Chapter Five

Measurement of Risk and Associations

Introduction

- The key to epidemiologic analysis is comparison.

- Occasionally you might observe an incidence rate among a population that seems high and wonder whether it is actually higher than what should be expected based on, say, the incidence rates in other communities.

- A measure of risk and association quantifies the relationship between exposure and disease among the two groups.

- Exposure is used loosely to mean not only exposure to foods, mosquitoes, a partner with a sexually transmissible disease, or a toxic waste dump, but also
- ✓ inherent characteristics of persons (for example, age, race, sex),
- ✓ biologic characteristics (immune status),
- ✓ acquired characteristics (marital status),
- ✓ activities (occupation, leisure activities),
- ✓ or conditions under which they live (socioeconomic status or access to medical care).

- The measures of risk and association described in the following section compare disease occurrence among one group with disease occurrence in another group.

Examples of measures of association include

1. Risk,
2. Attributable Risk,
3. Risk Ratio (Relative Risk) And
4. Odds ratio.

1. Risk

- **Risk is defined as** the probability that an event will occur
- **E.g.** that an individual will become ill or die within a stated period of time or age.

- The term is usually used with reference to unfavorable events.

- It is often used to **compare** the risk of an event between groups.

- There are lots of ways to define the groups you might want to compare.
- **For example**, socio-demographic factors, or exposure to factors that may cause the disease.

There are three types of measuring risk in epidemiology:

a. Absolute Risk

- Absolute Risk is **measured by the incidence of an event (disease) in a population**.
- This can indicate the magnitude of the risk associated with a certain exposure.
- The main implications of absolute risk are in both clinical and public health policies.

Calculated by :

1. Incidence among exposed

Absolute risk is the number of people experiencing an event in relation to the population at risk.

Example

- Let's say a study of **100** workers in factory A revealed that **20** workers experienced back pain on the job.
- In factory B, **30** workers in a similar workplace of **150** workers developed back pain.
- The absolute risk of developing back pain is simply the percentage of people affected.
- **This is 20% in both groups.**

Example

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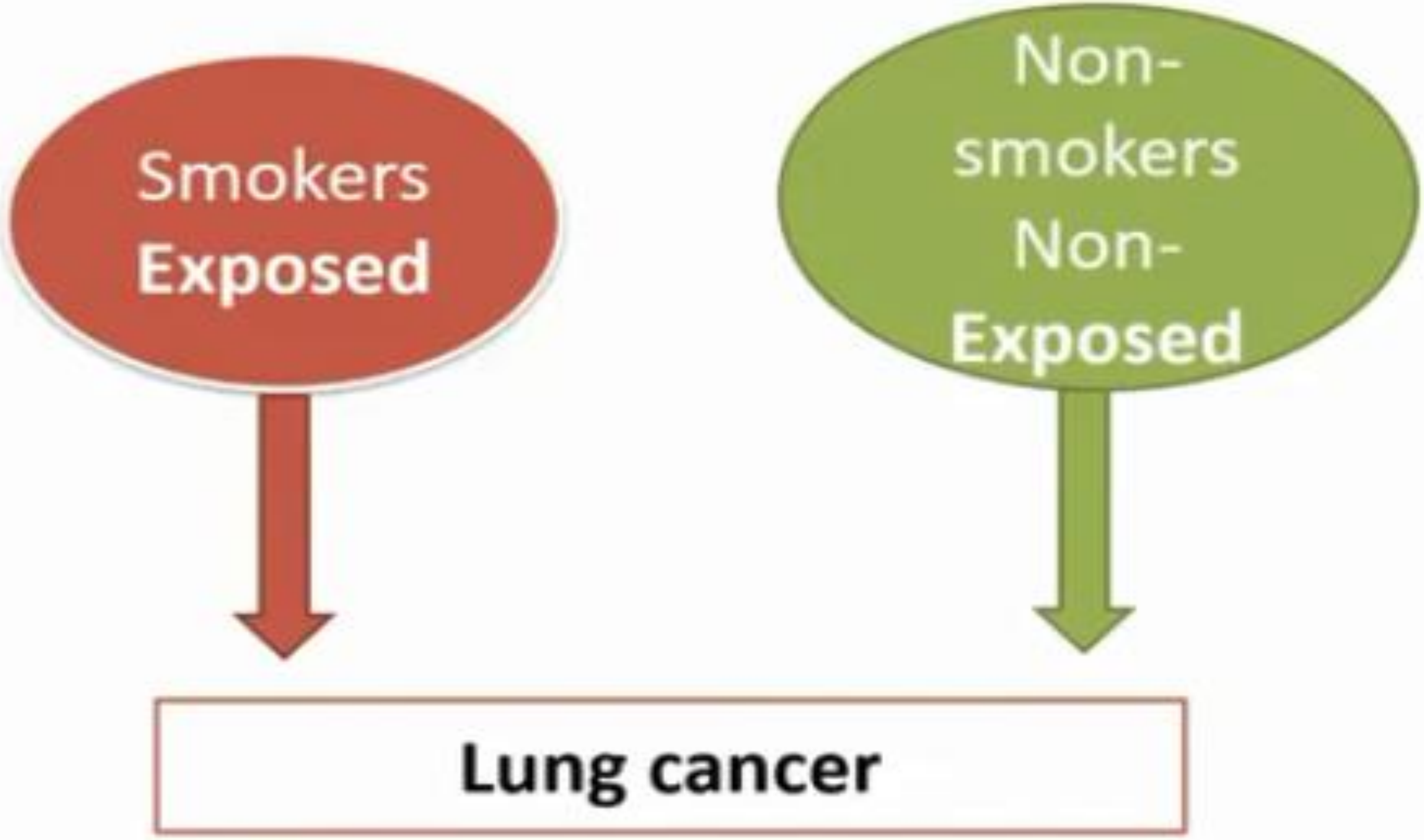
- The absolute risk of developing back pain is simply the percentage of people affected.
- **Factory A**: $\frac{20}{100}$ x 100 = 20/100 workers
- **This is 20% in both groups.**

