

EPIDEMIOLOGY II

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Epidemiological Approach

Asking Questions

Making Comparisons

Asking Questions

RELATED TO HEALTH EVENTS

- a. What is the event ?
(the problem)
- b. What is its magnitude?
- c. Where did it happen?
- d. When did it happen?
- e. Who are affected?
- f. Why did it happen?

RELATED TO HEALTH ACTION

- a. What can be done to reduce this problem and its consequences ?
- b. How can it be prevented in the future ?
- c. What action should be taken by the community ?
By the health services? By other sectors ? Where and for whom these activities be carried out ?
- d. What resources are required ? How are the activities to be organized ?
- e. What difficulties may arise, and how might they be overcome?

Answer to the above questions may provide clues to disease aetiology, and help the epidemiologist to guide planning and evaluation

Making Comparisons.....1

- ❖ The basic approach is to make comparisons and draw inferences.
 - ❖ This may be comparison of two (or more groups) –
 - ❖ one group having the disease (or exposed to risk factor) and
 - ❖ the other group(s) not having the disease (or not exposed to risk factor),
 - ❖ or comparison between individuals.
- ❖ By making comparisons, the epidemiologist tries to find out
 - ❖ the crucial differences in the host and environmental factors
 - ❖ between those affected and not affected.
- ❖ In short the epidemiologist weighs, balances and contrasts.
- ❖ Clues to aetiology come from such comparisons.

Making Comparisons.....2

- ❖ First consideration before making comparisons –
 - ❖ ensure what is known as "comparability" between the study and control groups.
 - ❖ "like can be compared with like".
- ❖ For facts to be comparable,
 - ❖ must be accurate, and
 - ❖ must be gathered in a uniform way.
- ❖ Randomization or Random allocation
- ❖ "Matching" is done for selected characteristics that might confound the results.
- ❖ Another alternative is Standardization
- ❖ International comparisons may be difficult because
 - ❖ differences in terminology
 - ❖ requires standardization of definitions, classifications, criteria and nomenclature

Measurements in Epidemiology

- a. Measurement of mortality
- b. Measurement of morbidity
- c. Measurement of disability
- d. Measurement of natality
- e. Measurement of the presence, absence or distribution of
 - the characteristic or attributes of the disease
- f. Measurement of
 - medical needs, health care facilities, utilization of health services and other health-related events
- g. Measurement of the
 - presence, absence or distribution of the environmental and other factors causing the disease
- h. Measurement of demographic variables.

Tools of Measurement

- ❑ Rate: Measures the occurrence of some particular event
 - ❑ In a population during a given time period
 - ❑ It is a statement of the risk of developing a condition.
 - ❑ It indicates the change in some event that takes place in a population *over* a period of time.

- ❑ Ratio: Expresses a relation in size between two random quantities.
 - ❑ The numerator is not a component of the denominator

- ❑ Proportion: A proportion is a ratio
 - ❑ Which indicates the relation in magnitude of a part of the whole.
 - ❑ The numerator is always included in the denominator.
 - ❑ A proportion is usually expressed as a percentage.

Incidence.....1

"the number of NEW cases occurring in a defined population during a specified period of time".

Number of new cases of specific disease during a given time period

$$= \frac{\text{Number of new cases of specific disease during a given time period}}{\text{Population at-risk during that period}} \times 1000$$

- a. only new cases
- b. during a given period (usually one year)
- c. in a specified population or "population at risk", unless other denominators are chosen.
- d. it can also refer to new spells or episodes of disease arising in a given period of time,
 - per 1000 population

Incidence2

Special Incidence Rates

- ❖ *Attack rate* : is an incidence rate (usually expressed as a per cent), used only when the population is exposed to risk for a limited period of time such as during an epidemic.
 - ❖ It relates the number of cases in the population at risk and
 - ❖ reflects the extent of the epidemic
- ❖ *Secondary Attack Rate* : number of exposed persons developing the disease
 - ❖ within the range of the incubation period following exposure to a primary case

