NIPH
Norwegian Institute of Public Health

Epidemiological principles – basic indicators

Course «Infections control in a global perspective» at NRSGH at NTNU

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Based on a lecture by Pawel Stefanoff and EPIET/EUPHIM material

Epidemiology

Epidemiology studies the occurrence of illness:

the frequency and distribution of diseases in the population and their determinants

Frequency and distribution of diseases (descriptive):

who, what, when, where

Determinants (analytical):

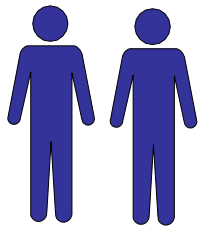
why

Measures in Epidemiology

Measures of…

frequency	association	impact
- Incidence	- Risk Ratio	- Attributable risk
- Prevalence	- Odds Ratio	- Population attributable fraction
	- Risk difference	
	…	…

Counts



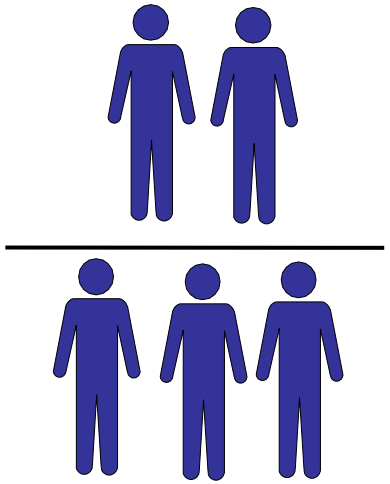
Number of cases

"we have 2 cases of tetanus"

On its own very little informative

Who is in the denominator?
In what time period did they occur?

Proportion, ratio and rate



Proportion
Ratio
Rate

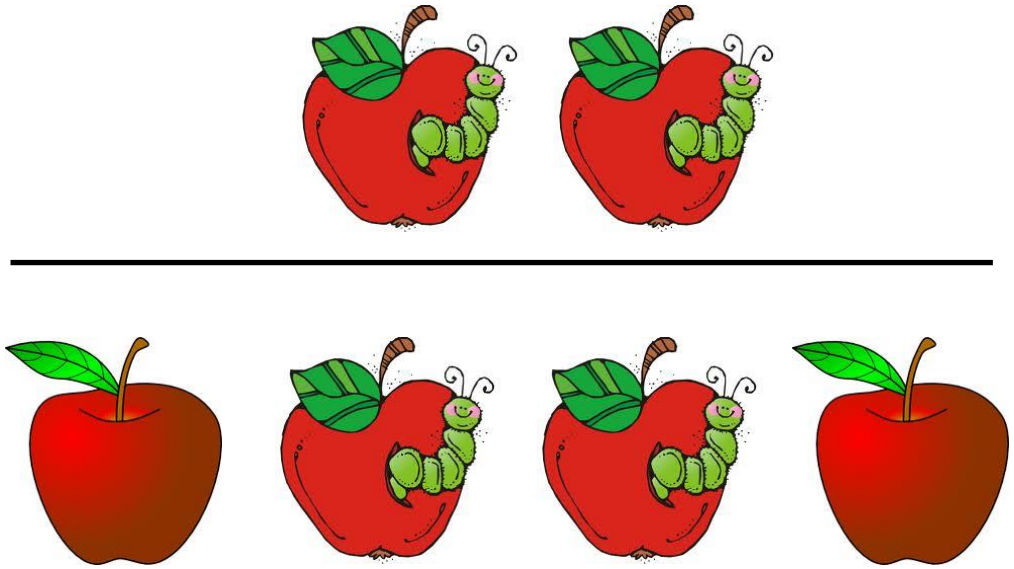
What, who is in the denominator ?
In what time period did they occur?

