

# *Measurements of Association*

**Prof. Dr.  
Maha AL-Nuaimi**

# Learning objectives

- Understand how to estimate the magnitude of association between exposure & health-related events
- Estimate absolute, relative and attributable risks, AR%, Odds Ratio, in epidemiological studies.
- Interpret these measures in a meaningful manner.

# Definitions

## *Risk*

- Probability of certain event to occur. An individual to develop a disease or change in health status over a fixed time interval. (Absolute risk)

## *A risk factor*

- Is any attribute, characteristic, behaviour or exposure that increases the likelihood of developing that event, disease or injury in an individual.

# Association

A statistical relationship between two or more variables.... Exposure & disease

## Measuring of Risk

Introduction:



- CHD is associated with Depression
- Stress is associated with heart blockage
- DM increased likelihood of non-paroxysmal AF
- Being overweight raises your risk for type 2DM, HD and stroke.
- Premenopausal women are less likely to develop CVD than postmenopausal women.
- So on .....

- *How we can determine the association between exposure & health-related events ??*

- **Applying an analytic type of Epidemiological Studies As :**
  - ✓ **Case –Control study**
  - ✓ **Cohort study**
- **Principles of epidemiology are ??**

- **Analytic studies .. Assess the likelihood of developing the disease in the exposed group in comparison to the non-exposed;**
- **So how we can determine the association is high or low from these studies??**
- **By measuring risk in these studies accordingly ...**

***In Cohort Study*** or prospective studies  
where the risk is estimated directly by:

- ✓ Relative Risk (RR),
- ✓ Attributable Risk,
- ✓ Attributable Risk %,

• ***In case-control studies*** –

where the risk is estimated indirectly by

- ✓ Odds Ratio (as the incidence is not known)

# *Relative Risk (Risk Ratio)*

- *Estimates the magnitude of an association between exposure & disease.*
- *It estimates the likelihood of developing a disease in exposed relatively to those not.*

$$\text{Relative risk (RR)} = \frac{\text{incidence among exposed (Ie)}}{\text{incidence among non exposed (Io)}}$$

- *It is the ratio of the Incidences.*
- *Calculation can be either for morbidity or mortality.*

**Start**

**Outcome**

**Pop.  
(>40 yrs)  
1000**

**DM  
500 Person  
*Exposed***

**Non-DM  
500 person  
*Not exposed***

1 year

**AF  
300**

**Not AF  
200**

**AF  
120**

**Not AF  
380**

# 2x2 Table (contingency) to determine the association..

		HEALTH EVENT (disease, death, or any outcome)		
		+VE	-VE	
EXPOSURE	+	a (300)	b (200)	
	-	c (120)	d (380)	

# Rate: Incidence rate

- Incidence of Resp. Infection among *exposed* children:

$$\frac{300}{500} * 100 = 60\%$$

- Incidence of Resp. Infect. Among *non exposed* children:

$$\frac{120}{500} * 100 = 24\%$$

**Relative Risk**  
**Risk Ratio** = 
$$\frac{\text{Incidence rate among exposed}}{\text{Incidence rate in non exposed.}}$$

$$60\% / 24\% = 2.5 ?$$

**RR = 1: Risk in exposed equal to risk in unexposed**  
*(no association).*

**RR > 1: Risk in exposed is greater than the risk in unexposed**  
*(positive association)*

- **RR < 1: Risk in exposed is less than the risk in unexposed**  
*(negative association, possibly protective)*
- **Interpretation of RR**

*DM were 2.5 times as likely to develop AF as were of non-DM.*

**Relative Risk** give an indication to the "strength of association."

# Why is relative risk important?

- RR *measure the strength of the association* between exposure and outcome.
- Can *identify potential risk factors* for disease. Or *protective factors* for a disease.
- RR contribute to *understand the disease etiology (causality)* by quantifying the impact of specific exposures. This guide further research and preventive measures.

