)

As parameters to characterize screening tests:

- Sensitivity of a screening test
- Specificity of a screening test

Case-Control Design: An Example

- A case-control study undertaken to identify the reasons for the exceptionally high rate of lung cancer among male residents of coastal Georgia.

  Cases (identified from these 3 sources)

  a. Diagnosis since 1970 at the single large hospital in Brunswick.

  b. Diagnosis during 1975-1976 at three major hospitals in Savannah

  c. Death certificates for the period 1970-1974 in the area

Proportion as a Descriptive Statistic: Case-Control Design

Controls – selected from admissions to four hospitals and from death certificates from the same period for diagnosis other than lung cancer, bladder cancer or chronic lung cancer.

Risk Factor – “shipbuilding” , employment in the shipyards during World War II.

Confounding Factor – an exposure itself, not under investigation but related to the disease and the exposure. In this case, smoking is a confounding factor.

Proportion as a Descriptive Statistic: Case-Control Design

- There was a high rate of lung cancer among male residents of coastal Georgia.
- Cases (people with lung cancer) were identified from hospital records.
- Controls (people without lung cancer or bladder cancer) were selected from the same hospital.
- Risk factor: exposure to shipyards during World War II.
- Confounding variable: smoking (*effect modifier*)

Shipbuilding Example Smokers

Smoking	Shipbuilding	Cases	Controls
No	Yes	11	35
	No	50	203
Yes	Yes	84	45
	No	313	270

- For the cases:
  - Proportion of exposure=84/397=0.212 or 21.2%
- For the controls:
  - Proportion of exposure=45/315=0.143 or 14.3%

Shipbuilding Example Smokers

The results for smokers reveal different exposure histories for cases and controls.

The proportion of exposure to shipbuilding among cases (21.2%) was higher than among controls (14.3%). The difference is 6.9%.

It is not conclusive *proof*; however, it is a *good clue* indicating a possible relationship between disease and exposure.

Shipbuilding Example Nonsmokers

Smoking	Shipbuilding	Cases	Controls
No	Yes	11	35
	No	50	203
Yes	Yes	84	45
	No	313	270

- For the cases:
  - Proportion of exposure=11/61=0.180 or 18.0%
- For the controls:
  - Proportion of exposure=35/238=0.147 or 14.7%

Shipbuilding Example Nonsmokers

The results for nonsmokers reveal different exposure histories for cases and controls.

The proportion of exposure to shipbuilding among cases (18.0%) was higher than among controls (14.7%). The difference is 3.3%.

It is not conclusive *proof*; however, it is a *good clue* indicating a possible relationship between disease and exposure.

Shipbuilding Example: Terminology Review

- The term ***exposure*** refers to a suspected ***risk factor***. The term exposure is also used when the factor has beneficial effects. This is called a ***protective factor*** (flouride).
- The ***confounder*** is not under investigation, but may be related to both disease and exposure. It may act as an ***effect modifier***, altering the effect of an exposure.
- The main effects were different: 6.9% among smokers versus 3.3% among nonsmokers.

Rate

- **The quotient of 2 numbers**
- **Speed of occurrence of an event over time**

Numerator
- number EVENTS observed for a given time

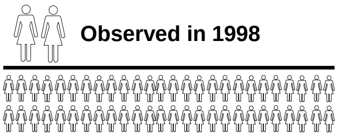
Observed in 1998

Rate

- The quotient of 2 numbers
- Speed of occurrence of an event over time

Numerator
- number EVENTS observed for a given time

Denominator
- population in which the events occur (population at risk)
- includes time



$$\frac{2}{100} = 0.02 \text{ / year}$$

Rate, Example

- Mortality rate of tetanus in France in 1995
  - Tetanus deaths: 17
  - Population in 1995: 58 million
  - Mortality rate = 0.029/100,000/year
- Rate may be expressed in any power of 10
  - 100, 1,000, 10,00, 100,000

Rates

- The term *rate* is often used interchangeably with the term proportion in epidemiology although sometimes it refers to a quantity of a very different nature.
- Types of rates we will cover:
  - Change rates
  - Death rate
  - Incidence rate
  - Follow-up death rate

