بسم الله الرحمن الرحيم

Measures of disease Frequencies "Ratio, Proportion & Rate"

Part I

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PhD of Epidemiology

Epidemiology is:

1. The description of the **distribution** of patterns of disease occurrence in population

2. The identification of **disease determinants**

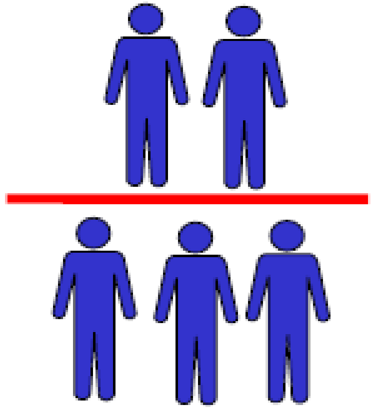
To achieve either of these objectives

It is necessary to measure:

the frequency of a disease or other outcome of interest

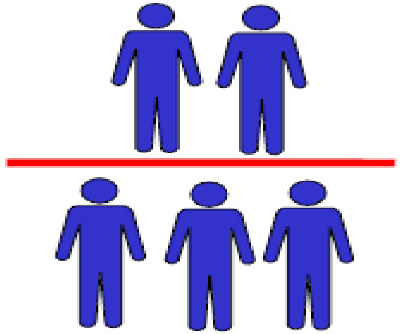
A prerequisite for any epidemiologic investigation is:

the ability to quantify the occurrence of disease



- Ratio

The most basic measure is the ratio, by simply dividing one quantity by another without implying any specific relationship between the numerator and denominator.



- Ratio

The most basic measure is the ratio, by simply dividing one quantity by another without implying any specific relationship between the numerator and denominator.

Ratio

- The division of two numbers
- Numerator NOT INCLUDED in the denominator
- Allows to compare quantities of different nature

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

$$\frac{\text{beds}}{\text{doctors}} = 850 / 10 = 85 / 1$$

$$\frac{\text{participants}}{\text{facilitators}} = 3 / 1$$

Ratio is a general term that includes a number of more specific measures, such as:

Proportion,

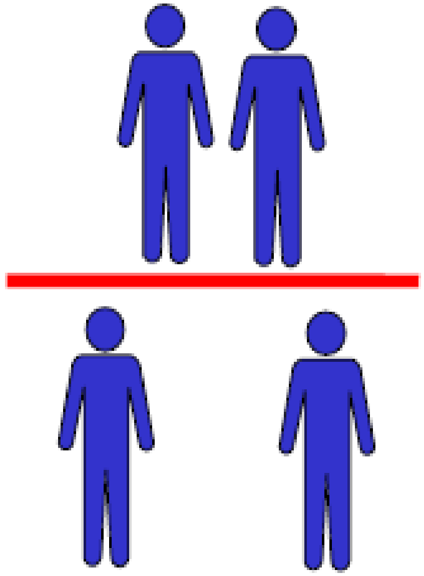
Percentage,

And rate.

Example

If there are 15 male cases (x) and 5 female cases (y) of malaria, the male:female ratio can be calculated as:

3:1 by dividing both values by 5 (y).



- Proportion

- A proportion, the second type of frequency measure used with dichotomous variables, is a ratio in which *x is included in y.*

Exp: ***Male/Female***

Male/All

Proportion

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

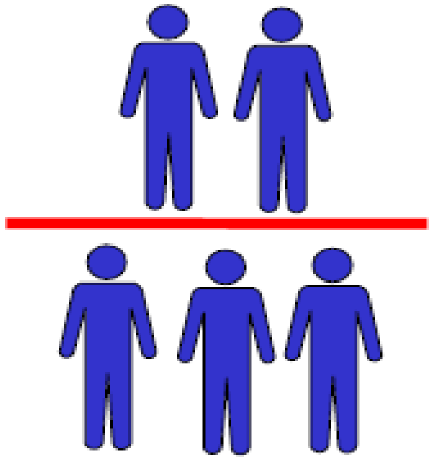
males/ population = 400 / 1000 = 40%

Example

Of the 120 cases of malaria admitted to hospital X last year, 80 were children. The proportion (percentage) of children among the cases is:

$$(80 / 120) \times 100$$

or 66.7%.



- Rate

Rate

A rate, **is a ratio** and, most essentially, **a measure of time is an intrinsic** part of denominator.

Measures of disease Frequencies

“Prevalence, Risk,Odds& Rate”

Part II

The measures of disease in epidemiology fall into two broad categories:

Prevalence

and

Incidence

There are there specific types of incidence measures:

A. Cumulative incidence or Risk,

B. Odds,

C. Incidence Rate or Density.

Prevalence

Prevalence
(point prevalence)

$$\frac{\text{No. of existing cases of disease at a specific time}}{\text{Total population of interest at that time}}$$

Proportion of a population affected by a disease at a **given time**.

Expressed as a percentage

Ex:

Population	350,000
Cases	96,200
Prevalence	27.6%

Example 1

In July, 3 new cases of malaria were detected in a village. There were already 10 people in the village who had the disease, but two successfully completed a course of therapy during the month and were considered cured. The population of the village was 2600. In this case:

The point prevalence as of 31 July is:

[(3 + 10 – 2) / 2600] = 0.4%

Period Prevalence:

this measure is not frequently used.
It represents the proportion of cases that exist within a population at any point during a specified of time.

