

# MEASURES OF ASSOCIATION IN EPIDEMIOLOGY

**Dr. Sireen Alkhaldi**

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**Faculty of Medicine, The University of  
Jordan**

# STUDY DESIGN IN EPIDEMIOLOGY

**Descriptive studies:** Case report or series, Ecological Study (Correlation Study, unit is a population).

## Analytical Studies

### Observational Study

1. Cross-Sectional Study (prevalence Study)
2. Case-Control Study
3. Cohort study: Follow up study (incidence)

### Experimental Studies

Randomized Control Trials (RCT)

# MEASURES OF ASSOCIATION IN EPIDEMIOLOGY

- Chi square
- Odds Ratio
- Relative Risk or Risk Ratio
- Attributable Risk

# 2X2 Table (contingency table)

		<b>Disease</b>		<b>Total</b>
		<b>Yes (+)</b>	<b>No (-)</b>	
<b>Exposure</b>	<b>Yes (+)</b>	<b>a</b>	<b>b</b>	<b>a+b</b>
	<b>No (-)</b>	<b>c</b>	<b>d</b>	<b>c+d</b>
<b>Total</b>		<b>a+c</b>	<b>b+d</b>	<b>a+b+c+d</b>

# CELLS

**A= Exposed, and diseased**

**B= Exposed, Not diseased**

**C= Not exposed, diseased**

**D= Not exposed, Not diseased**

**A+B+C+D=Total**

# TOTALS

## Marginal totals

$$a+b = \text{Exposed}$$

$$c+d = \text{Non-exposed}$$

$$a+c = \text{Diseased}$$

$$b+d = \text{Non-diseased}$$

## Grand total

$$n = a+b+c+d$$

# 1. CHI-SQUARE IN CROSS-SECTIONAL STUDIES

Chi-square tests whether there is an association between two categorical variables.

For a 2X2, table: 
$$X^2 = \frac{n(ad - bc) - n/2)^2}{(a+b)(a+c)(c+d)(b+d)}$$

If the calculated chi-square value is greater than the critical value or **P<0.05** we say that there is a significant association between the risk factor and the disease.

**Chi-square statistic tells only whether there is association. It doesn't tell us how strong an association is.**

## 2. RELATIVE RISK (RR) OR RISK RATIO (RR) IN A COHORT STUDY

RR: The estimation of disease risk associated with exposure (strength of association)

RR Expresses risk of developing a disease in exposed group (a + b) as compared to non-exposed group (c + d)

RR= Incidence (risk) among exposed  
Incidence (risk) among non-exposed

$$RR = \frac{a/(a+b)}{c/(c+d)}$$

# INTERPRETATION OF RELATIVE RISK

What does a RR of 2 mean?

Risk in exposed=2X Risk in non-exposed

Thus a relative risk of 2 means the exposed group is two times at a higher risk of developing the disease when compared to non-exposed

# ANALYSIS IN COHORT STUDIES

In a Cohort Study, we can calculate Incidence.  
So, Relative Risk can be obtained from a cohort study.

<i>Cigarette smoking (Exposure)</i>	<i>Disease (with Ca lung )</i>	<i>No Disease (without Ca lung )</i>	<i>Total</i>
<i>Yes</i>	<i>70 (a)</i>	<i>6930 (b)</i>	<i>7000 (a+b)</i>
<i>No</i>	<i>3(c)</i>	<i>2997(d)</i>	<i>3000 (c+d)</i>

# RR IN A COHORT STUDY

Incidence rates :

Risk among smokers =  $70/7000 = 10 / 1000$ .

Risk among non smokers =  $3/3000 = 1 / 1000$ .

RR = Risk (Incidence) among exposed  
Risk (Incidence) among non exposed.

