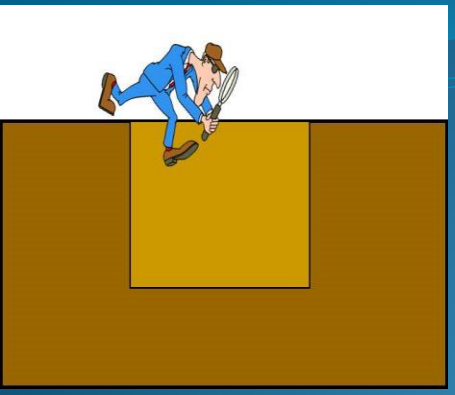
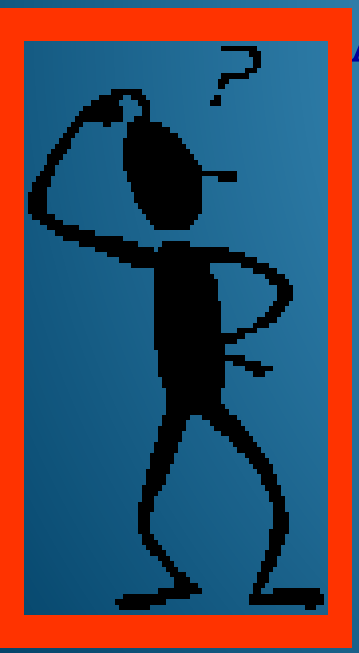


ANALYTIC EPIDEMIOLOGY

L10



Associate Professor Dr. Eman A. Al-Kamil

Dep. Of Community Medicine

Collage of Medicine

Hashemite University

Learning Objectives:

At the end of this lecture ,the student is able to:

1. Describe the difference between descriptive and analytic epidemiologic studies in terms of information/evidence provided for medicine and public health.
2. to estimate the differences or variations in the occurrence of diseases or health related events regarding exposure.
3. Give explanations for these variations.
4. Understand the role of analytic epidemiology in describing the population and helping in the exploration of variation to aid in the planning of the health services.
5. Understand the association between risk factors and the outcome, and the criteria of association.

- We search for the determinants of health outcomes, first, by relying on descriptive epidemiology to generate hypotheses about associations between exposures and outcomes.

- Analytic studies are then undertaken to test specific hypotheses.

- Samples of subjects are identified and information about exposure status and outcome is collected.

- The essence of an analytic study is that groups of subjects are compared in order to estimate the magnitude of association between exposures and outcomes.

ANALYTIC EPIDEMIOLOGY

Investigating a hypothesis about the cause of disease by studying how exposures relate to disease.

DEFINITION OF BASIC TERMS

Risk: A probability that an individual will become ill or die within a specified period of time or age. It is used to denote incidence rate.

Risk factor: is a variable associated with an increased risk of disease or infection. Sometimes, **determinant** is also used, being a variable associated with either increased or decreased risk.

Risk factors

- A risk factor refers to an aspect of personal habits or an environmental or occupational exposure, nutritional factors, that is associated with an increased probability of occurrence of a disease.

- Since risk factors can usually be modified, intervening to alter them in a favorable direction can reduce the probability of occurrence of disease.

- The impact of these interventions can be determined by repeated measures using the same methods and definitions.

- Risk factors can include tobacco and alcohol use, diet, physical inactivity, blood pressure and obesity ect. .....

- Since risk factors can be used to predict future disease, their measurement at a population level is important.

Relative risk (RR): is a measure of strength of association between an exposure and an outcome.

Its value is an indicator of the significance of the exposure in the etiology of the outcome.

The relative risk is calculated by relating the incidence rate (IR) of the disease among those exposed to the risk factor to the incidence rate of the disease among those not exposed.

$$\text{Relative risk (RR)} = \frac{\text{Incidence rate among exposed}}{\text{Incidence rate among non exposed}}$$

The value of the relative risk depends on the difference in the incidence rates of the disease in the two groups (exposed group and non exposed group).

a. If the value is 1, then no association exists,
b. if it is below 1, the factor may be protective,
c. when it is greater than 1 , then the association exists and positive.