The numerator includes: cases that were present at the start of the period plus new cases that developed during this time.

Period Prevalence combines both point prevalence and incidence in a single parameter.

Cumulative incidence
or risk

RISK

- **Non-technical definition**
  - Vague, culture-dependent
  - Unexpected, unusual, dangerous/negative events

- **Epidemiologic definition**
  - **Probability that an event will occur**
  - Estimated by:
    - **Observing events among a population during a specified time**

Cumulative Incidence (CI)

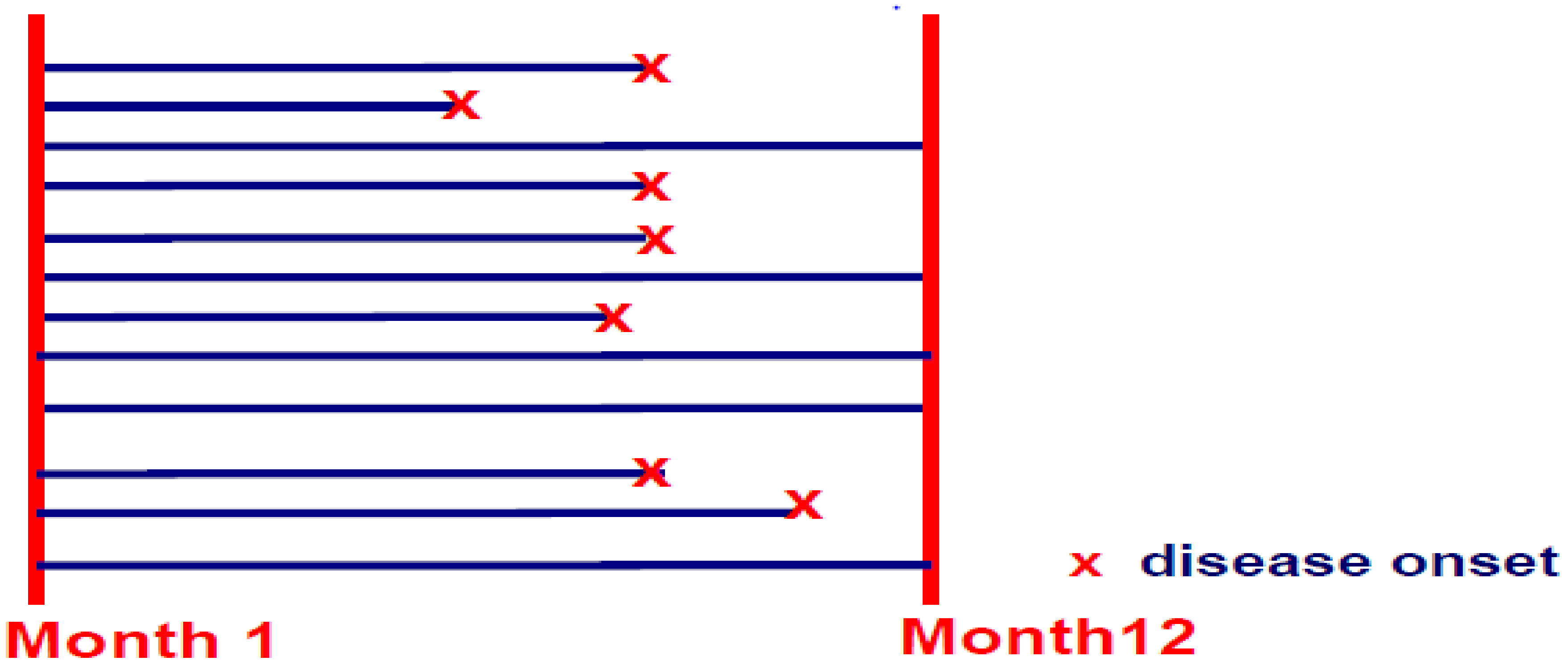
$$CI = \frac{\text{number of new cases of a disease during a given period of time}}{\text{Total population at risk (free of disease) at the beginning of the period}}$$

Example: Cumulative Incidence (CI)

Ex:

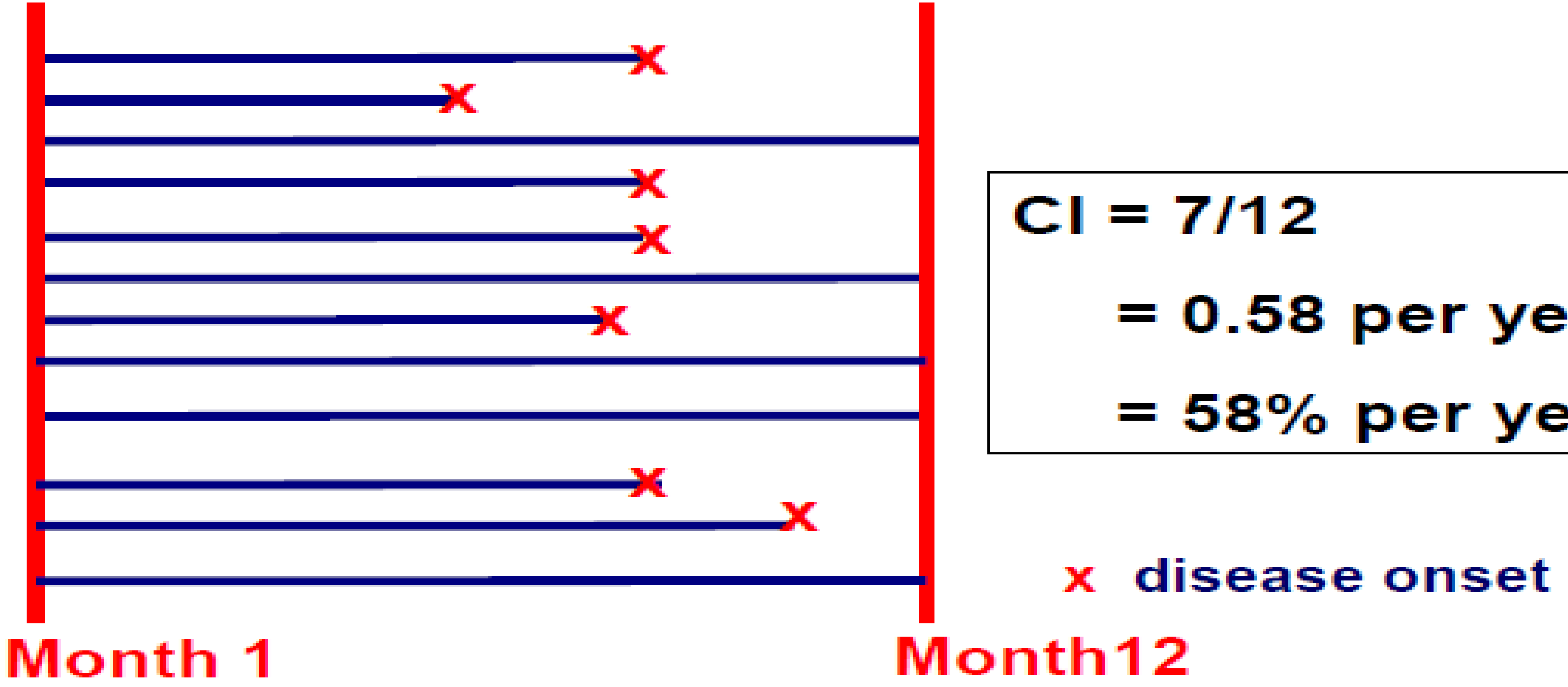
New cases	1,250
Population	350,000
Cumulative incidence	= 0.0036 per year
	= 0.36 % per year
	= 3.6 new cases / 1000 during a year

Cumulative Incidence (Or Risk)