Proportion

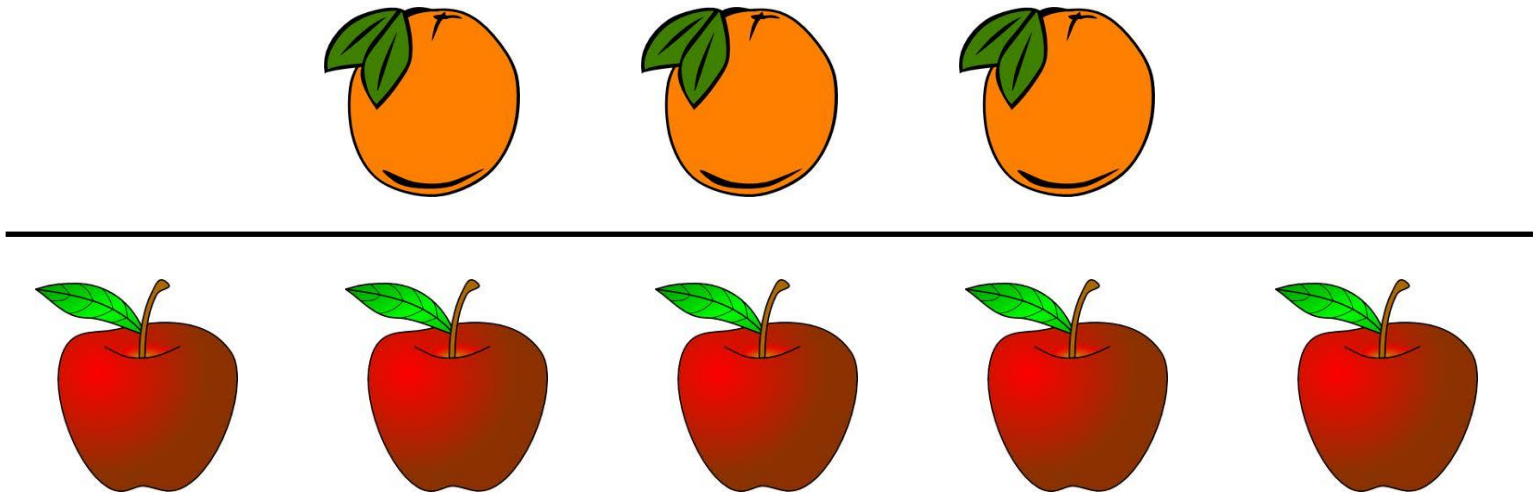
- The division of 2 numbers
- Numerator included in the denominator
- In general, quantities are of same nature
- In general, ranges between 0 and 1
- Percentage = proportion x 100%
- Example:

$$\frac{males}{population} = \frac{400}{1{,}000} = 0.4 = 40\%$$

Proportion of rotten apples



Oranges to apples- a proportion?



Ratio

- The division of 2 numbers
- Numerator not included in the denominator
- Allows to compare quantities of different nature

