



Measures Of Disease Frequency

Lecture 1: Incidence & Prevalence

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Learning objectives

- **By the end of this lecture, the students will be able to:**
 1. Understand the meaning of epidemiology
 2. Know the importance of disease measurement and methods to measure it.
 3. Calculate different disease measures.
 4. Realize the difference between disease incidence and prevalence

علم الوبائيات

Definition of Epidemiology

- تكرار المرض التوزيع
- Epidemiology is the study of the frequency, distribution, and determinants of diseases and health-related states in populations

المسببات

to prevent and control disease.

انا بدو امرنا لا عرف اسبابه

وبهذه جعل control على امرنا.

Importance of Measuring Disease

▶ Measuring disease frequency:

1. Helps track trends, allocate resources, and plan interventions. → اخطط للقضاء على المرض (المتدخل).
2. Allows comparison across populations and assessment of public health interventions. معدل الانتشار، DM شيئاً

بالتزود / بمصدر
بالتزود / بالامان

هل البرنامج كان effective ؟!
قضى على المرض اولاً ؟!
وإذا قضى بنسبة كم ؟!

Measures of Disease Occurrence and Frequency

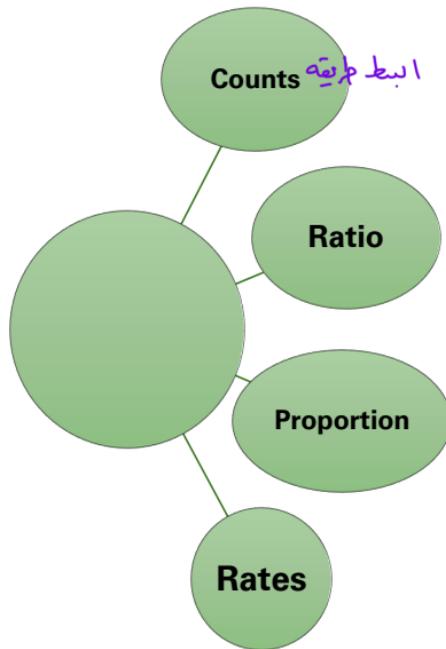
Measures of disease frequency in mathematical quantities:

- Counts
- Ratio
- Proportion
- Rates

Measures of disease frequency in epidemiology:

- Prevalence
- Incidence

Measures of disease frequency in mathematical quantities:



1. Counts:

- **Definition:** The simplest measure of disease occurrence. The absolute number of persons who have a disease or characteristic of interest.

عدد افراد مصابين
بمرض معين
او عندهم سمة معينة.

↳ No Fraction

Examples:

A. Counting the number of flu cases in a city over a month (3000 cases).

B. Total COVID-19 cases in a country from 2020 to 2022. (100000 cases)

عدد الحالات.

2. Ratio:

نسبة الاناث
لذكور داخل العائلة مثلاً.

- **Definition:** A ratio is a fraction in which the numerator is not part of the denominator.

• **Formula of ratio is** $\frac{a}{b}$ (where a and b are independent of each other)

↳ كل واحد طويلاً علاقتهم بالثاني

Example:

- Male-to-female ratio in lung cancer cases. (200/300 cases)

3. Proportion

ا لبيط جزى
من اعقام
Ratio فرقتها عن

نسبة الفئات
من كل الفئات
(ذكور واناث)

البيط

جزى ←

- **Definition:** A proportion is a type of ratio in which the numerator is a subset of the denominator, representing a part-to-whole relationship. Always presented as a percentage.

- **The formula of Proportion** = $\frac{\text{number of cases}}{\text{total population}} \times 100 = \frac{a}{a+b} \times 100$
نسبة مئوية

(Where the **total population** includes both those with and without the condition)

- **Example:** From 1000 females aged 16 – 45 years, 675 use modern contraceptive methods.

The proportion of those who use modern contraceptive method?

$$\bullet \text{ Proportion} = \frac{675 \times 100}{1000} = 6.75\%$$

الأكثر تحقيد

4. Rates:

البسط جزء من المقام / خلال وقت عدد

- **Definition:** Is the measure of an event, condition (disease, disability ,or death), within a unit population and within a time period.