Population = 12 Diseased = 7

Cumulative Incidence

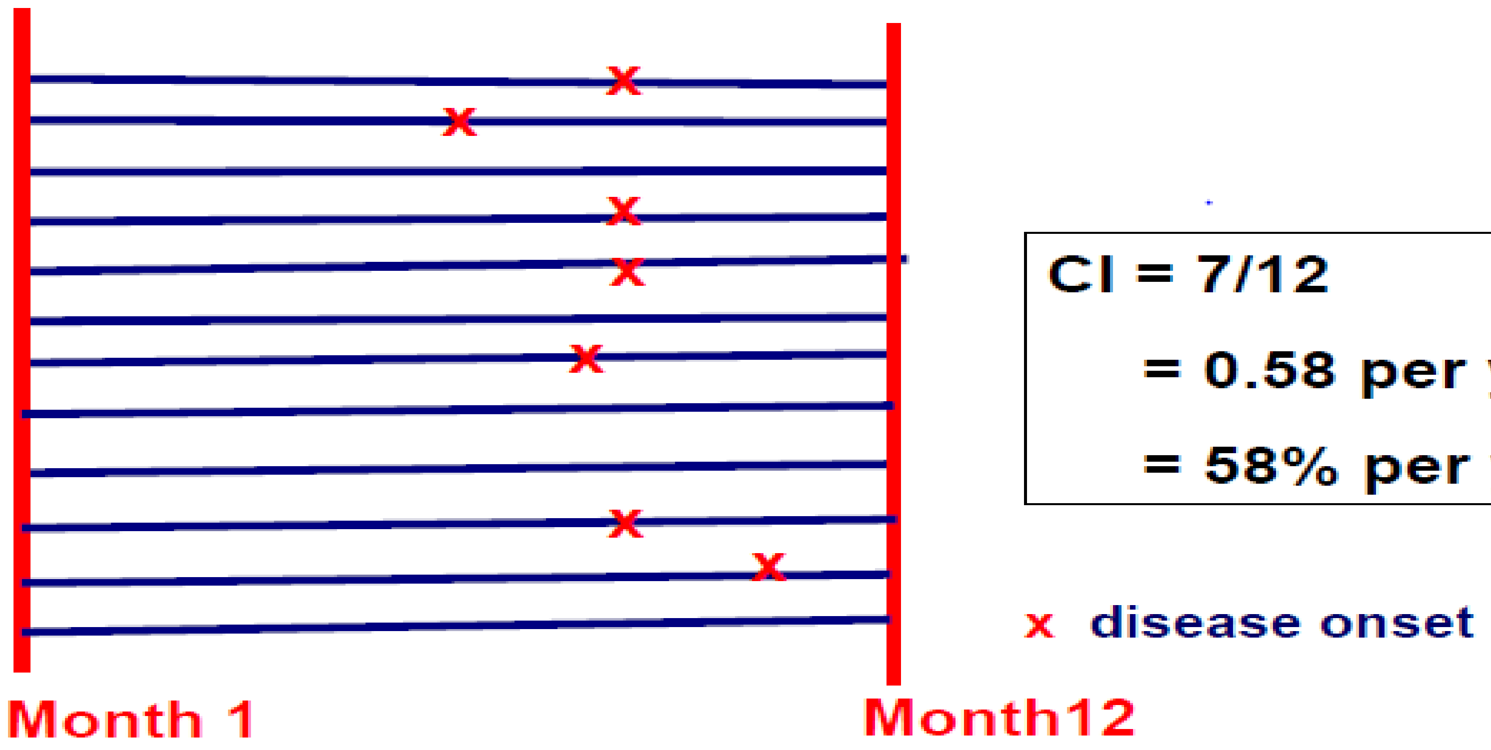


CI = 7/12

= 0.58 per year

= 58% per year

Cumulative Incidence



CI = 7/12
= 0.58 per year
= 58% per year

CI assumes that the entire population at risk is followed up for the **same time period**

Attack Rate (AR)

special type of cumulative incidence during an outbreak

Expressed for the <u>entire epidemic period,</u> from the first to the last case

Attack Rate (cont...)

Ex: Outbreak of cholera in country X in summer 2011

- Number of cases 490
- Population 18,600
- Attack rate 2.6%

Attack Rate during an outbreak

FOOD	FOOD EATEN			FOOD NOT EATEN		
	Cases	Total	AR (%)	Cases	Total	AR (%)
استیک_1	45	78	58	6	11	55
همبرگر_2	30	50	60	21	39	54
پوره_3	22	38	58	29	51	57
سوسیس_4	26	48	54	25	41	61
ماهی دودی_5	5	10	50	46	79	58

Odds

Odds (plural)

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

Example

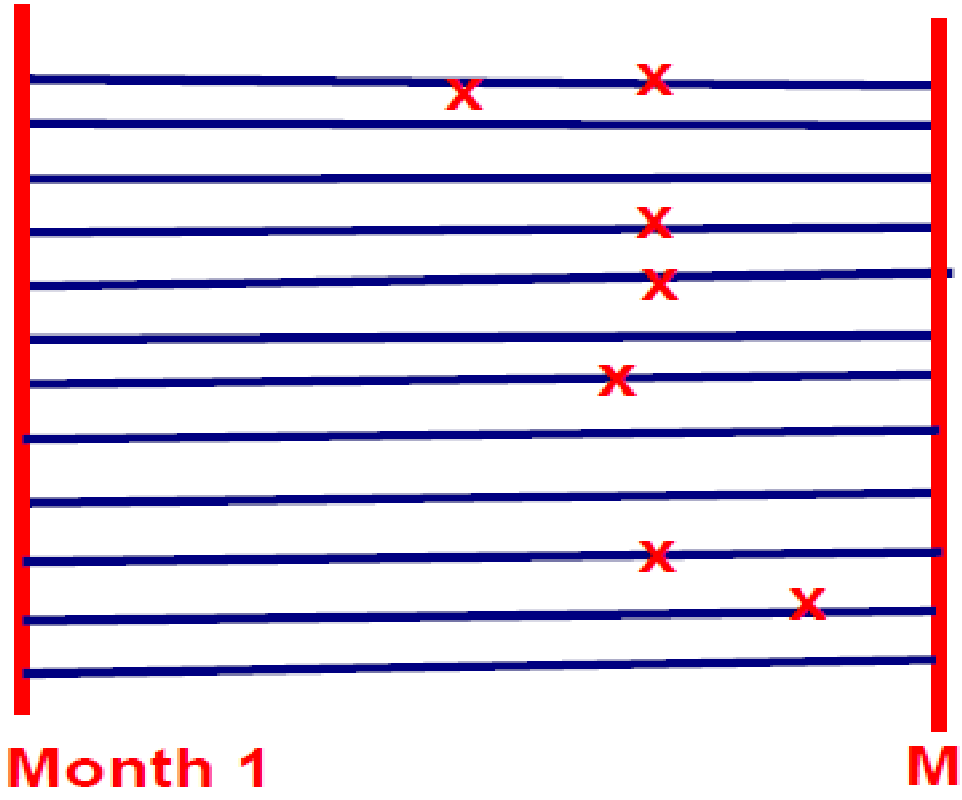
The number of hepatitis cases during an outbreak

