SAFOSO

Animal Health Matters.
For Safe Food Solutions.

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Introduction to disease occurrence principles and measures of central location

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Knowing the level of disease occurrence is important for:

1) priority setting (e.g. decide whether to institute a programme to either control or eradicate the disease)

2) to provide data for risk analysis

3) serve as proxy to estimate disease impact in economic analyses.

Calculating measures of central location

Range and measures of central tendency (mean, median and mode) are values that summarize a set of data. They are useful when analyzing data.

Three types of measures of central tendency:

The **mean** (**arithmetic mean** or **average**)

Визначення: the arithmetic average of the scores. The arithmetic mean is the
value that is closest to all the other values in a distribution.

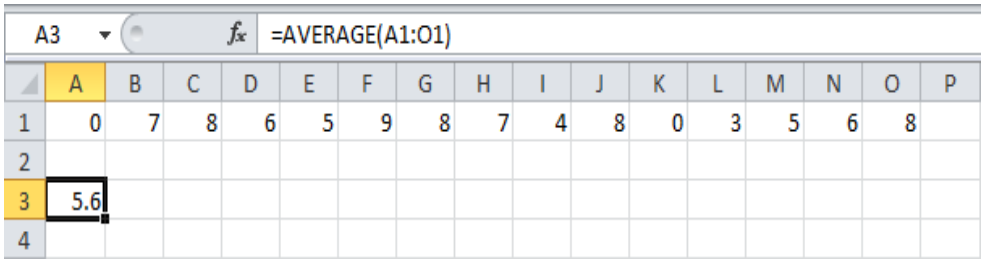
Як рахувати: of a set of data is found by adding up all the items and then dividing by the sum of the number of items.

Median **(middle)** divides a group of numbers into two parts, with half the numbers below the median and half above it.

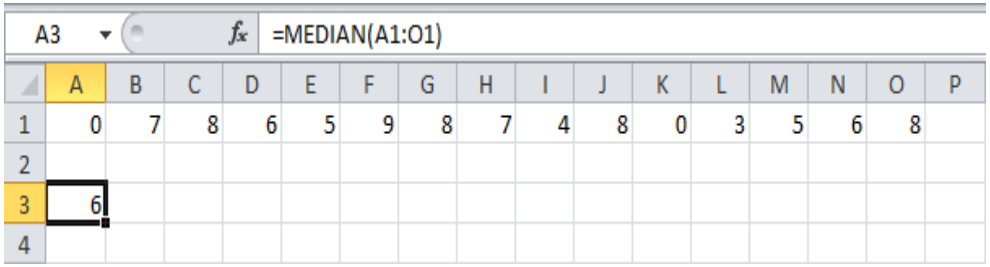
The **mode** **(most)** of a data set is the value that occurs the most often.

Calculating measures of central location in Excel

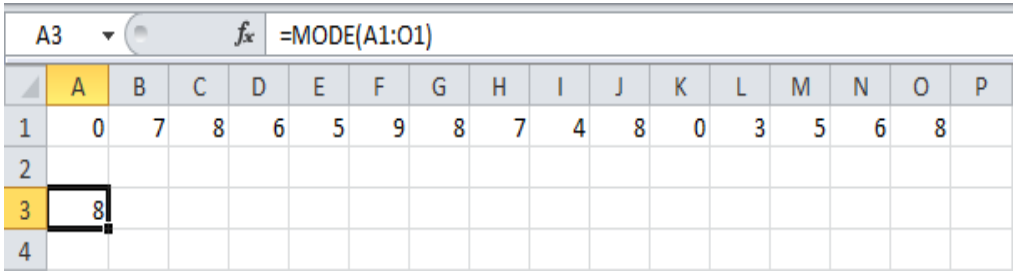
- **Mean (average) -** to calculate the average of a range of cells, use the **AVERAGE function**.