- **Formula:** Rate =
$$\frac{\text{Number of events in a population}}{\text{Population at risk during a given time}} \times k$$

= 100 / 1000 / 10000

- **Number of events:** the occurrences of the health outcome (e.g., new disease cases).
- **Population at risk:** includes only those who are susceptible to the condition. فقط المعرضين
- **Time:** is included to reflect the period over which the events occur.
- **k** is the constant (e.g., 1,000, 10,000, or 100,000)

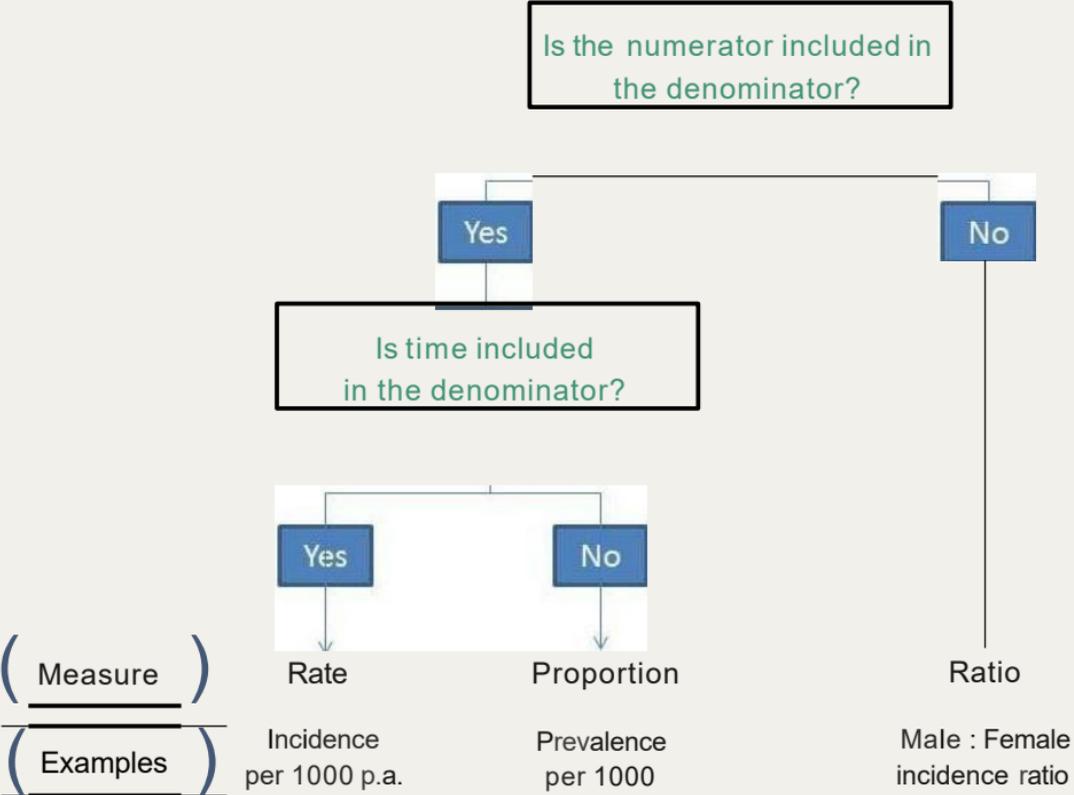
معدل الوفيات لكل 100000

Example:

Incidence rate of heart attacks: =
$$\frac{5 \text{ heart attacks}}{2000 \text{ people per year}} \times 1000 =$$

2.5 cases per 1,000 people per year

Distinguishing Proportions, Rates, and Ratios



Measures of disease Frequency in epidemiology

There are two main measures of disease frequency:

Prevalence 1- Point prevalence

2- Period prevalence

Incidence 1- Cumulative incidence (risk)

2- Incidence rate

A. Prevalence → proportion (نسبة مئوية)

• DEFINITION:

“Prevalence is an estimate of individuals in the population with a given disease, disability, or health state at a particular point in time.”

صائبين
البيط مجموعة جزئية من المعتم
فقدار

• Prevalence is a proportion and should usually be reported as one. Denominators in prevalence always include the entire population; the numerator encompasses both new and old cases.

• Categories of prevalence:

1. Point prevalence
2. Period prevalence

يستعمل
لازم اعدد فترة زمنية ونقطة عمرية معينة
لانه يمكن احسب مره خلال فترة
وعدد منهم يصير الهمم يتفاد بعد وقت
هاد حتى معاناته الي حسبه بالاول خلط

Point prevalence

Prevalence means **ALL**. (Pre existing + New)

Attempts to measure disease at one point in time.

Point prevalence =

$$\frac{\text{Number of cases of disease at a point in time}}{\text{Total number of people in the defined population at the same point in time}}$$

* $\frac{100\%}{\Sigma}$

Example on disease prevalence:

Among 10000 population. We found 50 with Type 1 Diabetes Mellitus (T1DM).

Calculate The Prevalence??