**RR = 10/1=10**

The exposed have 10 times the risk of developing the disease when compared to non-exposed

# STRENGTH OF ASSOCIATION

In general **strength of association** can be considered as:

High association if  $RR \geq 3$

Moderate if RR is between 1.5 & 2.9

Weak association if RR is between 1.2 & 1.4

No association exists if RR is 1

Negative association (protective effect) if  $RR < 1$

### **3. ODDS RATIO (OR)**

**Odds Ratio (OR) is a measure of the strength of the association between risk factor & outcome.**

- ✓ The odds ratio is the cross product of the entries in table.**
- ✓ OR can be calculated in case-control studies instead of RR**
- OR can be a good estimate of RR**

# ODDS RATIO (OR)

Odds Ratio can be a good estimate of RR.

Odds ratio is the ratio of odds of exposure among diseased to odds of exposure among non-diseased

$$\text{OR} = \frac{\text{Odds of exposure among diseased}}{\text{Odds of exposure among non-diseased}}$$
$$= (a/c)/(b/d) = ad/bc$$

**Interpretation of OR is the same as that of RR**

# ODDS RATIO...

**RR can be best estimated by OR if the following conditions are fulfilled:**

- 1. Controls are representative of general population**
- 2. Selected cases are representative of all cases**
- 3. The disease is rare**

# **ANALYSIS IN CASE-CONTROL STUDIES**

**Estimation of disease risk associated  
with exposure ( odds ratio )**

# OR IN A CASE-CONTROL STUDY

	<i>Cases (with Ca lung )</i>	<i>Controls (without Ca lung )</i>
<i>Smokers</i>	<i>33 (a)</i>	<i>55 (b)</i>
<i>Non smokers</i>	<i>2 (c)</i>	<i>27 (d)</i>
<i>Total</i>	<i>35 (a+c)</i>	<i>82 (b+d)</i>

# OR IN CASE-CONTROL STUDIES

**Odds ratio is a key parameter in the analysis of Case-control studies**

	<i>Disease</i>	
	<i>Yes</i>	<i>No</i>
<i>Exposed</i>	<i>a (33)</i>	<i>B (55)</i>
<i>Not exposed</i>	<i>c (2)</i>	<i>D (27)</i>

$$\text{Odds Ratio} = ad/bc = \frac{33 \times 27}{55 \times 2} = 8.1$$

# ATTRIBUTABLE RISK (AR)

AR indicates how much of the risk is due to (attributable to) the exposure.

Quantifies the excess risk in the exposed that can be attributable to the exposure, by removing the risk of the disease that occurred due to other causes

AR= Risk (incidence) in exposed- Risk (incidence) in non-exposed

$$AR = [a/(a+b)] - [c/(c+d)]$$

Attributable risk is also called risk difference.

# ATTRIBUTABLE RISK PERCENT (AR%)

Estimates the proportion of disease among the exposed that is attributable to the exposure.

$$\text{AR\%} = \frac{(\text{Risk in exposed} - \text{Risk in non-exposed})}{\text{Risk in exposed}} \times 100\%$$

$$\text{AR\%} = \frac{10 - 1}{10} \times 100\% = 90\%$$

90% of the lung cancer among smokers was due to their smoking. This suggests the amount of disease that might be eliminated if smoking could be controlled or eliminated.

# POSSIBLE OUTCOMES IN STUDYING THE RELATIONSHIP BETWEEN EXPOSURE & DISEASE

## 1. No association

$$RR=1$$

$$AR=0$$

## 2. Positive association

$$RR>1$$

$$AR>0$$

## 3. Negative association

$$RR<1 \text{ (fraction)}$$

$$AR<0 \text{ (Negative)}$$

# RISK VS PREVENTIVE FACTORS

A *risk factor* is any factor positively associated with a disease ( $RR > 1$ ). It is associated with an increased occurrence of a disease

A *preventive factor* is any factor negatively associated with a disease ( $RR < 1$ ). It is associated with a decreased occurrence of a disease.

Risk and preventive factors *may (not)* be amenable to change (e.g. Smoking, age)

21% of boys and 30% of girls support me; therefore I'll get 51% of the vote.



VOTE FOR ME  
AS PRESIDENT  
OF THE  
MATH CLUB

*Ben Shabat*