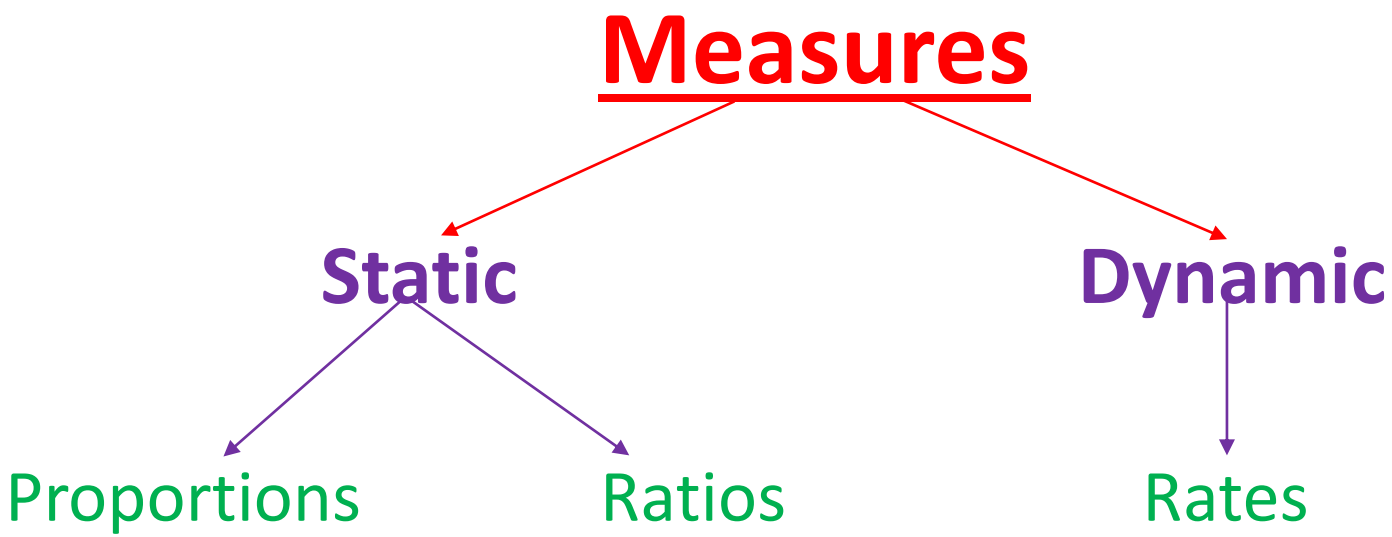
- **Median -** to find the median (or middle number), use the **MEDIAN** function.



- **Mode -** to find the most frequently occurring number, use the **MODE** function.



Frequency of disease occurrence can be expressed through:



Static measures

A **proportion** is a fraction in which the numerator is included within the denominator

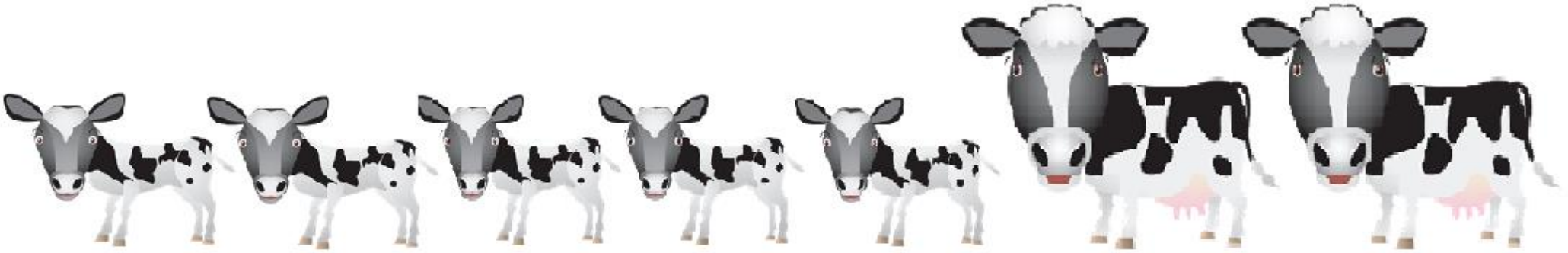
- **The quotient of 2 numbers**
- **Numerator IS INCLUDED in the denominator**
- **Proportion is always between 0 and 1**

  (or, equivalently, between 0% and 100%)

$$\frac{\text{Numerator}}{\text{Denominator incl. (!) Numerator}}$$

Example:

In the picture below what proportion of subjects are calves?



There are 7 total subjects – this is the denominator.

Of those subjects, 5 are calves – this is the numerator

The proportion of subjects who are calves is 5/7 = 0.71 = 71%

Static measures

Ratio - the size of two quantities, expressed in relation to one another

$$\frac{\text{Numerator}}{\text{Denominator excl (!) Numerator}}$$

Example: *Among 100 cows tested using the tuberculin test, 60 tested negative, and 40 tested positive*

- The ratio of tested negative to tested positive could be presented in any of the following:
  - 60:40
  - 60/40
  - 3:2 (both sides of original ration divided by 20)
  - 1.5:1 (both sides of original divided by 40
  - 1.5 (the result of dividing 60 by 40)

Prevalence vs. incidence

Prevalence and Incidence are often confused!

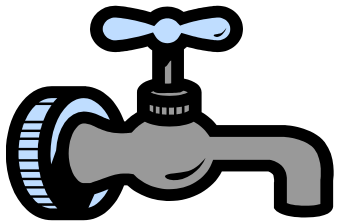
How and why differentiate?

Prevalence vs. incidence

- **Incidence** is the rate of ***new*** cases of disease that develop in the population during a defined period.

- **Prevalence** is the proportion of ***existing*** cases of disease in the population at a given time.