$$\frac{males}{females} = \frac{5}{2} = 2.5:1$$

$$\frac{hospital-beds}{doctors} = \frac{850}{10} = 85:1$$

$$\frac{controls}{cases} = \frac{90}{30} = 3:1$$

Rate

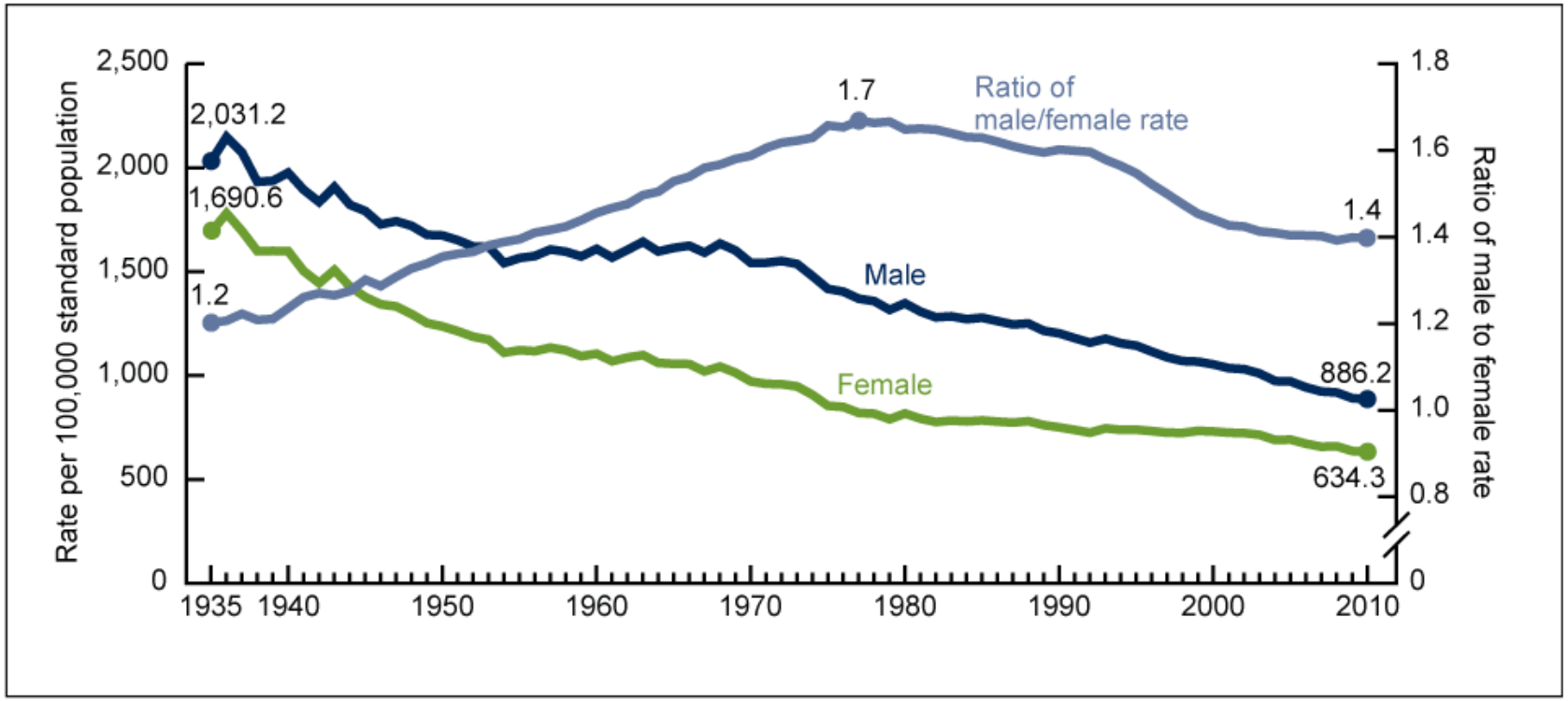
- The division of 2 numbers
- Time included in the denominator
- Speed of occurrence of an event over time
- Rates may be expressed in any power of 10

$$\frac{Births(2007)}{Population(2007)} = \frac{2{,}000}{15{,}000{,}000} = 0.00013 = 13/100{,}000$$

- 13 births per 100,000 population in the year 2007

Example: Rates and Ratio

Age-adjusted death rates and ratio of rates by sex: United States, 1935–2010



NOTE: 2010 data are preliminary. Age-adjusted rates are per 100,000 U.S. standard population. Rates for 2001-2009 are revised and may differ from rates previously published

SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

Summary

- Proportion
  - Division of two related numbers
  - Numerator is a subset of denominator
- Ratio
  - Division of two unrelated numbers
- Rate
  - Division of two numbers
  - Time is always in the denominator

Prevalence

$$\frac{\text{Number of cases of disease}}{\text{Population}}$$

- Number of cases of a disease in a given population at a specific time
  - Point in time (point prevalence)
  - Time period (period prevalence)
- Proportion often measured for chronic diseases which have long duration and dates of onset that are difficult to pinpoint.
- Probability of having the disease

Factors influencing Prevalence

- Factors that **increase** prevalence?
  - Longer duration of disease
  - Prolongation of life
  - Increase in new cases
  - In-migration of cases
  - Out-migration of healthy individuals
  - Improved diagnosis

Factors influencing Prevalence

- Factors that **decrease** prevalence?
  - Short duration of disease
  - High case fatality
  - Decrease in new cases
  - In-migration of healthy individuals
  - Out-migration of cases
  - Improved cure rate

Incidence

- The occurrence of new cases of disease or injury in a population over a specified period of time
- Two types commonly used
  - Incidence proportion
  - Incidence rate

Incidence Proportion

$$\frac{\text{Number of new cases of disease during a period}}{\text{Population at the beginning of the period}}$$

- Number of new cases of a disease in a given population at a specific time
- Proportion of the population that acquires or develops a disease in a period of time
- Probability of developing a disease
- Synonyms
  - Attack rate
  - Risk
  - Probability of developing disease
  - Cumulative incidence

Attack Rate

- An incidence proportion used in outbreak setting as a synonym for risk
- Overall attack rate

$$\frac{\text{Total number of new cases}}{\text{Total population}}$$

- Food-specific attack rate

$$\frac{\text{No. of persons who ate a specified food and became ill}}{\text{Total no. of persons who ate that food}}$$