	Cases	Non cases	Population
Hepatitis A	30	49,970	50,000

$$\text{Odds of disease} = \frac{30 / 50{,}000}{49{,}970 / 50{,}000} = 0.006$$

Rate

Cumulative Incidence



CI = 7/12

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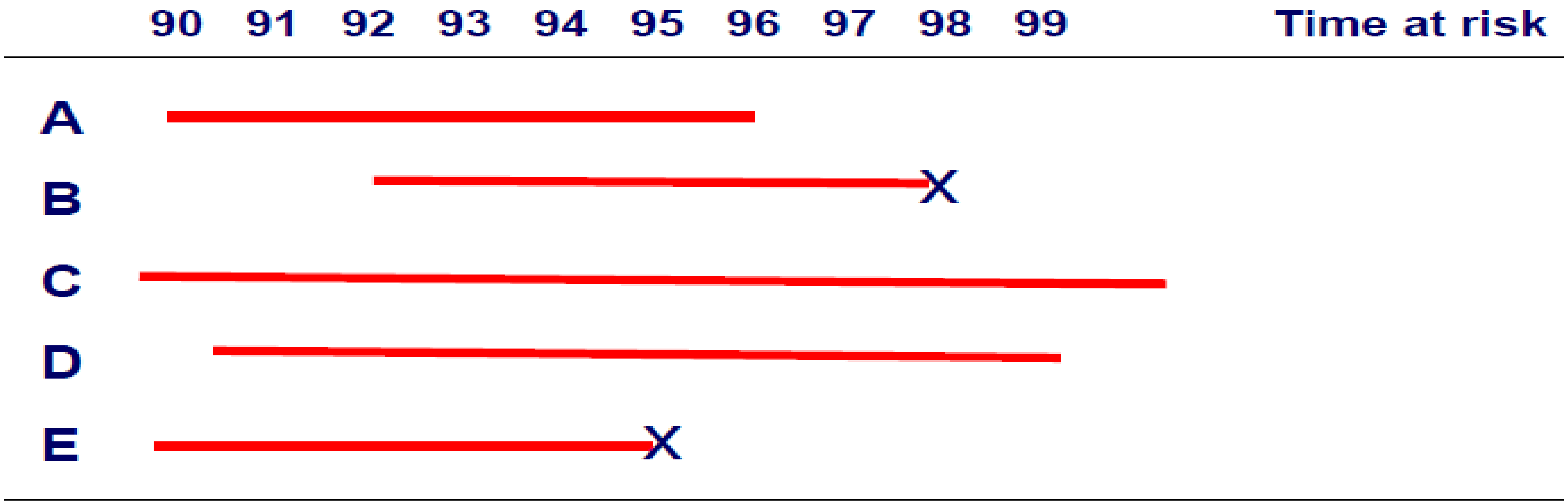


-:time followed

X: disease onset

The length of follow-up, or the time during which the outcome could be observed, will not be uniform for all participants.

What will be the approaches to account for these varying time period of follow-up.

A more precise estimate of the impact of exposure in a population that utilizes all available information is called the incidence rate (IR),

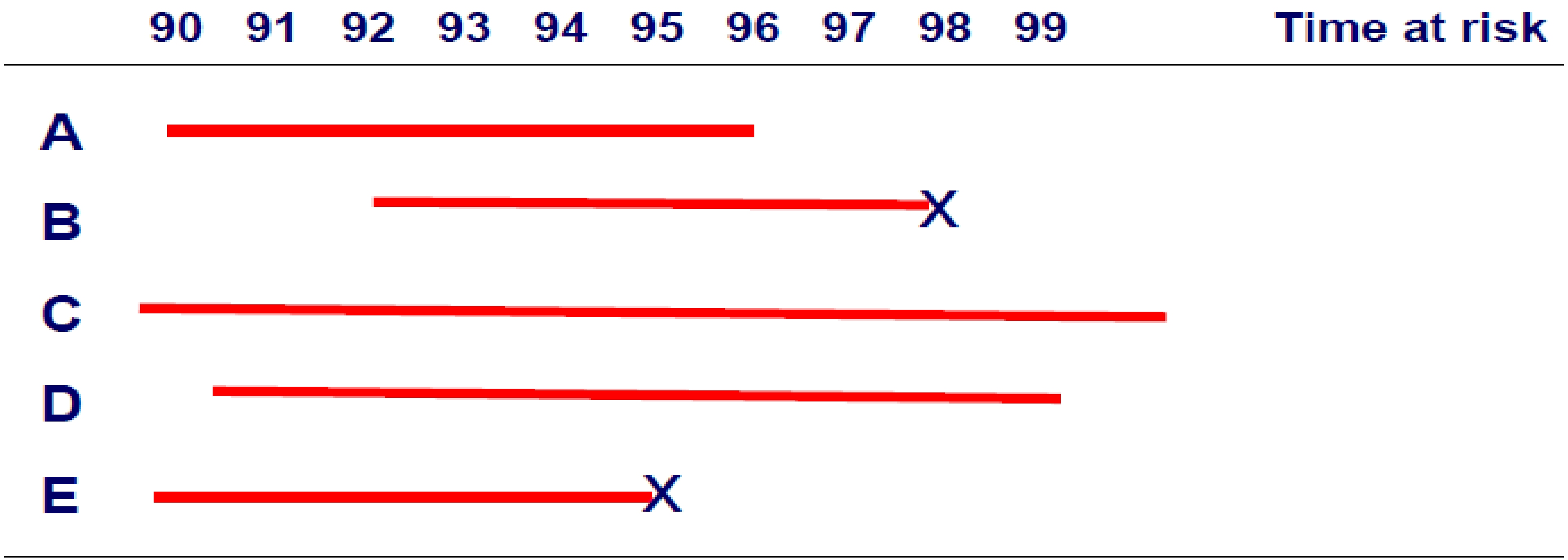
force of morbidity

and mortality,

or incidence density (ID).