Change Rates

- These types of rates are used to describe changes after a certain period of time.

$$\text{change rate (\%)} = \frac{\text{new value - old value}}{\text{old value}} \text{ X } 100$$

- Example: A total of 35,238 new AIDS cases were reported in 1989 compared to 32,196 reported during 1988.
  - The change rate for new AIDS cases:

$$\left(\frac{35{,}238 - 32{,}196}{32{,}196}\right)100 = 9.4\%$$

Rate

- **Infant mortality rate in one year**

$$\frac{\textbf{\# of Infant deaths at a defined stage of gestation}}{\textbf{\# of live births in one year}}$$

Rates vs. Proportions

We must have a clear definition of the denominator to determine if we have a rate or and proportion.

- Rate : denominator contains units of exposure (person-years).
- Proportion: denominator contains a count or the number of individuals at risk (or exposed).

Difference

Difference between Two Probability

Baseball Games	Won	Lost	Total
Taiwan Team	14	6	20
China Team	8	12	20

Probability Difference = 0.7- 0.4 = 0.3

Odds

$$\frac{\textbf{Probability that an event will happen}}{\textbf{Probability that an event will not happen}}$$

	Won	Lost	Total
Taiwan Team	14	6	20

$$\text{Odds} = \frac{14 / 20}{6 / 20} = 14 \text{ TO } 6 = 2.33$$

Odds Ratio

Odds_1 / Odds_2

Baseball Games	Won	Lost	Total
Taiwan Team	14	6	20
China Team	8	12	20

$$\text{Odds Ratio} = \frac{(14 / 20) / (6/20)}{(8 / 20) / (12/20)} = 3.5$$

Risk and Rate

Risk

- **The probability of an unaffected individual developing a given disease over a specified period**

Rate

- **Special case of a proportion that includes time (or other factor) in the denominator**

Measurements in Epidemiology

Epidemiology involves estimating frequency and distribution of diseases in populations and comparing the effect of suspected risk factors on the frequency of disease

Measuring Disease Frequency

- Measures of disease frequency are tools used to describe how common an illness (or other outcome) is with reference to the size of the population (population at risk).
- Used to quantify cases in relation to the population and a measure of time.
- 2 main measures:
  - Prevalence
  - Incidence

Measures of Disease Occurence

1. Prevalence
   Measures population disease status proportion
   – (Point) Prevealence
   – Lifetime prevalence
   – Period Prevalence
2. Incidence
   Assess frequency of disease onset
   – Cumulative incidence (incidence proportion)
   – Incidence density (incidence rate)

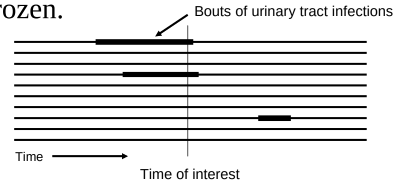
Two Measures of Incidence

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

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

Measures of Disease Frequency - Prevalence

- Measures frequency of disease in a defined population at a *specified point in time*.
  – Fundamentally a static measure of disease frequency – a "snapshot" view, with time frozen.



Measures of Disease Frequency - Prevalence

– The "Point in time" at which prevalence is determined may refer to any of several time scales. Examples:
  - Calendar time – e.g., prevalence of HIV infections in Utah on January 1, 2005.
  - Age – e.g., prevalence of HIV infections among 20-year-old military recruits (regardless of whether they achieved age 20 in calendar time).
  - Time since some event – e.g., prevalence of depression among widows/widowers 6 months after the death of a spouse.

(Point) Prevalence

$$\frac{\text{Number of cases of disease at a specific time}}{\text{Population exposed at that time t}}$$

- **Proportion of a population affected by a disease at a given time**
- **Expressed as a percentage**

Example of lung cancer in a community, Jan 1, 1980:

Population	**3,500,000**
Cases	**95,000**
Prevalence	**2.71%**

Period Prevalence

$$\frac{\text{Number of cases of disease between a specific time (T0, T1)}}{\text{Population exposed during that time (T0, T1)}}$$

- **Proportion of a population affected by a disease at a given time**
- **Expressed as a percentage**

