Research
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Revised by
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# Measures of disease effect and impact

Lecture No. 15

Objectives:

1. To calculate and interpret: Risk ratio and Odds ratio
2. To calculate and understand: Risk difference and attributable risk

~ This lecture was presented by **Dr. Afnan Younis**
~ It is included in the **Midterm Exam**
~ We highly recommended reading the **Ayah** in the first page

Slides

**Color code**

Original text
Dr. Notes
Important
Golden note
Extra

Editing file

# Measures of association (effect)



## Relative risk and Odds ratio

Overall rate of disease in an exposed group says nothing about whether exposure is a risk factor for or causes a disease.

- This can only be evaluated by comparing disease occurrence in an exposed group to another group that is usually not exposed.
- The later group is usually called the comparison or reference group. we use association term more than effect. We use association in exams.


| | yes | no | total |
|---|---|---|---|
| Exposed | a | b | a+b |
| non exposed | c | d | c+d |
| total | a+c | b+d | a+b+c+d |

Risk/ incidence

= a/(a+b) among exposed

= c/(c+d) among unexposed

= (a+c)/(a+b+c+d) among total population

## Example

Data from a fixed cohort study of oral contraceptive pills (OCP) use and myocardial infarction (MI) in pre-menopausal women followed for 5 years (adapted from Rosenberg et al, AJE 1980).

| | MI | no | total |
|---|---|---|---|
| OCP | 23 | 304 | 327 |
| Without OCP | 133 | 2816 | 2949 |
| total | 156 | 3120 | 3276 |

Risk (incidence) of myocardial infarction

= 23/327 = 7.0% among OC users

= 133/2949 = 4.5% among non-OC users.

# Relative risk (RR)

| | yes | no | total |
|---|---|---|---|
| yes | a | b | a+b |
| no | c | d | c+d |
| total | a+c | b+c | a+b+c+d |

| | yes | no | total |
|---|---|---|---|
| yes | 23 | 304 | 307 |
| no | 133 | 2816 | 2949 |
| total | 156 | 3120 | 3276 |

**Important**

**Relative risk**

**= RR = $I_E$ / $I_U$ = $R_E$ / $R_U$**

= [a/(a+b)] / [c/(c+d)]

-Based on ratio of 2 measures of frequency

-Dimensionless and ranges 0 - infinity

**Relative Risk**

= Incidence of disease among exposed/Incidence of disease among non-exposed

Incidence among exposed = a/(a+b)

Incidence among non-exposed = c/(c+d)

**RR example** of MI among Oral Contraceptives users compared to non OC users:

RR = Re/Ru = [a/(a+b)]/[c/(c+d)] = (23/327)/(133/2949) = 1.6

**Interpretation**:

(RR = 1.6)

Women who used OCP had 1.6 times the risk of having MI compared to non-OCP users (1.6-fold increased risk).

There is a 60% increase risk of MI among OCP users compared to non-users (60% more likely to have MI).

| | |
|---|---|
| **RR=1** | Risk in exposed = risk in non-exposed<br>No association |
| **RR>1** | Risk in exposed > risk in non-exposed Positive association, factor is associated with disease<br>Larger RR → stronger association |
| **RR<1** | Risk in exposed < risk in non-exposed<br>Negative association, factor is "protective" |

**Interpretations of Relative Risk:**

- Gives information on the relative effect of the exposure on the disease.
- Tells how many times higher or lower the disease risk is among the exposed as compared to the unexposed.
- Therefore, commonly used in etiologic research as a measure of risk.

# Odds Ratio

In some study designs

- Participants are selected on the basis of their disease (outcome) status.
- No follow up.
- Cannot estimate incidence
- Calculate the odds ratio (OR)

-ratio of odds of exposure among cases to odds of exposure among controls

$$OR = (a/c)/(b/d) = ad/bc$$

| | yes | no | total |
|---|---|---|---|
| yes | a | b | a+b |
| no | c | d | c+d |
| total | a+c | b+c | a+b+c+d |

| Shampoo brand | yes | no | total |
|---|---|---|---|
| Exposed | 15 | 14 | 29 |
| non Exposed | 9 | 45 | 54 |
| total | 24 | 59 | 83 |

Odds of exposure:

= a/c among cases

= b/d among controls

OR = (a/c)/(b/d) = ad/bc

OR = (15*45)/(14*9) = 5.4

Interpretation (OR= 5.4)

The odds of using Rely shampoo among patients with scalp folliculitis were 5.4 times higher than the odds of using Rely shampoo among those without folliculitis (technical)

Patients who used Rely shampoo were 5.4 times more likely to develop scalp folliculitis than patients who used other brands (loosely).

| | OR<1 | OR=1 | OR>1 |
|---|---|---|---|
| **Odds comparison between cases and control** | Odds of exposure for cases are less than the odds of exposure for control | Odds of exposure are equal among cases and control | Odds of exposure for cases are greater than the odds of exposure for control |
| **Exposure and likelihood of outcome** | Outcome is less likely to be found with exposure | The likelihood of outcome doesn't change with exposure | Outcome is more likely to be found with exposure |

# Odds Ratio Approximates Relative Risk

When disease is Rare

Proportion of cases in exposed and unexposed groups is low

$a < b$, so $a+b \approx b$ and $c < d$, so $c+d \approx d$

$RR = a/(a+b) / c/(c+d) \approx a/b / c/d = ad/bc$

Not important it will not be include in exam (for your information)

| | Cases | Control | total |
|---|---|---|---|
| yes | 10 | 999,990 | 1,000,000 |
| no | 5 | 999,995 | 1,000,000 |

## Risk difference

**Difference (Absolute) Comparisons**

Based on difference between 2 measures of frequency

Gives information on:

- the **absolute effect of exposure** on disease occurrence
- the excess disease risk, or **disease burden,** in the exposed group compared to the unexposed group
- the **public health impact of an exposure,** that is, how much disease would be prevented if the exposure were removed

Note: this assumes that the exposure causes the disease

Risk difference (RD) = R exposed – R unexposed = $R_{exp} - R_{unexp}$

Also called **attributable risk, or rate difference.**

Note: "attributable" implies causality

RD = 0 when there is no association between exposure and disease

What we can hope to accomplish in reducing risk of disease among exposed if exposure were eliminated

# Risk Difference, *Cont.*

| | CHD | no | total | Per 1000 |
|---|---|---|---|---|
| yes | 84 | 2,916 | 3,000 | 28 |
| no | 87 | 4,913 | 5,000 | 17.4 |

Risk difference = incidence among smokers – incidence among nonsmokers

= 28 – 17.4 = 10.6 / 1,000

Interpretation:

Risk difference = 10.6 / 1,000

Broad: 10.6 cases of the 28/1,000 CHD in smokers are attributable to smoking.

Narrow: Eliminating this exposure (smoking) would prevent 10.6 cases of the 28/1,000 cases of CHD in smokers.

## Attributable proportions

**Attributable Proportion among Exposed:**

Describes the proportion of disease among exposed that is due (attributable) to exposure or that would be prevented if exposure were eliminated

$$AP_e = [(R_e - R_u)/R_e] \times 100$$

$$= RD / R_e \times 100$$

$R_e$ = Re = "risk" (IR, CI, P) among exposed

$R_u$ = Ru = "risk" (IR, CI, P) among unexposed

Also called **etiologic fraction, attributable risk percent, attributable risk among exposed**

# Attributable proportions

## Alternative formula

APe = [(Re – Ru)/Re] x 100

Divide numerator and denominator by Ru

APe = [(RR-1)/RR] x 100

## Example

| | Breast cancer cases | PY | Rates/10,000 PY |
|---|---|---|---|
| Radiation exposure | 41 | 28,010 | 14.6 |
| no radiation exposure | 15 | 19,017 | 7.9 |
| total | 56 | 47,027 | 11.9 |

APe = [(14.6-7.9)/14.6] x 100 = 46%

Interpretation: APe = 46%

46% of cases of breast cancer among those exposed to radiation may be attributed to radiation exposure and could be eliminated if exposure were removed.

## In other words

- **Relative risk** is a measure of **strength of association** between exposure and disease and is useful in analytical studies
  - **Risk**
- **Relative difference** is a measure of how much disease incidence is **attributable** to exposure, and is useful in assessing exposures' public health importance
  - **Burden**

In MCQ, it will give you a scenario then what is the appropriate **study design** then what **measure of association** can be used to calculate from the study design?

| Study design | Measure of association |
|---|---|
| Cross-sectional | OR |
| Case control | OR |
| Cohort | RR |
| Experimental | RR |

# Exercises

In the year 2000, City A had a population of 183,000. There were 264 existing cases of colon cancer, 40 of which were diagnosed in 2000. During the same year, 20 deaths were attributed to colon cancer.

1) Calculate the prevalence of colon cancer.
2) Calculate the incidence of colon cancer in the year 2000.

1- Calculate the prevalence of colon cancer.

Prevalence = no. of cases / population at risk x 1,000

= 264 / 183,000 x 1,000 = 1.4 per 1,000

2- Calculate the incidence of colon cancer in the year 2000.

Incidence = No. of new cases / Population at risk x 1,000

*Population at risk= 183,000 – 264 = 182,736

Incidence = 40 / 182,736 x 1,000 = 0.22 per 1,000

In an outbreak of tuberculosis among prison inmates in South Carolina in 1999, 28 of 157 inmates residing on the East wing of the dormitory developed tuberculosis, compared with 4 of 137 inmates residing on the West wing.

1) Draw 2 X 2 table
2) Calculate the relative risk

| Wings | TB +ve | TB -ve | total |
|---|---|---|---|
| East | 28 | 129 | 157 |
| West | 4 | 133 | 137 |
| total | 32 | 262 | 294 |

Risk of tuberculosis among East wing residents

= 28/157 = 0.178 = 17.8%

Risk of tuberculosis among West wing residents

= 4/137 = 0.029 = 2.9%

RR = 17.8/2.9 = 6.1

القادة:

نواف التركي  عبدالله الشهري  لمتحمي

ريان الغنامي  وهى ا

الأعضاء:

عبدالله التركي  عبدالله المياح

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عبدالعزيز القحطاني  عبدالله القرني

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نوف الضلعان

أثير الاحمري

وعد ابو نخاع

ثراء الهويش

في الدوسري

منار الزهراني

Answer: Q1:C |Q2:A |Q3:A |Q4:A

**MCQ:**

**Q1: Which measure of association is dimensionless and ranges from 0 to infinity?**

A. Risk difference
B. Odds ratio
C. Relative risk
D. Prevalence

**Q2: When is the odds ratio (OR) commonly used?**

A. When participants are selected based on their disease status
B. When calculating the risk difference
C. When evaluating the prevalence of a disease
D. When estimating the incidence rate

**MCQ:**

**Q3: What does a relative risk (RR) of 1 indicate?**

A. No association between exposure and disease
B. Positive association, the factor is associated with the disease
C. Negative association, the factor is "protective"
D. Stronger association between exposure and disease

**Q4: What does the risk difference (RD) measure?**

A. The absolute effect of exposure on disease occurrence
B. The strength of association between exposure and disease
C. The public health impact of an exposure
D. The incidence rate of a disease