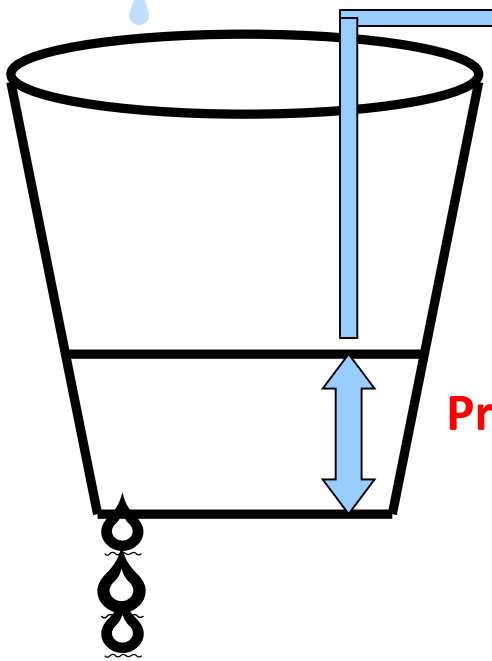
Measuring disease (inputs and outputs)



Incidence (new cases)

Recovery

Loss to follow-up



Prevalence (existing cases)

Deaths

Reference: *Marco De Nardi s'* ppt "*Measuring diseases in pastoral settings" 30 Nov.-04 Dec. 2009, Bamako-MALI*

Cumulative Incidence (Risk)

- measure of the ***average risk***, that is, the ***probability that an individual would develop disease in a specified time period***
- range from 0 to 1 and must be accompanied by a specified time period

$$CI = \frac{\text{Number of newly diseased individuals for a specific time period}}{\text{Population at risk for the same period}}$$

Example:

Last year a herd of 121 cattle were tested using the tuberculin test and all tested negative. This year, the same 121 cattle were tested again and 25 tested positive.

Cumulative Incidence = 25/121 = 0.21 per year

dimensionless!!!
(not time^{-1} e.g. „per week“)

Hence, an individual animal within this herd had a **21%** chance of becoming infected over the 12 month period.

Cumulative Incidence can be estimated when:

- Closed population
- Disease has short period at risk

Incidence Rate (density) (I)

- measures the ***rapidity*** with which new cases of disease develop over time
- denominator is measured as «animal-years at risk» or other periods (animal-weeks at risk etc.) => dimension: **time^{-1}**

$$I = \frac{\text{Number of new cases of disease that occur in a population during a particular period of time}}{\text{The sum, over all individuals, of the length of time at risk of developing disease}}$$

Example:

A study was conducted over a period of 12 months to determinate the incidence of clinical mastitis of cows at farm which has a total 100 cows at the beginning of the study.

- in 5 cows the mastitis developed after 2 months which means they were:

5* 2 = 10 animal-months at risk

- in 2 cows the mastitis developed after 5 months which means they were:

2 * 5 = 10 animal-months at risk

- in 3 cows the mastitis developed after 8 months which means they were:

3 * 8 = 24 animal-months at risk

This means a total in 10 cows developed the mastitis, and these experienced

44 animal-months at risk based on the calculation (5* 2 + 2*5 + 3*8)

- in 90 cows the mastitis did not develop past the study period which means they were

90*12 months = 1080 animal months at risk

Therefore, the **incidence density** of cow mastitis in this farm is calculated as

10 / 1124 = **0.009** mastitis per animal month.

Prevalence

- is the proportion of a population affected by a disease at a given point in time

$$P = \frac{\text{Number of individuals having a disease at a particular point in time}}{\text{Number of individuals in the population } \textbf{at risk} \text{ at that point in time}}$$

- cases at any point in time (***mix of new cases and existing cases***)
- ***static*** measure of disease, not a rate
- measurement of ***disease status*** (snap-shot in time)
- Proportion (0 to 1) or percentage (0 to 100%)
- Depends on disease control interventions

Prevalence

Period prevalence: number of cases occurring during a specified period of time (e.g. annual prevalence, lifetime prevalence)

Point prevalence: amount of disease at a particular point in time (if the time is not specified)

Example:

The milk samples are taken from a herd of 173 dairy cows to assess the frequency of *Staphylococcus aureus* infection. The 15 of these samples test positive.

prevalence = 15/173 = 0.09 (9%)

This means that each dairy cow within the herd has a 9% chance of being infected at this point in time.

Mortality vs. Fatality

How and why differentiate?

Crude Mortality Rate

$$\frac{\text{Total number of deaths from all causes in a population over a given time period}}{\text{Total population over the same time period}}$$

Cause-Specific Mortality Rate

$$\frac{\text{Number of total deaths from a specific cause in a population over a given time period}}{\text{Total population over the same time period}}$$

Case Fatality Rate

represents the proportion of animals with a specific disease that die from it

$$\frac{\text{Number of deaths due to a disease}}{\text{Number of diagnosed cases of that disease}}$$

It is a risk measure, not a rate, and is used to describe the **impact of epidemics or the severity** of acute disease.

Survival (S)

- probability of individuals with a specific disease remaining alive for a specified length of time

$$S = \frac{\text{Number of cases observed - Deaths in same time period}}{\text{Number of cases observed}}$$

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Thanks