b. Attributable Risk

- Proportion of the total incidence in the exposed group that is attributable to the exposure can be calculated by:

$$\textbf{Proportion AR} = \frac{\text{Incidenice of exposed (I. Exp)} - \text{incidence of non exposed(I. Non Exp)}}{\text{Incidence of exposed (I. Exp)}}$$


Smokers
Exposed
Non-smokers
Non-Exposed
Lung cancer

b. Attributable Risk

- Attributable risk is the proportion of disease incidence that can be attributed to a specific exposure.

- The incidence in the exposed group that is attributable to the exposure can be calculated by subtracting:

(Incidence among Exposed) - (Incidence among non- Exposed)

Example

Table 3.2: Risk of wound infections when an incidental appendectomy was done

Calculate

- Absolute risk
- Attributable risk

Had incidental appendectomy	Wound Infection	No Wound Infection	Total
Yes	7	124	131
No	1	78	79

Attributable Risk =

$$\frac{\left(\frac{7}{131}\right)-\left(\frac{1}{79}\right)}{\left(\frac{7}{131}\right)} =$$

$$\frac{0.053-0.012}{0.053} = \mathbf{0.76}$$

Example

- non-smokers are expected to develop lung cancer at a rate of **10 cases of lung cancer per 100,000 people per year.** Among smokers, the rate of lung cancer is **100 cases of lung cancer per 100,000 people per year.**
- Calculate AR

C. Relative Risk (RR)

- Relative Risk (also called the risk ratio) is the ratio of the incidence of event in exposed individuals to the incidence of event in non- exposed individuals.

$$\text{Relative Risk} = \frac{\text{Incidenice of exposed population}}{\text{Incidence in non exposed population}}$$

- **Table 3.1: Relationship between cigarette smoking and incidence rate of stroke in a cohort of 118 539 women**

Smoking category	Number of cases of stroke	Person-years of Observation (over 8 years)	Stroke incidence rate (per 100) person/years
Never smoked	70	395.594	17.7
Ex-smoker	65	232.712	27.9
Smoker	139	280.141	49.6
Total	274	908.447	30.2

- As shown in **Table 3.1**, the relative risk of stroke in women who smoke, compared with those who have never smoked, is

$$(49.6 / 17.7) = 2.8$$

- The relative risk is a better indicator of the strength of an association than the risk difference, because it is expressed relative to a baseline level of occurrence.

- The relative risk is used in assessing the likelihood that an association represents a causal relationship

- Of course, **smaller relative risk** can also indicate a causal relationship.