لے اذا فاهددے النوع يكون
المقصود point
Prevalence

The prevalence is $50/10000 = 0.005 = 0.5\%$

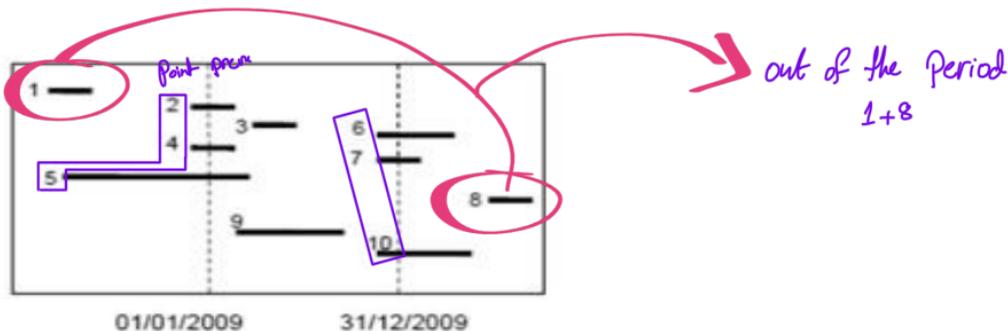
Period prevalence

هون بعتي حواله اكثر (خلال ه اشهر / سنة)

$$\text{Period prevalence} = \frac{\text{Number of cases of disease at any time during a specified period (usually short)}}{\text{Total number of people in that defined population}}$$

- **Point prevalence** represents a ^{يمثل كظه معينة} single moment in time (e.g., how many people have a disease on January 1st). Pre-existing cases present at the specific time point
- **Period prevalence** covers a time frame (e.g., how many people had the disease at any point during launna .g.E .doirep eht gnirud sesac gnitsixe-erP .(2023 .etar ecnelaverp
- ❖ It describes the prevalence of disease over a period of time.
- ❖ *When the type of prevalence rate is not specified, it is usually point prevalence.*

Prevalence divided into two types:



Point prevalence

01/01/2009: case No. 2, 4, 5

31/12/2009: case No. 6, 7, 10

Period prevalence between 01/01-31/12/2009:

Case No. 2, 3, 4, 5, 6, 7, 9, 10

Factors influencing prevalence

Increased by:

- 
- 1- Longer duration of the disease *chronic*
 - 2- Prolongation of life of patients without cure *مست عييت*
 - 3- Increase in new cases (increase in incidence) *جعل حدوثات عالي*
 - 4- In-migration of cases *هجرة داخلية*
 - 5- Out-migration of healthy people *هجرة خارجية حالات healthy تطلع بجزء (بشأن باعتماد حيقه)*
 - 6- In-migration of susceptible people
 - 7- Improved diagnostic facilities (better reporting)

reporte

بعض الحالات تظلت وتنسب healthy
وهي من healthy من رقة

Decreased by:

- 
- 1- Shorter duration of the disease
 - 2- High case-fatality rate from disease \Rightarrow *عيت*
 - 3- Decrease in new cases (decrease in incidence) \Rightarrow *جعل حدوثه قليل*
 - 4- In-migration of healthy people *بجى ناس healthy (زود الامام)*
 - 5- Out-migration of cases *يطلع حالات النبط حيقه*
 - 6- Improved cure rate of cases

هون بسوف
الفشطنى (كتر
من مره .

B. Incidence

- Incidence measures the number of new cases or new events of disease that develop in a given population during a specified time period.

* دراسات متبعية (تقدمية)

To determine incidence, it is necessary to follow prospectively a defined group of people and determine the rate at which new cases of disease appear.

Categories of incidence:

1. Cumulative incidence (risk)
2. Incidence rate (Density)

* اذا علمت دراسة وكانت 30 ← Prevc

بعد سنة علمت لمرض المرفأ ومارت 40

incid + Prevc
تتبع
تتبع

End Point - Start Point = Incidence

$$40 - 30 = 10$$

تراكمي .

Cumulative Incidence (Risk)

بدأت من زمانه
واله افعله
ظهور عندها



▶ The **cumulative incidence (CI)** is a measure of the probability that a particular event (the development of a disease) will occur within a defined period in a specified population.

خلال فترة محددة
وسكان محددين .



▶ Cumulative Incidence (CI) or Risk is defined as the number of new cases divided by the total population-at-risk at the beginning of the follow-up period.

* يقين احتمالية
اصابة الـ
healthy.



CI is a proportion

▶ Risk =

$$\frac{\text{\#new cases}}{\text{total \# of individuals at risk}}$$

x10ⁿ

غالبًا
→ 100

→ 100%

Who is the population at risk (PAR)?