- The numerator of the incidence density is the number of new cases in the population.
- The denominator, is the sum of each individuals' time at risk or the sum of the time that each person remained under observation *and free from disease.

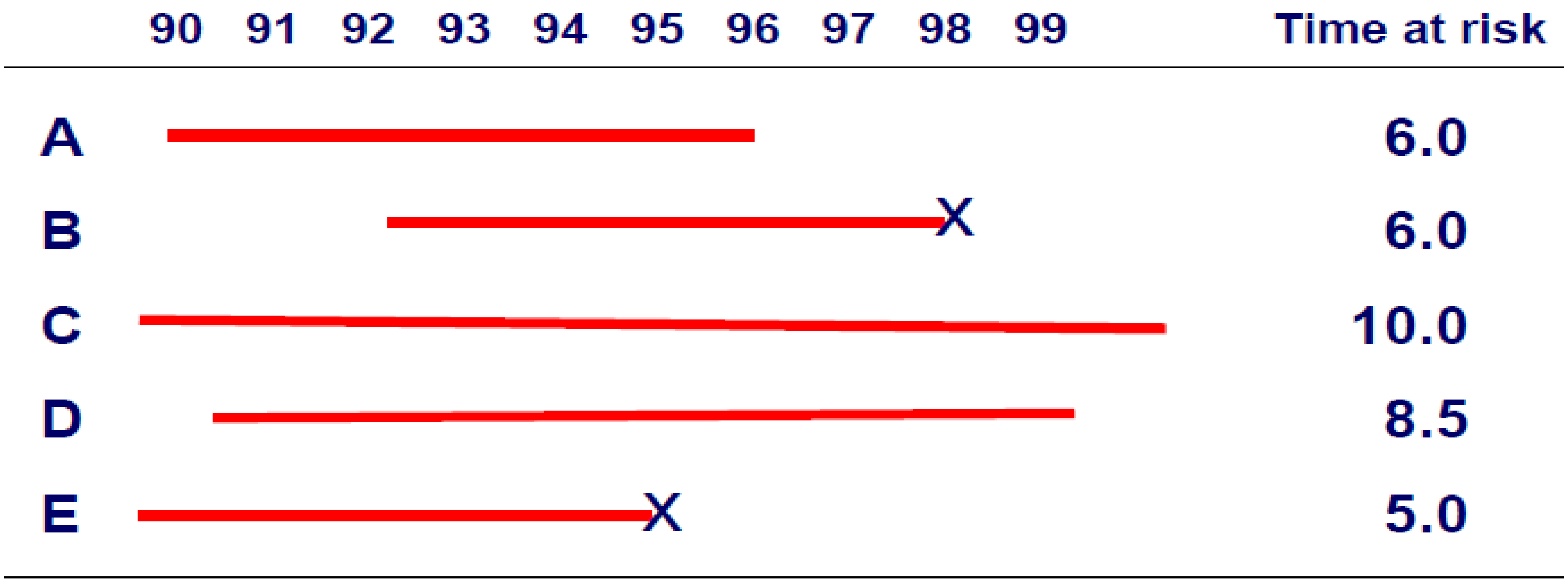
* person-day, person-month, person-year, etc.



-:time followed

X: disease onset

Person-time



Total years at risk **35.5**

- :time followed

X : disease onset

Incidence rate

$$\frac{\text{Number of New cases of disease}}{\text{Total Person - time of observation}}$$