Lung cancer in a community, Jan1--Dec 31, 1980:

Population	**3,500,000**
Cases	**96,250 (1250 new cases)**
Prevalence	**2.75%**

Prevalence

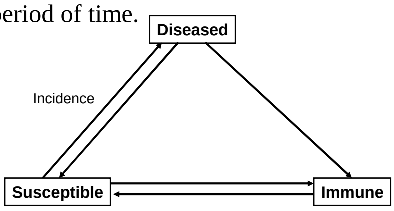
- **often expressed with a population multiplier**
  - **–Pr = 0.1**
  - **–or 10%**
  - **–or Pr = 10 per 100 animals**

Prevalence of URT infection in class

- **42 students**
- **7 with URT**
- **Prevalence: 7/42 = 0.17 or 17%**

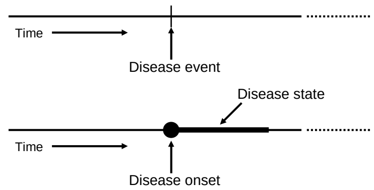
Measures of Disease Frequency - Incidence

- Incidence measures the frequency at which new disease is occurring in a defined population at risk *over time*.
  - Fundamentally a dynamic measure of disease frequency – requires that people be observed over a period of time.



Measures of Disease Frequency - Incidence

- Applies to events…
  - The disease may itself be an event (e.g. aneurysm rupture)
  - Or the onset of a disease state may be treated as the event of interest.



Incidence

Incidence rate	**Cumulative incidence**
Incidence density	**Incidence proportion**
Rate	***Risk (probability)***

Cumulative Incidence (CI) = Incidence Proportion

$$\frac{\text{Number of NEW cases of disease during a period}}{\text{Population exposed during this period}}$$

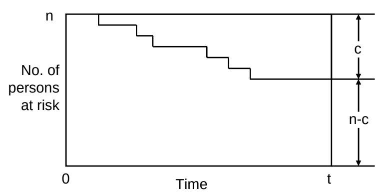
Incidence Proportion

Example of lung cancer in Jan 1—Dec 12, 1980:

Population	**3,500,000**
New cases	**1,250**
Cumulative incidence	**0.36/1000 per year**
Prevalence	**2.71%**

Measures of Disease Frequency - Incidence

- Diagrammatically:



- n persons are initially at risk
- c of them develop disease during the observation period. Each time a new case occurs, the number at risk declines by one.
- n – c persons remain at risk at the end of the period.

Cumulative Incidence (Risk)

$$CI = \frac{I}{N_0}$$

- **No units**
- **Theoretical range 0 to 1**
- **Probability that an individual will become diseased over specified period**
- **CI in population = average risk for individual**

Measures of Disease Frequency - Incidence

- Provides an estimate of the probability (or risk) that a person selected at random from this population develops this disease during the specified time period
- Can be measured directly *only* in a closed population.
- Example: "43% of persons who ate the potato salad became ill within 6 hours thereafter."
- Aliases: attack rate, incidence proportion, risk.

Risk

The probability of occurrence of an outcome in an outcome free population during a specified time period.

If d = number of new cases

And,

N = population initially at risk,

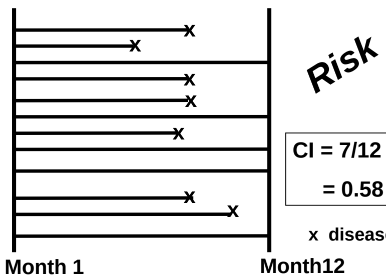
Then,

Risk (over a defined period) = d/N

Risk is usually applied to non-recurrent diseases or to the first episode of a disease.

Cumulative Incidence
Incidence proportion

CI assumes that entire population at risk followed up for specified time period



CI = 7/12 per year
= 0.58 per year

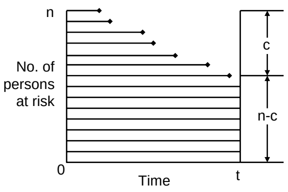
x disease onset

Cumulative Incidence

- Perhaps most intuitive measure of incidence since it is just proportion of those observed who got the disease
- Proportion = probability = **risk**
- Basis for **Survival Analysis**
- Two primary methods for calculating
  - **Kaplan-Meier method**
  - **Life table method**

Measures of Disease Frequency - Incidence

- When we have detailed data on the amount of time at risk contributed by each member of the population, person-time can be obtained directly.
  - Consider again the situation where a closed population of susceptibles in which the incidence of new disease cases is monitored over a given time period.



