

# **Measures of health**

- One of the most fundamental tasks in epidemiological research is to quantify the occurrence of disease. This can be done by counting the number of affected individuals however, to compare levels of disease among groups of individuals, time frames and locations, we need to consider counts of cases in context of the size of the population from which those cases arose.
- A **ratio** defines the relative size of two quantities expressed by dividing one (numerator) by the other (denominator). Proportions, odds, and rates are ratios. Say we have a herd of 100 cattle and 58 are found to be diseased. The odds of disease in this herd is 58:42 or 1.4 to 1.
- A **proportion** is a fraction in which the numerator is included in the denominator. Say we have a herd of 100 cattle and 58 are found to be diseased. The proportion of diseased animals in this herd is  $58 \div 100 = 0.58 = 58\%$ .
- A **rate** is derived from three pieces of information: (1) a numerator: the number of individuals diseased or dead, (2) a denominator: the total number of animals (or animal time) in the study group and/or period; and (3) a specified time period. To continue the above example, we might say that the rate of disease in our herd over a 12-month period was 58 cases per 100 cattle.

# Prevalence

- Strictly speaking, prevalence refers to the number of cases of a given disease or attribute that exists in a population at a specified time. Prevalence risk is the proportion of a population that has a specific disease or attribute at a specified point in time.
- Many authors use the term 'prevalence' when they really mean prevalence risk, and these notes will follow this convention.
- $\text{Prevalence} = \text{Number of existing cases} / \text{Size of population}$
- Prevalence can be interpreted as the probability of an individual from a population having a disease at a specified point in time.

- Two types of prevalence are reported in the epidemiological literature:

- 1) **point prevalence** equals the number of disease cases in a population at a single point in time (a snapshot),
- 2) **period prevalence** equals the point prevalence at the beginning of a study period plus the number of new cases that occurred during the remainder of the study period.

# Incidence

- Incidence measures how frequently initially susceptible individuals become disease cases as they are observed over time.
- An incident case occurs when an individual changes from being susceptible to being diseased.
- The count of incident cases is the number of such events that occur in a defined population during a specified time period.
- There are two ways to express incidence: **incidence risk** and **incidence rate**.

# Incidence risk

- Incidence risk (also known as cumulative incidence) is the proportion of initially susceptible individuals in a population who become new cases during a defined time period.

- Incidence risk =

Number of incident cases / Number of individuals initially at risk

- The defined time period may be arbitrarily fixed (e.g. 5-year incidence risk of arthritis) or it may vary among individuals (e.g. the lifetime incidence risk of arthritis). In an investigation of a localised epidemic the defined time period may be simply defined as the duration of the epidemic.
- Individuals have to be disease-free at the beginning of the observation period to be included in the numerator or denominator of this calculation.
- The time period to which the risk applies must be specified.
- The quantity is dimensionless and ranges from 0 to 1.

- Populations at risk can be either closed or open.
- A closed population has no additions during the course of the study and no or few losses to follow-up.
- An open population is where individuals are recruited (e.g. as births or purchases) and leave (e.g. as sales or deaths) throughout the course of the study period.
- Incidence risk can be measured directly when the population is closed and all subjects are followed for the entire study period.
- When the population is open incidence risk cannot be measured directly, but can be estimated by making one of the following adjustments to the denominator:
- Denominator = population size at the mid-point of the study period.

# Incidence rate

- Incidence rate (also known as incidence density) is the number of new cases of disease that occur per unit of individual time at risk, during a defined time period. The denominator of incidence rate is measured in units of animal (or person) time.
- Incidence rate = Number of incident cases/ Amount of at-risk experience



# The relationship between prevalence and incidence

- $\text{Prevalence} = (\text{incidence rate} \times \text{duration of disease}) \div (\text{incidence rate} \times \text{duration of disease} + 1)$