Interpretation of relative risk values in a simple comparison between an experimental group and a control group:

- A relative risk of 1 means there is no difference in risk between the two groups.

- A relative risk of < 1 means the event is less likely to occur in the experimental group than in the control group.

- A relative risk of >1 means the event is more likely to occur in the experimental group than in the control group

Example 3.1: Calculating RR

- Table 3.2 shows how the relative risk was calculated in the study examining the risk of wound infections when an incidental appendectomy was done during a staging laparotomy for Hodgkin disease.

Example

Table 3.2: Risk of wound infections when an incidental appendectomy was done

Calculate

- Relative risk

Had incidental appendectomy	Wound Infection	No Wound Infection	Total
Yes	7	124	131
No	1	78	79

$$RR = \frac{7/131}{1/79} = 5.34/1.27 = 4.2$$

Interpretation of the result

- In this study, patients who underwent incidental appendectomy had 4.2 times the risk of post-operative wound infection compared to patients who did not undergo incidental appendectomy.

Example 3.2: Calculating RR

- In 1982. the Physicians' Health Study (a randomized clinical trial) was begun in order to test whether low-dose aspirin was beneficial in reducing myocardial infarctions (MI).
- The study population consisted of over 22,000 male physicians who were randomly assigned to either low-dose aspirin or a placebo
- They followed these physicians for about five years. Some of the data is summarized in the 2x2 table shown below.

- **Table 3.3: How beneficial is aspirin in reducing myocardial infarctions**

Treatment	MI	No MI	Total
Aspirin	139	10898	11037
Placebo	239	10795	11034

- $RR = \frac{0.0126}{0.0217} = 0.58$

Interpretation of result:

- Those who take low dose aspirin regularly have 0.58 times decrease the risk of myocardial infarction compared to those who do not take aspirin.

2. Odds Ratio (OR)

- An odds ratio is a measure of **association between an exposure and an outcome**.

- Odds ratios are most commonly used in **case-control studies.**

2. Odds Ratio (OR)

- The odds ratio quantify how strongly the presence or absence of **property A** is associated with the presence or absence of **property B** in a given population.

- In **prospective studies**, odds ratio is the ratio of the odds of exposed people developing the disease to the odds of non-exposed people developing the disease.

2. Odds Ratio (OR)

- In **retrospective studies**, odds ratio is the ratio of the odds of the cases having been exposed to the odds of the controls having been exposed.

Table 3.4: Calculation of odds ratio

	Diseased	Health
Exposed	A	B
Non Exposed	C	D

$$\text{Odds Ratio} = \frac{A \text{ X } D}{C \text{ X } B}$$

Usage of odds ratio

- to compare the relative odds of the occurrence of the outcome
- to determine whether a particular exposure is a risk factor for a particular outcome
- to compare the magnitude of various risk factors for that outcome.

Interpretation of OR

- **OR = 1**, Exposure does not affect odds of outcome
- **OR > 1**, Exposure associated with higher odds of outcome
- **OR < 1**, Exposure associated with lower odds of outcome

Table 3.5: Calculate OR from the following 2x2 table

Treatment	Diseased	Non-Diseased	Total
Exposed	60	108	168
Non-Exposed	45	341	386

$$OR = \frac{60 \times 341}{45 \times 108} = 4.21$$

Interpretation of the result:

- Those who are exposed to factor (x) have 4.21 times the odds to have the risk of a disease compared to those who are not exposed.

- A study looking at breast cancer in women compared cases with non- cases, and found that 75/100 cases did not use calcium supplements compared with 25/100 of the non-cases.

1) Develop a table to display the data.

2) Calculate the odds of exposure in cases and non-cases.

	osteoporosis	No osteoporosis	Total
No Calcium supplements	75	25	100
Calcium supplements	25	75	100

$$OR = \frac{75x\ 75}{25x\ 25} = 9.0$$

- Use the following table to calculate the attributable risk associated with taking a supplement containing folate during pregnancy:
- **Calculate RR**
- **Calculate OR**

	Neural tube defect	No	Total
No Folate	631	727	1358
Folate	24	563	587

	Neural tube defect	No	Total
No Folate	631	727	1358
Folate	24	563	587

OR = (631x563) / (24x 727) =