Total person-time at risk corresponds graphically to the summed length of all the horizontal lines

Persons destined to become cases contribute person-time at risk until they develop the disease.

Incidence Density (incidence Rate)

Number of NEW cases of disease during a period

Total person-time of observation

Rate

Instantaneous concept (like speed)

Denominator:
- **is a measure of time**
- **the sum of each individual's time at risk and free from disease**

Incidence Rate

$$IR = \frac{I}{PT}$$

- **Units of new cases/person-time**
- **Theoretical range zero to infinity**
- **Numerical value has no meaning at the individual level**

Person-Years

- Person-years: the sum of the amount of time each individual is observed while *free of disease.*
- Each subject may contribute a different amount of person-years.

Person-Years

Time begins when they are enrolled in study.

- Time end with one of three events:
  1. *Subject still alive on the analysis date.*
  2. *Subjects who died on a known date within the study period.*
  3. *Subjects who are lost to follow-up after a certain date.*

Person-Time at Risk

- **Person-time at risk is the denominator for rates of disease**
- **1000 person-years at risk =**

100,000 people for 1/100 years

10,000 people for 1/10 years

1000 people for 1 years

100 people for 10 years

20 people for 50 years

Person-Time at Risk

- **Disease frequency: need to define**
  - **disease events and time period**
  - **population at risk (PAR)**
- **Population at risk**
  - **All individuals being observed**
- **Person-time at risk**

  Σ(subject * time)

Smoking : Pack-Year

- **Pack-year smoking for a subject at risk**
- **1 x 365 pack-year =**

  0.5 x 365 for 2 years

  2 x 365 for 0.5 years

	90 91 92 93 94 95 96 97 98 99 00	Time at risk
A	————	6.0
B	————X	6.0
C	————————	11.0
D	———————	9.5
E	————X	5.0
Total years at risk		**37.5**

-- time followed
x disease onset

ID = 2 / 37.5 person- years
= 0.053 person-year

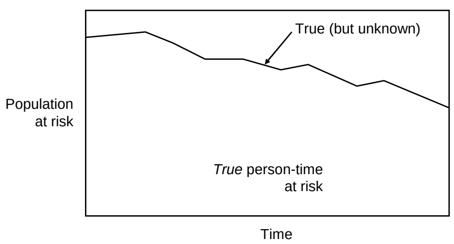
Measures of Disease Frequency - Incidence

- Sometimes detailed information about time at risk is unavailable for each member of the population. It may nevertheless be possible to estimate total person-time at risk by multiplying *the average size of the population at risk* by *duration of the observation period*.
- Total person-time

  ~ (Avg. size of population at risk) X (Length of observation period)
  - Often the mid-period size of the population at risk is used as an estimate of the average population at risk.

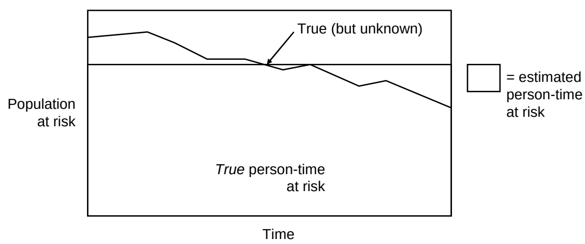
Measures of Disease Frequency - Incidence

- Area under the curve in the figure below is the denominator we would *like* to know:



Measures of Disease Frequency - Incidence

- But since detailed information on the true population at risk is unavailable, we may estimate it instead as the shaded area in this figure:



Incidence Rate

- Incidence Rate (Incidence Density): the number of new cases of disease during a defined period of time, divided by the total person-time of observation.

$$IR = \frac{\textbf{Number of new cases of disease during a defined period of time}}{\textbf{Total person-time of observation}}$$