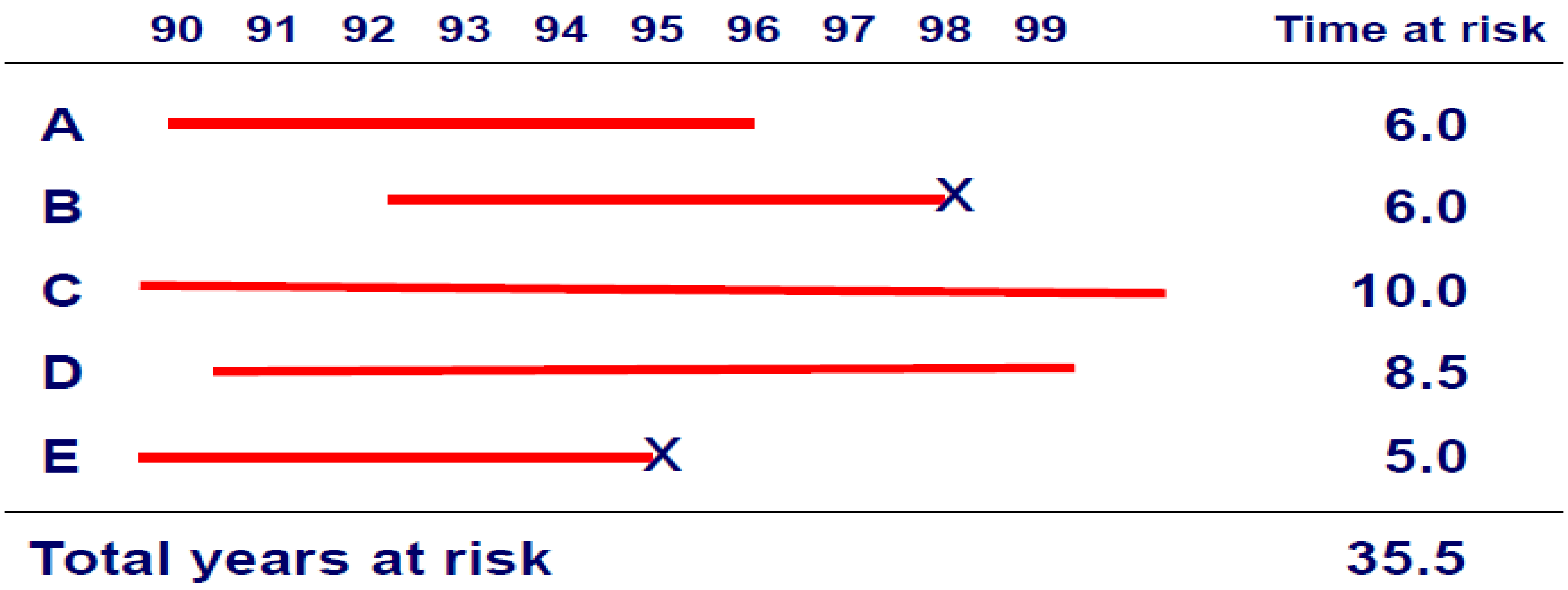
Incidence rate

$$\frac{\text{Number of New cases of disease}}{\text{Total Person - time of observation}}$$

Denominator:

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

Person-time



- :time followed

X : disease onset

Incidence rate (IR)
(Incidence density)

IR = 2 / 35.5 person years

= 0.056 cases / person year

= 5.6 cases / 100 person years

= 56 cases / 1000 person years

$$CI = \frac{\text{number of new cases of a disease during a given period of time}}{\text{Total population at risk at the beginning of the period}}$$

$$Odds = \frac{\text{number of new cases of a disease during a given period of time}}{\text{Total population who did not become a case during the period}}$$

$$IR = \frac{\text{number of new cases of a disease during a given period of time}}{\text{Total person-time of observation}}$$

Measures of association

Relative risk:

Which indicates how much likely one group is to develop a disease than another

Attributable risk (risk difference):

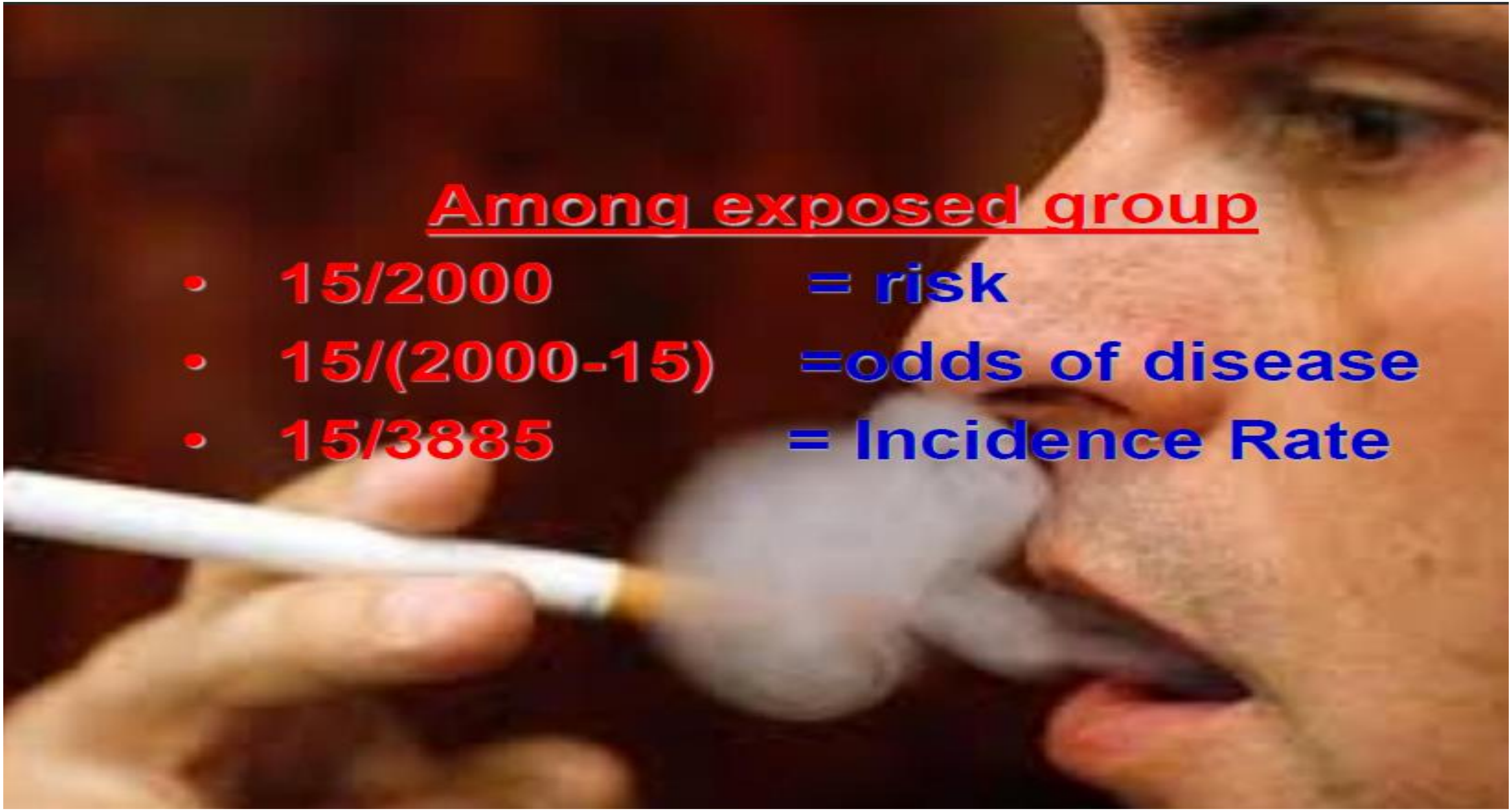
Which indicates on an absolute scale how much greater the frequency of disease in one group compared with the other