# Rate Ratio

A **rate ratio** compares two groups in terms of , incidence rates, or mortality rates (If the rates were computed)

$$\text{Rate ratio} = \frac{\text{rate for group of primary interest}}{\text{rate for comparison group}}$$

*The interpretation of the value of a rate ratio is similar to that of the risk ratio.*

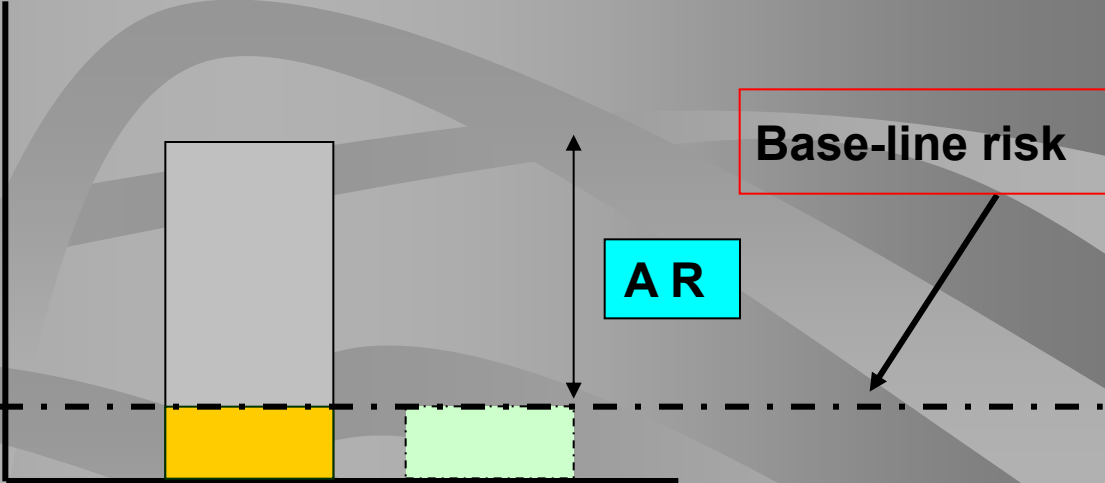
Exposure Category	Annual Death Rates / 100,000 persons
<b>Lung Cancer</b>	
Heavy smokers	166
Nonsmokers	7
<b><u>Measures of Risks</u></b>	
Rate ratio:	$166 / 7 = 23.7$

**Attributable risk (AR), *Risk difference*)  
Excess Risk, (Incidence Difference :**

- **It indicates how much of the disease is attributed to that particular risk factor**

$$AR = Inc.exp - Inc. non-exp$$

Incidence



Base-line risk

AR

I. among exposed

I. among non exposed

## AR means .....

- *How much those of the non-exposed will get the disease if they are exposed to the risk factor.*

## *Attributable Risk:*

$$60\% - 24\% = 36\%$$

- *interpretation*

*36% of AF among diabetics can be attributed to DM.*

**OR**

*36% of those non-diabetics might develop AF if they get DM.*

- ***Attributable Risk % (AR%):***

***(population attributable risk)***

- The percentage of disease which could be prevented if we remove the exposure to that factor in the pop. Under study.
- The proportion prevented in Population or in the exposed group.

- $$AR\% = \frac{I_e - I_o}{I_e} * 100$$

$AR\% = 36\% / 60\% = 60\%$  **interpretation?**

# OR (Odds Ratio, Relative Odds)

- It is a measure of choice for case-control study.
- In (CCS), we cannot calculate the IR → NO RR.
- OR used to measure the association between exposure & disease in (CCS), instead of RR (cohort).

# OR:

- Odds refer to single entity“
- **Ratio of the proportions.**
- Odds of factor among cases divided by odds of factor among control”

$$\frac{a / c}{b / d} = \frac{a}{c} \times \frac{d}{b} =$$

$$\text{OR} = \frac{ad}{bc}$$

# Case Control Studies

	<b>Leukemia <i>Cases</i></b>	<b>Healthy <i>Controls</i></b>	
<b>Benzene <i>Exposed</i></b>	<b>a</b>	<b>b</b>	
<b>Benzene <i>Non Exposed</i></b>	<b>c</b>	<b>d</b>	
	<b>a+c</b>	<b>b+d</b>	

***CROSS -RATIO***

# Odds ratio

***a*** = No. of persons with disease and with exposure of interest

***b*** = No. of persons without disease, but with exposure of interest

***c*** = No. of persons with disease, but without exposure of interest

***d*** = No. of persons without disease & without exposure of interest

***a + c*** = total number of persons with disease (“cases”)

***b + d*** = total number of persons without disease (“controls”)

# Example: A study of TB with alcohol consumption in a case-control study.

	TB	HEALTHY
Present	a=100	b=40
Absent	c=80	d=140
Risk Factor	a + c 180	b + d 180

$$\text{OR} = 100 \times 140 / 40 \times 80 = 4.4$$

- TB patients have been exposed to alcohol 4 times than healthy.
- Alcoholism was seen among TB patients 4 times than non TB.