USES of Incidence

- ❖ (a) to control disease, and
- ❖ (b) for research into aetiology and pathogenesis, distribution of diseases, and
 - ❖ efficacy of preventive and therapeutic measures

Prevalence

All current cases (old and new)

- existing at a given point in time, or
- over a period of time
- in a given population

(a) Point prevalence (b) Period prevalence

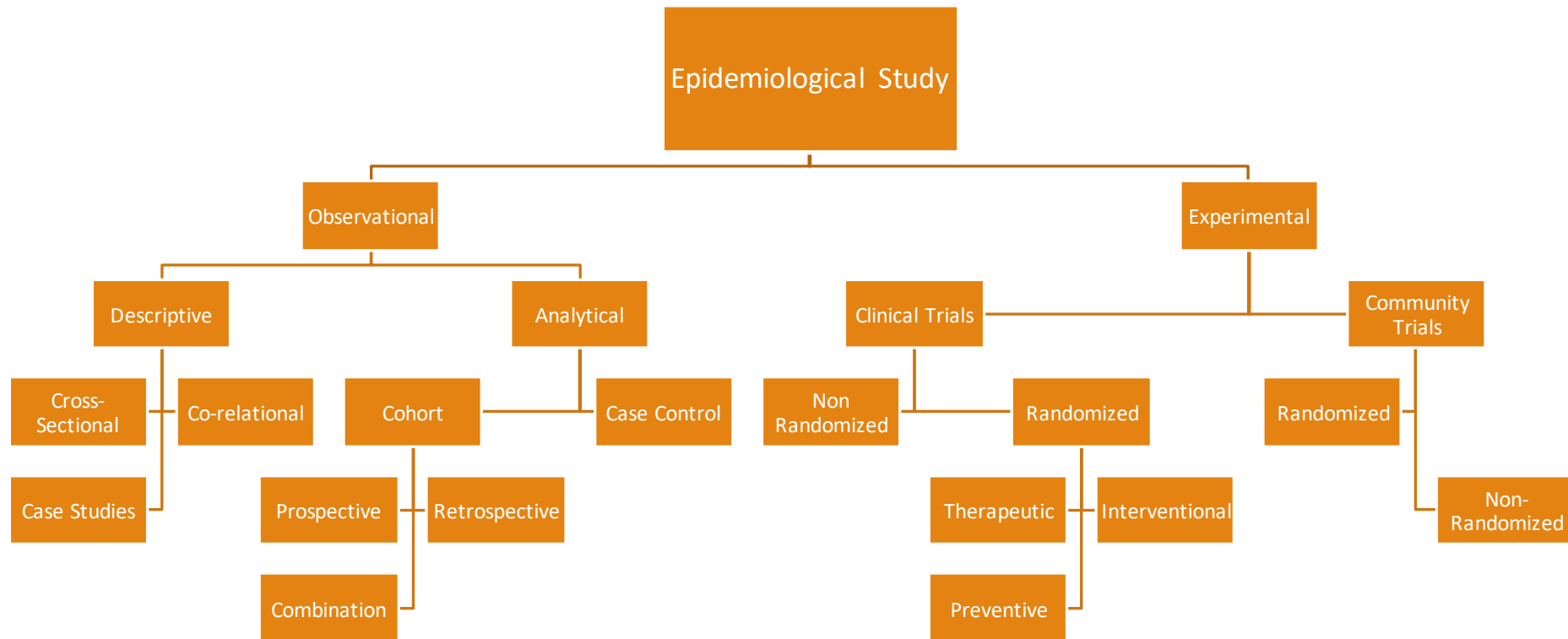
$P = I \times D$ = incidence x mean duration

USES of Prevalence

(a) Prevalence helps to estimate the magnitude of health/ disease problems in the community, and identify potential high-risk populations

(b) Prevalence rates are especially useful for administrative and planning purposes, e.g., hospital beds, manpower needs, rehabilitation facilities, etc.