The greater the value of the relative risk is, the stronger the association is and the more likely that the association is causal.

Incidence rate (IR) of lung Ca among smokers is 100/1000, IR of lung Ca among non -smokers is 20/1000,

$$\textbf{Relative risk} = \frac{100}{20} = 5$$

{ RR >1) ⟹ **there is association between** smoking and lung Ca}

This means that smokers develop lung Ca 5 times more than non- smokers

Attributable risk (AR):

It refers to the fraction of the incidence rate of the disease that can be attributed to the exposure to the risk factor.

It is calculated by the following formula:

Attributable risk (AR) = IR among exposed – IR among non exposed .

The significance of the attributable risk is that it gives an idea about the expected gain in health and life or the expected reduction in incidence rate if the risk factor is eliminated.

$$\text{Percentage reduction} = \frac{\text{IR among exposed} - \text{IR among non exposed}}{\text{IR among exposed}} \times 100$$

The expected reduction can be expressed as percentage out of the incidence rate among the exposed (Attributable risk proportion) as follows:

IR of lung Ca among smokers is 100/1000, IR of lung Ca among non- smokers is 20/1000,

AR = 100-20= 80/1000

Smoking attributed to 80/1000 cases of lung Ca.

$$\text{Percentage reduction} = \frac{80}{100} \times 100 = 80\ \%$$

That means , we can prevent 80% of lung ca by preventing smoking, or by implementation of smoking cessation program we prevent 80% of lung Ca among smokers.

prospective study : is a type of **study** where participants are enrolled into the study before they develop the disease or outcome under study and follow up for a period of time (depend on the type of disease), to estimate the risk of exposure (incidence).

Retrospective: A **retrospective study** looks backwards and examines exposures to suspected risk or protection factors in relation to an outcome that is established at the start of the **study**

Association

A statistical (quantitative) dependence between two or more variables. Variables are said to be associated if they tend to occur together more frequently than could be explained by chance. The degree of association is determined by statistical tests.

Types of association:

A.statistical association

B. Biological association: Koch's Postulates

Types of statistical association:

a. Non causal when the apparent association is due to confounding process, when a third factor is related both to the risk factor (the cause) and the outcome or effect (the disease).

b. Causal which is either direct A ⟶ B

i.e,: vit. A deficiency causes night blindness

or indirect: A ⟶ B ⟶ C

Vit D deficiency causes osteoporosis , ⟶ bone fracture

Causal association

A statistical association is likely to be causal if the following criteria are fulfilled:

Epidemiological criteria (Bradford Hill criteria):

1. Strength of association, as measured by the relative risk
2. Dose-response relationship ,The larger the dose and or the longer the duration of exposure, the higher the risk of disease.
3. Time sequence, Temporality , Exposure comes before the outcome.
4. Experimental evidence, Elimination of risk factor reduces or eliminates the disease.

5. Consistency, Different studies have similar results regarding the association.

6. Coherence: Coherence between epidemiological and laboratory findings increases the likelihood of an effect. However, Hill noted that "... lack of such [laboratory] evidence cannot nullify the epidemiological effect on associations.

7. Biological plausibility, Is the association consistent with another knowledge? (mechanism of action; evidence from experimental animals)

8. Specificity, The outcome or disease occurs only in relation to the risk factor..

Strength of association

- Measures of association"
  used to quantify the strength of the association between an exposure and outcome
  e.g. Relative risk, odds ratio

- Strong associations are more likely to be causal than weak associations
  The larger the relative risk (RR) or odds ratio (OR), the greater the likelihood that the relationship is causal.

- Weak associations are more likely to be explained by undetected biases or confounders

- How large must a relative risk or odds ratio be to be considered 'strong':
  - 2 ? 4 ? 20 ? .....?