Attack Rates

	Ill	Not ill		
Ate food item	60	9	69	87%
Did not eat food item	6	14	20	30%
	66	23	89	74%

Attack Rates

	Ill	Not ill		
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	66	23	89	74%

Risk ratio (RR) = (60 / 69) / (6 / 20) = 2.9

Incidence Rate

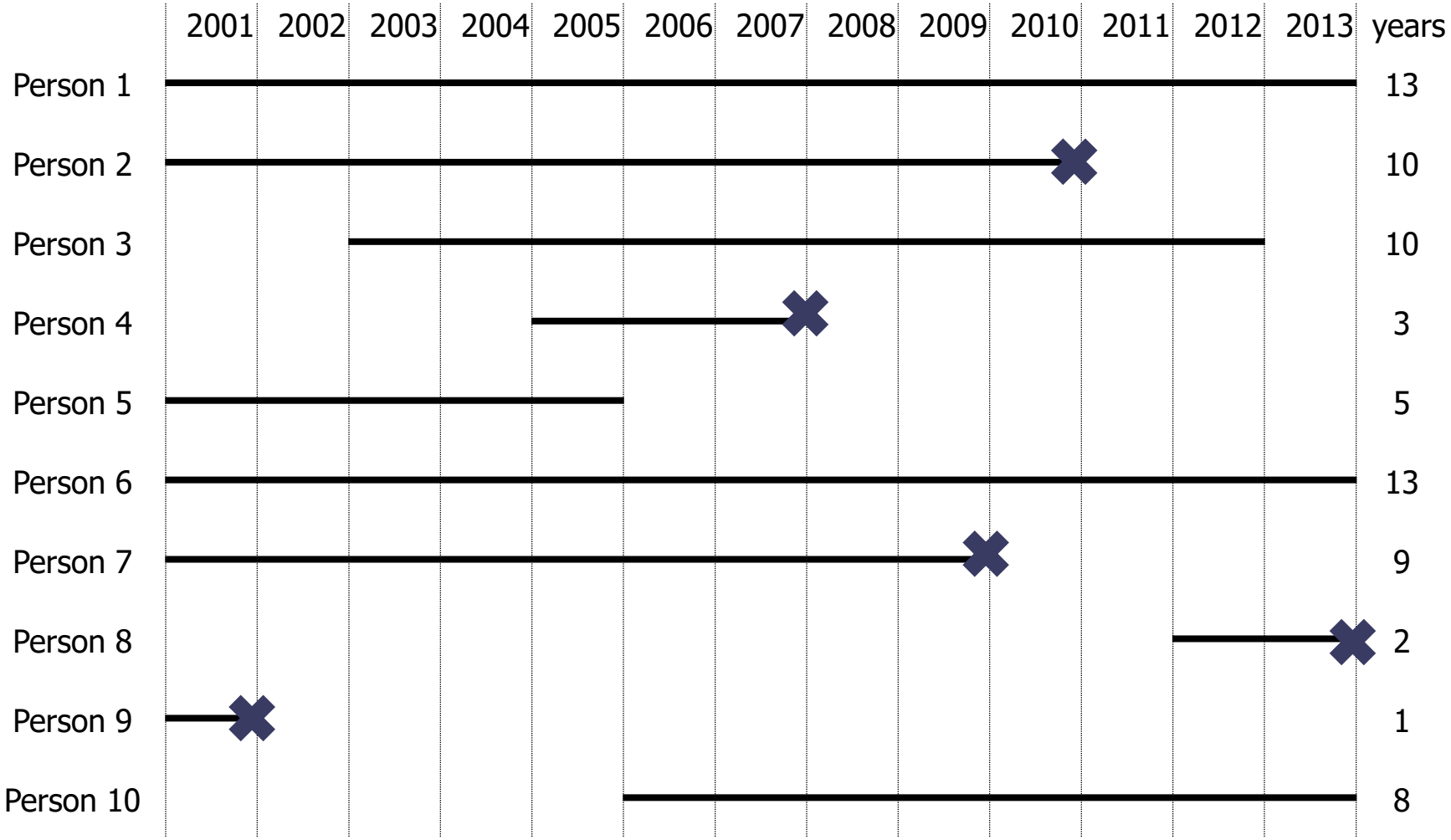
- Measure of incidence that incorporates time directly into the denominator
- Generally calculated from a long-term cohort follow-up study
- Each person is observed from a starting time until one of four "end points" is reached
  - Onset of disease
  - Death
  - Migration out of the study ("lost to follow-up")
  - End of the study