Epidemiological Study Type



Descriptive Studies.....1

Procedures in descriptive studies

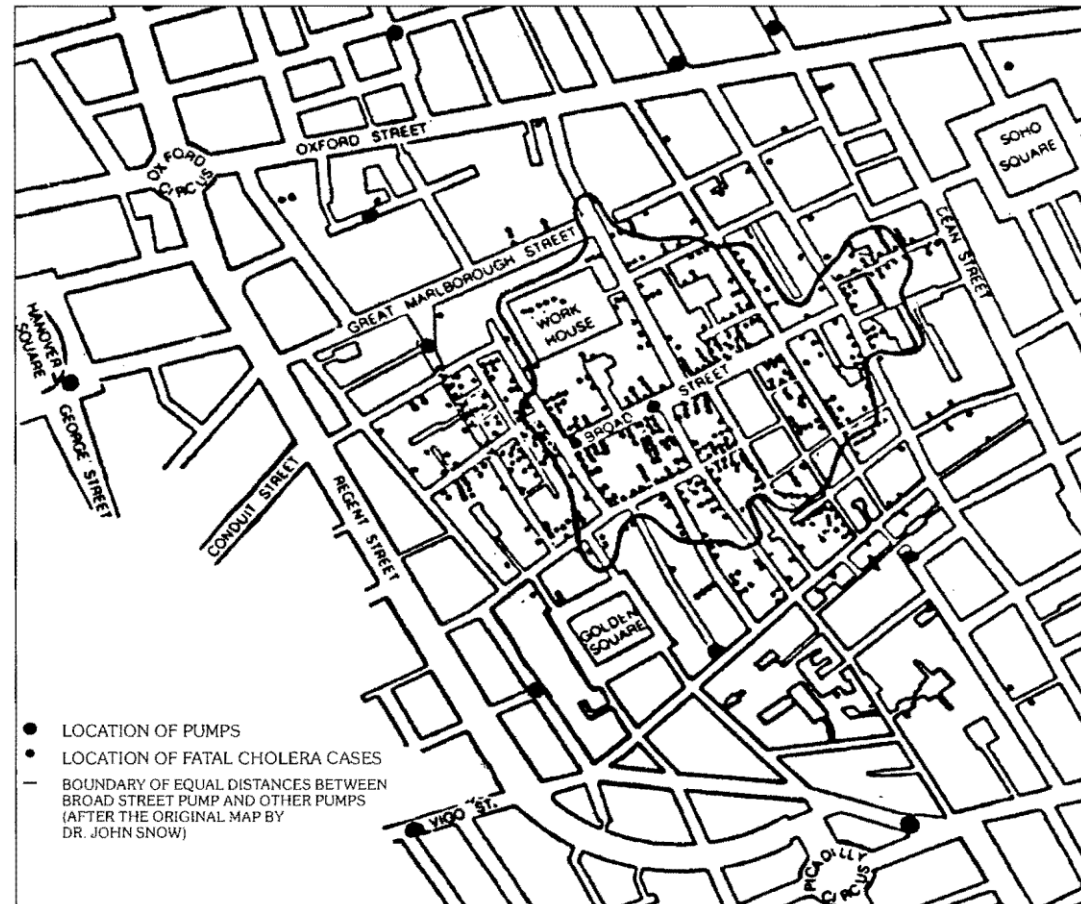
1. Defining the population to be studied
2. Defining the disease under study
3. Describing the disease by
 - a. time
 - b. place
 - c. person
4. Measurement of disease
5. Comparing with known indices
6. Formulation of an aetiological hypothesis

Descriptive Studies.....2

Characteristics frequently examined
in descriptive studies

Time	Place	Person	
Year, season	Climatic zones	Age	Birth order
Month, week	Country, region	Sex	Family size
Day, hour of onset,	Urban/rural Local community	Marital state	Height Weight
Duration	Towns Cities Institutions	Occupation Social status Education	Blood pressure Blood cholesterol Personal habits