Follow-up Death Rate

Follow-up Death Rate
= the number of deaths in a year divided by the total follow-up time (usually in person-years).

$$\text{Follow-up Death Rate} = \frac{\text{Number of deaths}}{\text{Total number of person-years}}$$

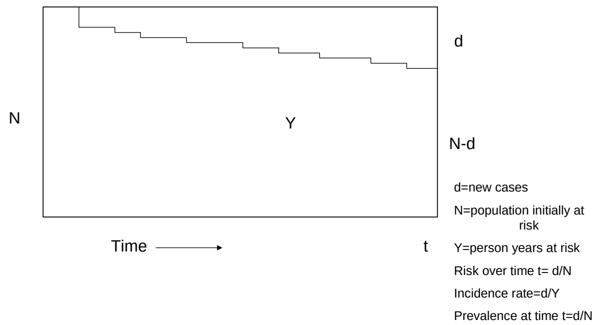
Follow-up death rates are used to measure the effectiveness of medical treatment programs.

Attack Rate (Cumulative Incidence, Incidence Proportion)

- Cumulative incidence during an outbreak
  Usually expressed for the entire epidemic period, from the first to the last case

Ex: Outbreak of cholera in country X in March 1999
- Number of cases = 490
- Population at risk = 18,600
- Attack rate = 2.6%

Risk, Rate, Prevalence



Cumulative Incidence and Incidence Rate

- **CI can be calculated from IR**
- **When incidence is very low or the time of observation is very short**

CI = IR x Duration Time

- **Assumes the PAR is constant**
- **Homicide in NY: 8.7/100,000 person-years**
- **Annual risk: 8.7/100,000**

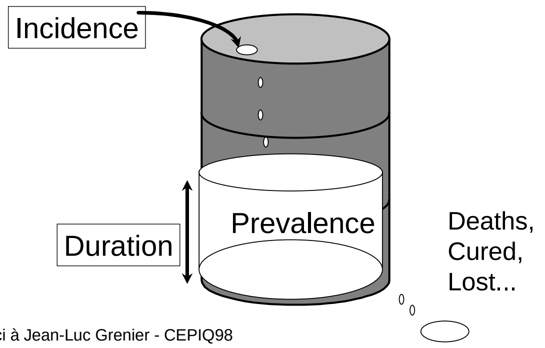
Relationship Between Incidence and Prevalence

Prevalence depends on the duration of the disease (T) and the rate of disease (ID).

When the disease is stable (both incidence rate and duration are stable) then prevalence approximates the product of mean duration and incidence (CI).

Prevalence = CI x T

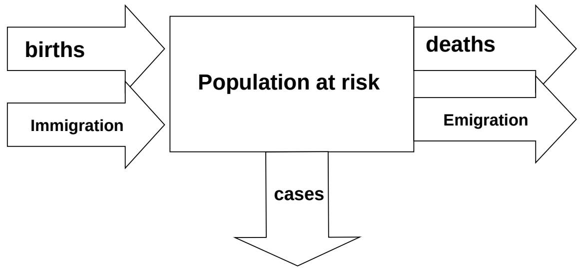
Incidence, Prevalence and Disease Duration



Merci à Jean-Luc Grenier - CEPIQ98

Steady State Population

Assume constant PAR



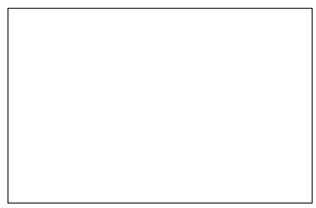
Measures of disease frequency

Incidence (new cases)

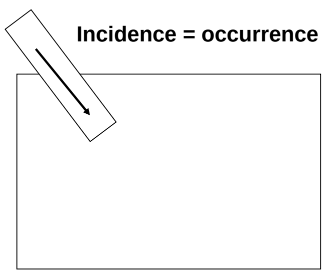
or

Prevalence (existing cases)?