Incidence Rate

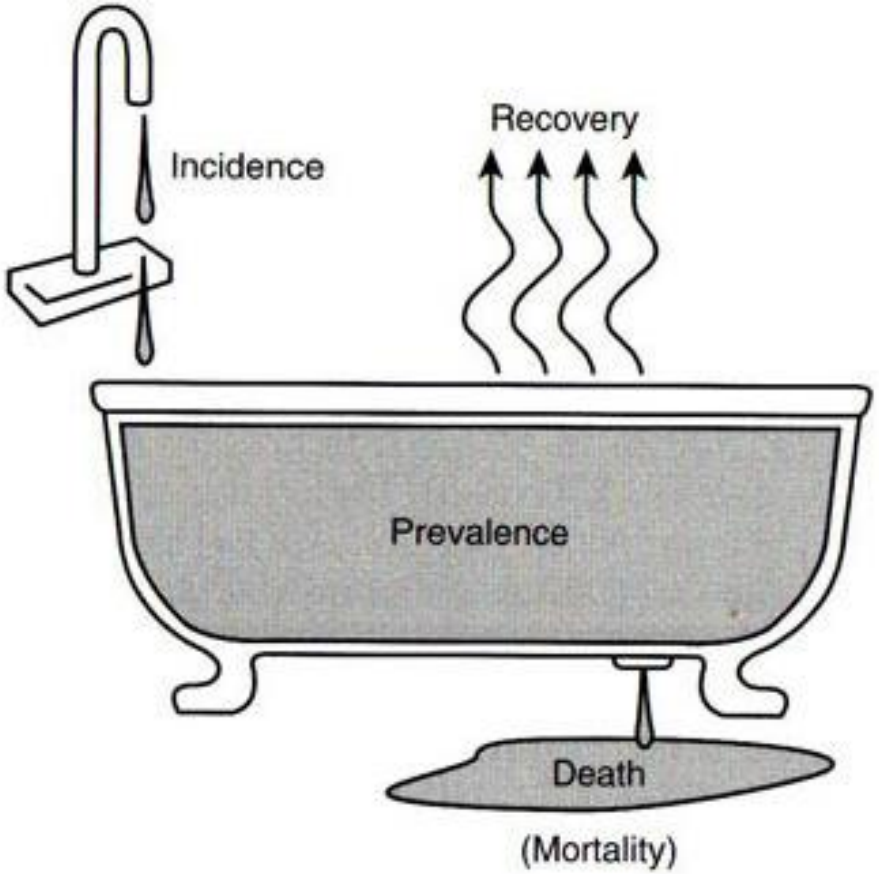
$$\frac{\text{Number of new cases of disease}}{\text{Total person-time of observation}}$$

- Proportion of the population that acquires or develops a disease in a period of time
- Speed of developing a disease
- Denominator
  - Measure of time
  - Sum of each individual's time at risk and free from disease

Person - Time


2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
years
Person 1
13
Person 2
10
Person 3
10
Person 4
3
Person 5
5
Person 6
13
Person 7
9
Person 8
2
Person 9
1
Person 10
8

„The Epidemiologist‘s Bathtub“



Prevalence vs. Incidence

	Prevalence	**Incidence**
Numerator:	No. of cases	No. of new cases
Denominator:	Population at time point/period	Population (+time)
Measures:	Probability of having disease	Probability of developing the the disease
Describes:	Burden	Risk
Used in:	Resource planning	Research on causes, prevention and treatment

Odds

$$\frac{\text{Probability that an event will happen } (1/6)}{\text{Probability that an event will not happen } (5/6)}$$

Odds = 1/5

$$\frac{\text{Probability that cases/controls will be exposed}}{\text{Probability that cases/controls will not be exposed}}$$

Risks, odds and 2x2 tables

	Cases	Non cases	
Exposed	a	b	a+b
Non exposed	c	d	c+d
	a+c	b+d	

- Risk of being a case in exposed = a / (a+b)
- Risk of being a case in non exposed = c / (c+d)
- Odds of being exposed among cases = (a/(a+c))/(c/(a+c))= a/c
- Odds of being exposed among non cases = (b/(b+d))/(d/(b+d))= b/d