Cholera in London: 1854 – John Snow



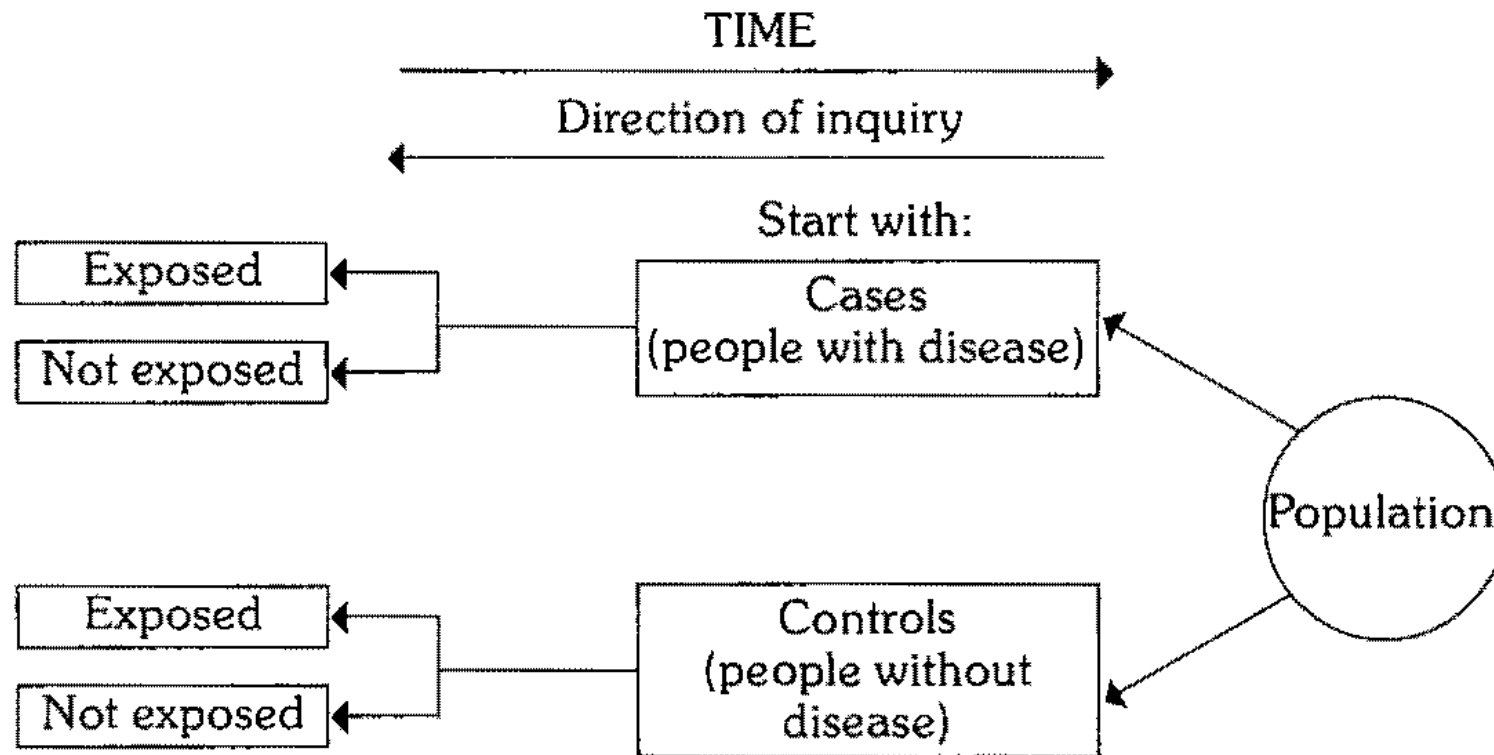
Formulation of Hypothesis

- a. the population the characteristics of the persons to whom the hypothesis applies
- b. the specific cause being considered
- c. the expected outcome - the disease
- d. the dose-response relationship - the amount of the cause needed to lead to a stated incidence of the effect
- e. the time-response relationship the time period that will elapse between exposure to the cause and observation of the effect.