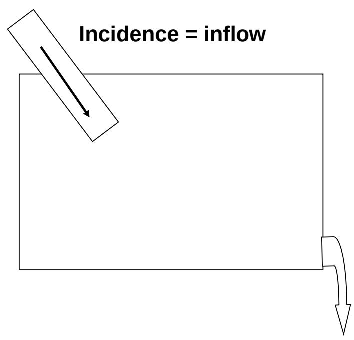
Steady state population



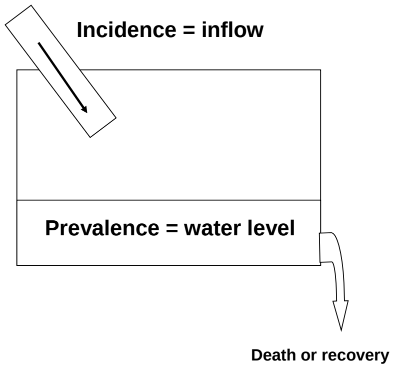
Incidence = occurrence of new cases

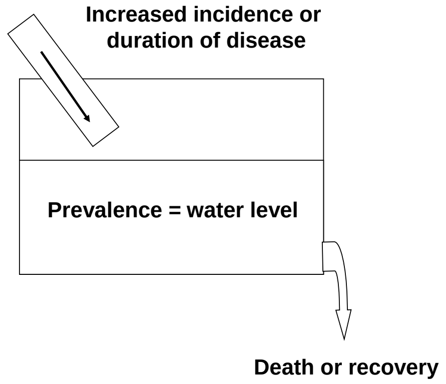


Incidence = inflow



Death or recovery





Measures of Disease Frequency

- **Disease events in *defined population* in *defined time***
- **Incidence measures**
  - **Based on new cases**
  - **Incidence rate (incidence density)**
  - **Cumulative incidence (incidence proportion)**
- **Prevalence measures**
  - **Based on existing cases**
  - **Point prevalence, period prevalence**

Confused Terminology

- **Not rates**
  - **case-fatality rate (proportion)**
  - **attack rate (proportion)**
  - **maternal mortality rate (ratio)**
- **Risk rate**
- **True rate**

Proportion as a Measure of Morbidity: Prevalence

Disease Prevalence = the proportion of people with a given disease at a given time.

Disease Prevalence =

$$\frac{\text{Number of diseased persons at a given time}}{\text{Total number of persons examined at that time}}$$

Prevalence is usually quoted as per 100,000 people so the above proportion is generally multiplied by 100,000 (in particular, for rare outcomes).

Proportion as a Measure of Morbidity: Incidence

Disease Incidence = the number of “new cases” developed in a defined period of time divided by the number of individuals at risk for the disease at the beginning of the time period.

Disease Incidence =

$$\frac{\text{Number of “new cases” in a period of time}}{\text{Number of individuals at risk for the disease (at the beginning of the time period).}}$$

Incidence is aimed to investigate possible time trends. Multiply incidence by 100,000 for rare outcomes.

Proportion as a Measure of Mortality: Death Rates

Crude Death Rate = the number of deaths in a year divided by the total population of interest. The total population is estimated at the midpoint of the year.

$$\text{Crude Death Rate} = \frac{\text{Number of deaths in a calendar year}}{\text{Population at midpoint of the year}}$$

Proportion as a Measure of Mortality: Death Rates

Follow-up Death Rate = the number of deaths in a year divided by the total follow-up time (usually in person-years).

$$\text{Follow-up Death Rate} = \frac{\text{Number of deaths}}{\text{Total number of person-years}}$$

Follow-up death rates are used to measure the effectiveness of medical treatment programs.

Traditionally Used Measures of Frequency

Age-specific rates: a rate used for a specific age group. Numerator and denominator refer to the same age group.

Rates that are not age specific are called **crude rates** (one example of a crude rate).

Case fatality rate: proportion of cases of a specified cause which die in a specified period of time. (Usually expressed as a percentage).

Traditionally Used Measures of Frequency

Cause specific mortality rate: number of deaths by a specific cause in a defined population in a defined period of time.

Infant mortality rate (IMR): number of deaths in children under one year of age divided by the number of live births in the same period, in a specified population.

Traditionally Used Measures of Frequency

Maternal mortality rate: The number of maternal deaths by the number of women in the reproductive age (15-49 y.o.) in a given year.