- No universal agreement regarding what constitutes a 'strong' or 'weak' association
  - An OR or RR > 2.0 is 'moderately strong'
  - An OR or RR > 5.0 is 'strong'

- The relationship between smoking and lung cancer is an excellent example of a 'strong association'

  - odds ratios and relative risks in different studies are in the 4 to 20 range

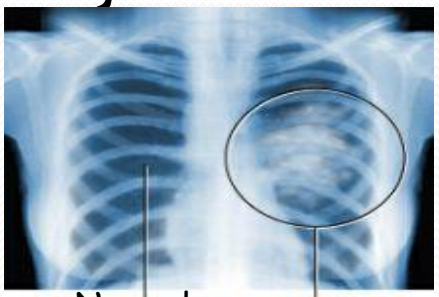
Time sequence ,Temporality:

- Exposure comes before the outcome.
- This refers to the necessity for the exposure to precede the outcome (effect) in time.
- Any claim of causation must involve the cause preceding in time the presumed effect

- Easier to establish in certain study designs
  - Prospective cohort study
- Lack of temporality rules out causality

Exposure

TIME

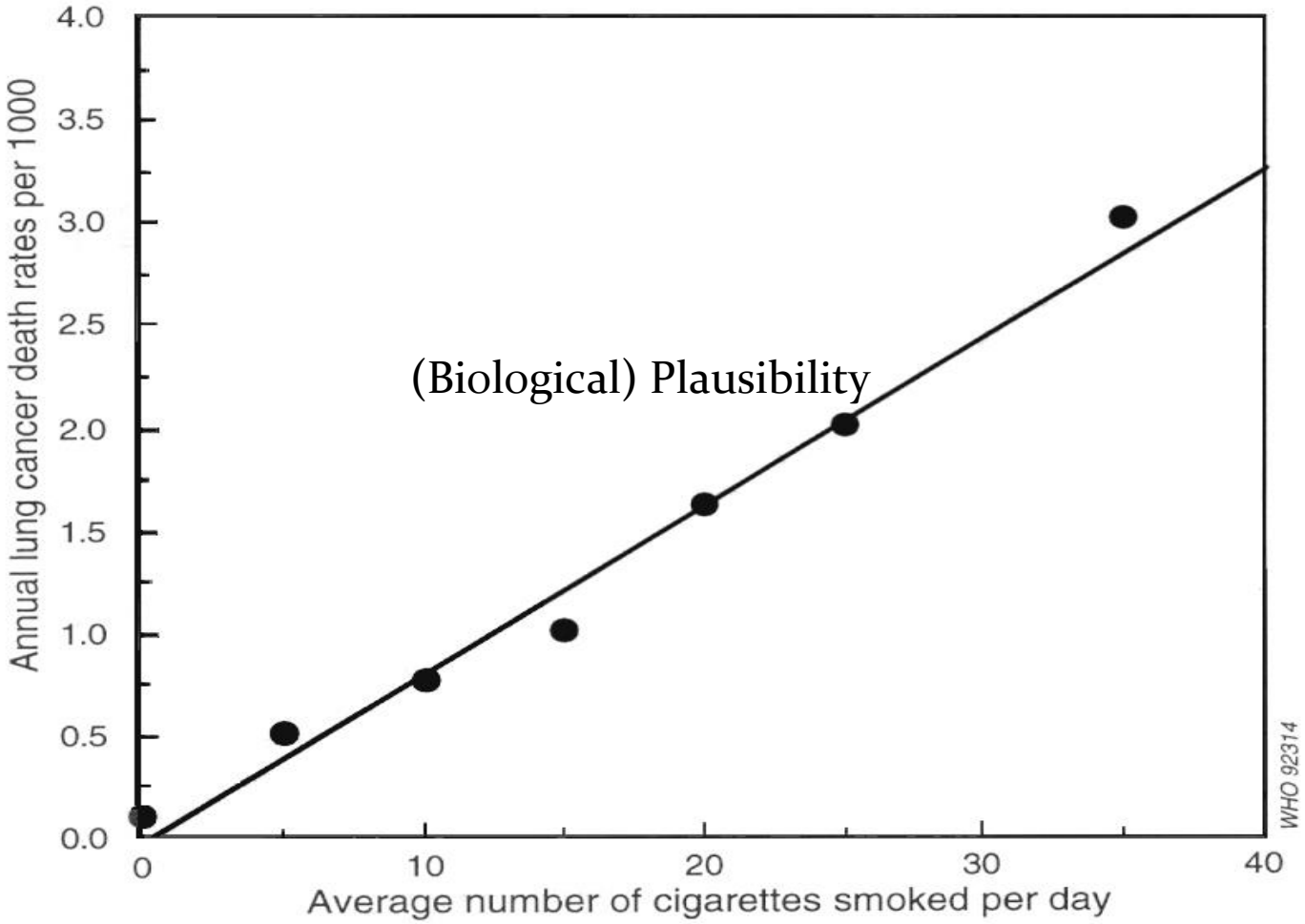


Outcome

Dose-response relationship

- Dose-response ('biological gradient') the relationship between the amount of exposure (dose) to a substance and the resulting changes in outcome (response)
- If an increase in the level of exposure increases the risk of the outcome.
- this strengthens the argument for causality.

Death rates from lung cancer (per 1000) by number of cigarettes smoked, British doctors, 1951–1961



(Biological) Plausibility

(Biological) Plausibility

Plausibility refers to the biological plausibility of the hypothesized causal relationship between the exposure and the outcome

Is there a logical and plausible biological mechanism to explain the relationship?

OBSTETRICS

Maternal caffeine consumption during pregnancy and the risk of miscarriage: a prospective cohort study

Xiaoping Weng, PhD; Roxana Odouli, MSPH; De-Kun Li, MD, PhD

"A high dose of caffeine could constrict a mother's blood vessels reducing the blood flow to the placenta" (Biological Plausibility)

200 mg/day, and aHR of 2.23 (1.34 to 3.69) for intake of 200 or more. **Key words:** abortion, caffeine, mi

, and Li D-K. Maternal caffeine consumption during pregnancy and the risk of

anthine, is
uently in-
ctive sub-
ffeine can
rier to the

feine could have an adverse effect on fetal development. Indeed, caffeine intake has been reported to increase the risk of miscarriage.[7-10]

Although numerous studies on mater-

sources
caffeine
sources
mg per
for pregn