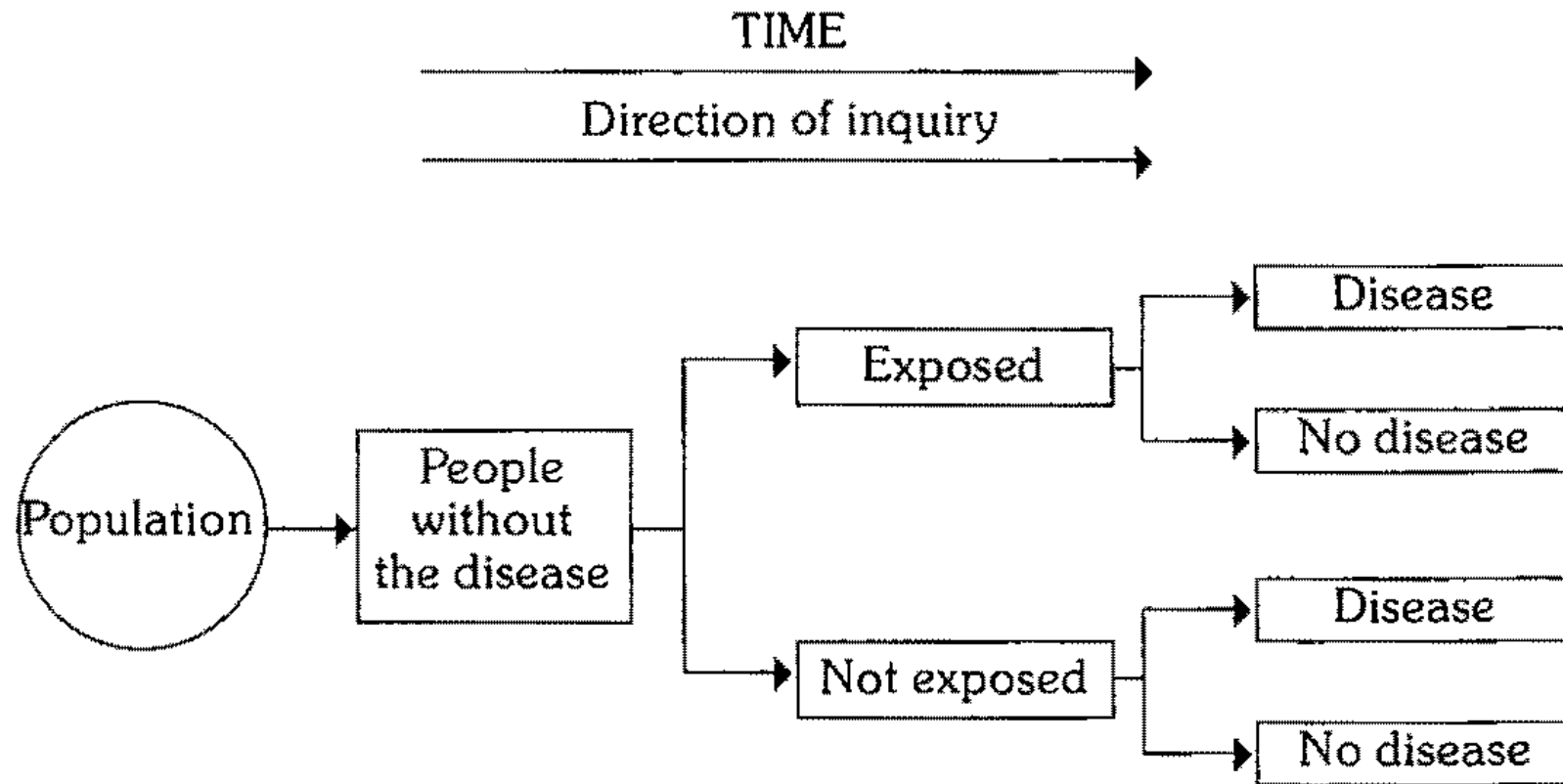
Uses of Descriptive Epidemiology

- (a) Provide data regarding the magnitude of the disease load and types of disease problems in the community in terms of morbidity and mortality rates and ratios
- (b) Provide clues to disease aetiology, and help in the formulation of an aetiological hypothesis.
- (c) Provide background data for planning, organizing and evaluating preventive and curative services
- (d) Contribute to research by describing variations in disease occurrence by time, place and person.