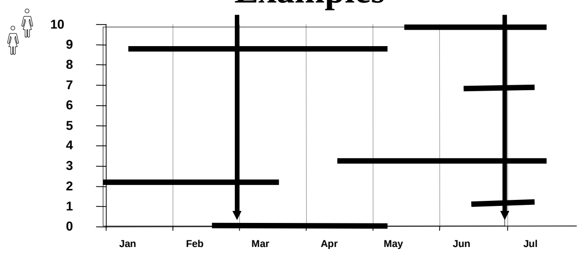
Perinatal mortality rate: Number of fetal deaths (28 weeks gestation or more) and early neonatal deaths in a year, in a defined population, divided by the total number of live births and fetal deaths in the same population and time period.

Survival rate: The proportion of survivors in a group, usually patients with a disease, who survived in a specified period of time.

Cumulative Incidence versus Prevalence

- **Temporality**
- **Prediction**
  - **CI implies probability that similar individuals will develop condition in future**
  - **prevalence describes current situation among group of individuals**
- **Probability of having a disease**
  - **prevalence guides clinical decision making**
  - **interpretation of diagnostic tests**

Examples



Ratio males/women=2/8
Proportion of women=2/10=2%

Prevalence March1 =3/10
Prevalence March-July =7/10
Incidence Proportion March-July =4/7

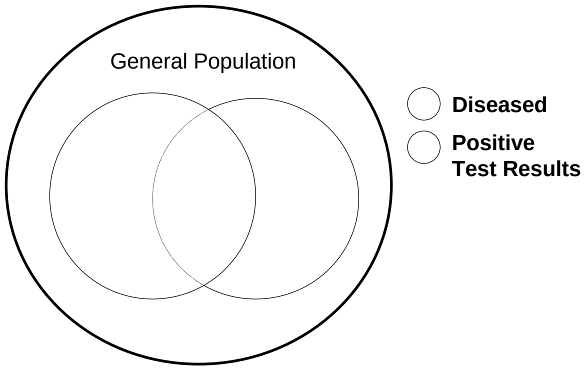
Measures of Disease Frequency

	Incidence		Prevalence	
	Cumulative incidence	Incidence rate	Point	Period
Synonym				
Numerator				
Denominator				
Unit				
Type				

Proportions as Parameters for Screening Tests

- Through screening tests people are classified as healthy or as falling into one or more disease categories.
- Examples: HIV test, Colon cancer, Skin tests for TB
- These tests are not 100% accurate and therefore misclassification is unavoidable.
- There are 2 proportions that are used to evaluate these types of diagnostic procedures.

Screening Tests



Sensitivity and Specificity

- Sensitivity and specificity are terms used to describe the effectiveness of screening tests. They describe how good a test is in two ways - finding false positives and finding false negatives
- ***Sensitivity*** is the Proportion of diseased who screen positive for the disease
- ***Specificity*** is the Proportion of healthy who screen healthy

Sensitivity and Specificity: An Example

A cytologic test was undertaken to screen women for cervical cancer.

	Test Positive	Test Negative	Total
Actually Positive	154	225	379
Actually Negative	362	23,362	23,724

- Sensitivity =?
- Specificity = ?

Example Continued

- Sensitivity = proportion of people who have the disease who test positive
  - Number of people who have the disease = a?
  - Number of people who have the disease who test positive = b ?
  - Sensitivity=b/a = 154/379 = 40.6%

Example Continued

- Specificity = proportion of people who do not have the disease who test negative
  - Number of people without the disease = a?
  - Number of people without the disease who test negative = b?
  - Specificity=b/a = 23,362/23,724= 98.5%

Example Continued

- This cytologic test is highly specific (specificity = 98.5%), but not very sensitive (sensitivity = 40.6%).
- If a healthy person is tested, the result will almost always be negative.
- If a woman with cancer is tested, there is a 59.4% (1- sensitivity) chance that the disease will not be detected!

False Negative and False Positive

- False Negative: the conditional probability that a person had a negative test result given they have the disease.

  False negative = 1 – sensitivity.
- False Positive: the conditional probability that a person has a positive test result given they do not have the disease.

  False positive = 1 – specificity.

Thanks !