- Sometimes, "There is no accepted biological mechanism to explain the epidemiological results; indeed, the relation may be due to chance or confounding"

- **Biological gradient.** Is there a dose response?

- **Biological plausibility.** Does it make sense?

- **Coherence.** Does the evidence fit with what is known regarding the natural history and biology of the outcome?

- **Experimental evidence.** Are there any clinical studies supporting the association?
- **Reasoning by analogy.** Is the observed association supported by similar associations?

Consistency

Repeated observation of an association in studies conducted on different populations under different circumstances

If studies conducted by….

- different researchers
- at different times
- in different settings
- on different populations
- using different study designs
- ……all produce consistent results,
- this strengthens the argument for causation.

e.g. The association between cigarette smoking and lung cancer has been consistently demonstrated in several and different types of epidemiological study (ecological, case-control, cohort)

Is there a causal relationship between fluoride in water and bone fractures?

- 18 studies have investigated the association between hip fractures (outcome) and water fluoride level (exposure)
- 30 separate statistical analyses
- 14 analyses produced a 'positive association'
- 13 analyses produced a 'negative association'
- 3 'no association'
- The inconsistency of these results casts doubt on the hypothesised causal relationship between fluoride in water and bone fractures

- The usual approach in epidemiology is to begin with a disease and search for its causes, although it is also possible to start with a potential cause (such as air pollution) and search for its effects.

- For example, social class is associated with a range of health problems.
- Low social class, as measured by income, education, housing and occupation, leads to a general susceptibility to poor health, rather than to a specific effect.

- A range of specific causes of disease could explain why poor people have poor health, among them excessive exposure to infectious agents due to overcrowding, lack of clean water and sanitation, insufficient and unsafe food, and dangerous working conditions.

Thank You