Case Control Study Design



Cohort Study Design



Case Control: Three Distinct Features

- a. both exposure and outcome (disease) have occurred before the start of the study
- b. the study proceeds backwards from effect to cause;
- c. it uses a control or comparison group to support or refute an inference.

Framework of a case control study
(The 2×2 contingency table)

Suspected or risk factors	Cases (Disease present)	Control (Disease absent)
Present	a	b
Absent	c	d
	a+c	b+d

Basic steps

There are four basic steps in conducting a case control study :

1. Selection of cases and controls
2. Matching
3. Measurement of exposure, and
4. Analysis and interpretation.

Case Control: Analysis

- (a) Exposure rates among cases and controls to suspected factor
- (b) Estimation of disease risk associated with exposure (Odds ratio)

A case control study of smoking and lung cancer

	Cases (with lung cancer)	Controls (without lung cancer)	Total
Smokers (less than 5 cigarettes a day)	33 (a)	55 (b)	88 (a+b)
Non-smokers	2 (c)	27 (d)	29 (c+d)
Total	35 (a+c)	82 (b+d)	n = a+b+c+d

Source : (34)

Exposure rates

- a. Cases = $a/(a+c) = 33/35 = 94.2$ per cent
 - b. Controls = $b/(b+d) = 55/82 = 67.0$ per cent
- $P < 0.001$

	Diseases	
	Yes	No
Exposed	a	b
Not exposed	c	d
Odds ratio = ad/bc		

Using the data in Table 12, the odds ratio would be estimated as follows :

$$\begin{aligned}
 \text{Odds ratio} &= \left(\frac{a}{b} \right) / \left(\frac{c}{d} \right) = \frac{ad}{bc} \\
 &= \frac{33 \times 27}{55 \times 2} = 8.1
 \end{aligned}$$

Case Control: Advantages

1. Relatively easy to carry out.
2. Rapid and inexpensive (compared with cohort studies).
3. Require comparatively few subjects.
4. Particularly suitable to investigate rare diseases or diseases about which little is known. But a disease which is rare in the general population (e.g., leukaemia in adolescents) may not be rare in special exposure group (e.g. prenatal X-rays).
5. No risk to subjects.
6. Allows the study of several different aetiological factors (e.g., smoking, physical activity and personality characteristics in myocardial infarction).
7. Risk factors can be identified. Rational prevention and control programmes can be established.
8. No attrition problems, because case control studies do not require follow-up of individuals into the future.
9. Ethical problems minimal.

Case Control: Disadvantages

1. Problems of bias relies on memory or past records, the accuracy of which may be uncertain; validation of information obtained is difficult or sometimes impossible.
2. Selection of an appropriate control group may be difficult.
3. We cannot measure incidence, and can only estimate the relative risk.
4. Do not distinguish between causes and associated factors.
5. Not suited to the evaluation of therapy or prophylaxis of disease.
6. Another major concern is the representativeness of cases and controls.

Cohort: Three Distinct Features

- a. the cohorts are identified prior to the appearance of the disease under investigation
- b. the study groups, so defined, are observed over a period of time to determine the frequency of disease among them
- c. the study proceeds forward from cause to effect.

Framework of a cohort study

Cohort	Disease		Total
	yes	no	
Exposed to putative aetiologic factor	a	b	a + b
Not exposed to putative aetiologic factor	c	d	c + d

The elements of a cohort study are :

1. Selection of study subjects
2. Obtaining data on exposure
3. Selection of comparison groups
4. Follow-up, and
5. Analysis.

Cohort: Analysis

- (a) Incidence rates of outcome among exposed and nonexposed,
- (b) Estimation of risk.