- “The total number of people who are *susceptible* to developing the disease or event being studied during a specific period.”
- It includes **only individuals who are disease-free** (or event-free) ^{suscept} **at the beginning of the study** and **capable of developing it.**

How to calculate PAR?

- Population *at Risk* = $\frac{\text{Total population} - \text{Not at risk individuals}}{\text{mean}}$

Who is NOT at risk?

1. People already having the disease at baseline
2. People immune to the disease (e.g., vaccinated or genetically immune)
3. People not exposed to the risk (depending on the study definition)
4. People incapable of developing the disease (e.g., men for cervical cancer)

بشيء لهم
من الحساب
عندهم المرضية
الدراسة .

بشيء لهم

عندهم مناعة من المرضية .

* موزن / مثل مرضية

36
Smoking
على Lung Cancer
في المرضية
→
not risk

Examples

Example 1:

- A village has 1,000 people at the start of the year, and 50 already have diabetes.
- **Population at risk** = 1,000 - ^{risk} ~~50~~ = 950 persons
- If 95 new cases develop during the year: **Calculate CI?**
- **Cumulative Incidence** = $\frac{95}{950} = 0.10 = 10\%$

Example 2:

- A study of lung cancer among **smokers**, 2,000 total adults, 600 are non-smokers (not exposed), 100 already have lung cancer. If you study *incidence among smokers per 10 years*, **calculate PAR?**
- Population *at risk* = 2,000 - 600 - 100 = 1,300
- If 10 new cases developed in that period, **calculate CI?**
- **CI = 10/1300 = 0.008** \longrightarrow **0.8%**

Incidence rate = incidence density

یعنی سریت

- Measures the rapidity with which new cases are occurring in a population.
- A way of taking into account time in the study, i.e. person-time at risk
- Unlike cumulative incidence, which considers new cases over a fixed period, the incidence rate accounts for the exact time each individual is observed (useful when follow-up times vary).
- **The rate** at which new cases of a disease arise

نہایت آہستہ کم new cases ظہرت معنا
صن دہم صنی ظہرت!

Incidence rate = incidence density

$$\text{Incidence Rate (IR)} = \frac{\text{Number of new cases during the study period}}{\text{Total person-time at risk}}$$

The sum of the time each individual was observed and at risk of developing the disease (measured in person-years, person-months, etc., depending on the study).

← هو مجموع الوقت الذي ستم فيه ملاحظة كل فرد وكان عرضياً
تخط الأهمية بالمرحز

- **Example:**

A study tracking a disease in 100 people, with follow-up times that vary:

- 60 people are observed for 1 year, 30 people for 2 years, and 10 people for 3 years.
- The total person-time would be $(60 \times 1) + (30 \times 2) + (10 \times 3) = 60 + 60 + 30 = 150$ person-years.
- If there are 15 new cases during this period, the **incidence rate** would be:
- Incidence Rate (IR) = $\frac{15 \text{ cases}}{150 \text{ person years}} = 0.1 \text{ cases per person-year}$

A study followed a population of 150 smokers for one year, and 25 had lung cancer at the start of follow-up, and another 15 new cases developed during the year.

1) What is the period prevalence for the year?

$$- pp = (25+15)/150 = 0.27 \text{ or } 27\%$$

2) What is the point prevalence at the start of the period?

$$- pp = 25/150 = 0.17 = 17\%$$

3) What is the cumulative incidence for the one-year period?

$$- CI = 15/125 = 0.12 = 12\%$$

Relationship Between Incidence and Prevalence

- Prevalence depends on two factors: the number of people who have been ill in the past (previous incidence) and the duration of their illness. If incidence and duration have been stable ^{fixed} over a long period, then:

$$\bullet \text{ Prevalence} = \text{Incidence} \times \text{Duration of Disease}$$

- If incidence increases → prevalence rises (if survival remains constant).
- If duration shortens (due to cure or death) → prevalence decreases even if incidence is high.
- If both incidence and survival increase → prevalence increases markedly.

• طر دیر

Practical Use of disease incidence and prevalence in Decision-Making

<u>Area</u>	<u>Measure Used</u>	<u>Example</u>
Infectious disease control	<u>Incidence</u>	Detecting outbreaks, evaluating vaccination programs <i>Effectiveness</i>
Chronic disease management	Prevalence	<u>Planning long-term care</u>
<i>ماہریت سے نکل کر</i> Health policy formulation	Both	Combining incidence and prevalence data for setting priorities
Screening program design	Incidence	Determines need and frequency of screening (e.g., cancer)

References

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2. Medical statistics at a glance, Aviva Petrie and Carolen Sabin, **Wiley Blackwell Publisher. 3rd edition; 2009. (Chapter 44, page 133-135)**

◆ *Thanks*