Our Population

10,000

Example:

		
Exposure	YES	NO
N Initially at risk	**2000**	**8000**
Cases	**15**	**30**
Person-years at risk	**3985**	**15970**


Among exposed group
• 15/2000 = risk
• 15/(2000-15) =odds of disease
• 15/3885 = Incidence Rate

Among unexposed group

- 30/8000 =risk
- 30/(8000-30) =Odds of disease
- 30/15970 = Incidence Rate

Among exposed group

- 15/2000 = risk
- 15/(2000-15) =odds of disease
- 15/3885 = Incidence Rate

Among unexposed group

- 30/8000 =risk
- 30/(8000-30) =Odds of disease
- 30/15970 = Incidence Rate

Example:

$$\text{Risk Ratio} = \frac{15/2000}{30/8000} = 2.0000$$

$$\text{Rate Ratio} = \frac{15/3885}{30/15790} = 2.0038$$

..

$$\text{Disease OR} = \frac{15/(2000-15)}{30/(8000-30)} = 2.0076$$

Interpretation of Measure of Association

This investigation demonstrated a 2-fold increased death rate from CHD among smokers when compared with nonsmokers.

The relative risk is a measure of the strength of the association between an exposure and disease and provides information that can be used to judge whether a valid observed association is likely to be causal.

RR = 1.0 : No association

RR > 1.0 : Positive association

RR < 1.0 :

Example 1

People who go into the forest have a malaria incidence rate (CI) of 10 / 1000 per month, while people who do not go into the forest have a malaria incidence rate (CI) of 1 / 1000 per month.

The risk ratio is:

The risk ratio is: *(10 / 1000) / (1 / 1000) = 10.*

Thus, people who go into the forest are 10 times more likely to contract malaria than those who do not.

Example 2

People who use mosquito nets have a malaria incidence rate (CI) of 2 / 1000 per month; people who do not use nets have a rate (CI) of 8 / 1000 for the same period. ***The ratio of the risks is:***

Example 2

People who use mosquito nets have a malaria incidence rate (CI) of 2 / 1000 per month; people who do not use nets have a rate (CI) of 8 / 1000 for the same period.

The ratio of the risks is: (2 / 1000) / (8 / 1000) = 0.25.

Example 2

Thus, those who use nets incur a lower rate of malaria incidence than those who do not (this is called the protective effect and is calculated as

1– the relative risk or 1– 0.25 = 0.75.

This is roughly equivalent to saying that 75% of those who use bed nets in these circumstances will be protected against malaria.

Example 3

People who are illiterate have a malaria incidence rate (CI) of 9/1000, while those who are literate have a rate (CI) of 3 /1000 for the same period. The ratio of the risks is 3.

Thus, those who are illiterate have three times more risk of malaria than those who are literate.

Here, literacy is a marker rather than a causal risk factor. Illiteracy does not cause malaria, but those who are illiterate are at risk for other reasons, such as living conditions, occupation…

Cumulative(Attack Rate)incidence during an outbreak

FOOD	FOOD EATTEN			FOOD NOT EATEN			
	Cases	Total	AR (%)	Cases	Total	AR (%)	RR
1_استیک	45	78	58	6	11	55	1.1
2_همبرگر	30	50	60	21	39	54	1.1
3_پوره	22	38	58	29	51	57	1.0
4_سوسیس	26	48	54	25	41	61	0.9
5_ماهی دودی	5	10	50	46	79	58	0.9

1.4 (95% CI= 1.2-1.60)

1.4 (95% CI= 0.80-1.60)

0.75 (95% CI= 0.20-0.90)

0.75 (95% CI= 0.20-1.90)

Risk difference (RD) or Attributable risk(AttR)

AttR is a measure of association that provides information about the **absolute effect** of the exposure or the **excess risk** of disease in those exposed compared those nonexposed

The AttR provides a measure of the public health impact of an exposure.

Attributable risk(AttR) In a cohort study of smoking and CHD incidence

AttR= CI_e (among smokers) –

CI_0 (among nonsmokers)

AttR = 28.0 per 1000 – 18.0 per 1000= 10.0 /1000

What does this mean? It means that

10.0 /1000 of the 28/1000 incident cases in smokers are attributable to the fact that these people smoke.

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