Contingency table applied to hypothetical cigarette smoking and lung cancer example

Cigarette smoking	Developed lung cancer	Did not develop lung cancer	Total
Yes	70 (a)	6930 (b)	7000 (a + b)
No	3 (c)	2997 (d)	3000 (c + d)

Incidence rates

(a) among smokers = $70/7000 = 10$ per 1000

(b) among non-smokers = $3/3000 = 1$ per 1000

Statistical significance : $P < 0.001$

RELATIVE RISK

Relative risk (RR) is the ratio of the incidence of the disease (or death) among exposed and the incidence among non-exposed. Some authors use the term “risk ratio” to refer to relative risk.

$$RR = \frac{\text{Incidence of disease (or death) among exposed}}{\text{Incidence of disease (or death) among non-exposed}}$$

In our hypothetical example (Table 18)

$$RR \text{ of lung cancer} = \frac{10}{1} = 10$$

Cohort: Attributable Risk

ATTRIBUTABLE RISK

Attributable risk (AR) is the difference in incidence rates of disease (or death) between an exposed group and non-exposed group. Some authors use the term “risk difference” to attributable risk.

Attributable risk is often expressed as a per cent. This is given by the formula :

$$= \frac{\text{Incidence of disease rate among exposed} - \text{incidence of disease rate among non-exposed}}{\text{Incidence rate among exposed}} \times 100$$

Attributable risk in our example (Table 18) would be :

$$\frac{10 - 1}{10} \times 100 = 90 \text{ per cent}$$

Cohort : Advantages

- (a) Incidence can be calculated.
- (b) Several possible outcomes related to exposure can be studied simultaneously
- (c) Cohort studies provide a direct estimate of relative risk.
- (d) Dose response ratios can also be calculated
- (e) Since comparison groups are formed before disease develops, certain forms of bias can be minimized like mis-classification of individuals into exposed and unexposed groups.

Cohort: Disadvantages

(a) Cohort studies involve a large number of people.

- They are generally unsuitable for investigating uncommon diseases or diseases with low incidence

(b) It takes a long time to complete the study and obtain results.

- It is difficult to keep a large number of individuals under medical surveillance indefinitely.

(c) Certain administrative problems such as

- loss of experienced staff, loss of funding and extensive record keeping are inevitable.

(d) It is not unusual to lose a substantial proportion of the original cohort.

- They may migrate, lose interest in the study or simply refuse to provide any required information.

(e) Selection of comparison groups representative of the exposed and unexposed segments of the population is a limiting factor.

- Those who volunteer for the study may not be representative of all individuals with the characteristic of interest.

(f) There may be changes in the standard methods or diagnostic criteria of the disease over prolonged follow-up.

- Once we have established the study protocol, it is difficult to introduce new knowledge or new tests later.

(g) Cohort studies are expensive.

(h) The study itself may alter people's behaviour.

(i) With any cohort study we are faced with ethical problems of varying importance.

- As evidence accumulates about the implicating factor in the aetiology of disease, we are obliged to intervene and if possible reduce or eliminate this factor

(j) Practical considerations dictate that we must concentrate on limited factors possibly related to disease outcome.

Main differences between case control and cohort studies

Case control study	Cohort study
1. Proceeds from “effect to cause”.	Proceeds from “cause to effect”.
2. Starts with the disease.	Starts with people exposed to risk factor or suspected cause.
3. Tests whether the suspected cause occurs more frequently in those with the disease than among those without the disease.	Tests whether disease occurs more frequently in those exposed, than in those not similarly exposed.
4. Usually the first approach to the testing of a hypothesis, but also useful for exploratory studies.	Reserved for testing of precisely formulated hypothesis.
5. Involves fewer number of subjects.	Involves larger number of subjects.
6. Yields relatively quick results.	Long follow-up period often needed, involving delayed results.
7. Suitable for the study of rare diseases.	Inappropriate when the disease or exposure under investigation is rare.
8. Generally yields only estimate of RR (odds ratio).	Yields incidence rates, RR as well as AR.
9. Cannot yield information about diseases other than that selected for study.	Can yield information about more than one disease outcome.
10. Relatively inexpensive.	Expensive.