

BSc/CBE

INTRODUCTION TO EPIDEMIOLOGY

By H. Halwindi, *PhD*
School of Public Health

Course content

1. Definition
2. Aims of epidemiology
3. Approaches in epidemiology
4. Basic measure of disease frequency

What is Epidemiology?

The study of:

- how disease is distributed in population
- the factors that determine or influence this distribution.

Definition – Main premise

- ❑ Disease, illness and ill-health not randomly distributed in population.
- ❑ Individuals have characteristics that predispose to or protect from disease.
 - Genetic, environmental, etc.

Common components in defining epidemiology

◆ Definition variances

◆ Three components common to all:

1. Studies of disease frequency
2. Studies of the distribution
3. Studies of determinants

1. Study of Disease Frequency

- Epidemiology concerned with:
 - measurement of frequency of disease.
 - measurement of frequency of disability.
 - Summarising info → rates and ratios.
 - E.g. Prevalence, death rate, incidence.

.... Disease frequency....

□ Basic measure of disease frequency:

- Rates
- Ratios

□ Importance of rates & ratios:

- ✓ Comparison of disease frequency in different populations or pop. Subgroups.
- ✓ Comparison of disease frequency vis-à-vis suspected risk factors
- Important clues of disease aetiology

.... Importance of rates & ratios....

Epidemiology also concerned with measurement of health related events and states

- Health needs
- Health demands
- Health activities
- Health care utilization

- Blood pressure
- Serum cholesterol levels
- Height/ weight

2. Study of Disease Distribution

Known fact

Disease not uniformly distributed in populations



Basic principal of epidemiological

Distribution of disease occurs in patterns



Role of epidemiology

Patterns can be identified



Patterns lead to hypotheses about cause

....Distribution of disease....

Thus important function of epidemiology:

➤ Study these distributions in various populations or subgroups of a population by

- Time
- Place
- Person

....study of distribution....

- i.e. Epidemiology determines whether:
 - ✓ Increase or decrease of disease over time.
 - ✓ Higher conc of disease in one geographical area.
 - ✓ Disease occurs more often in men or a particular age grp.
 - ✓ Characteristics of affected differ from those not affected.

3. Determinants of Disease

□ Epidemiology:

- Tests aetiological hypotheses.
- Identifies underlying causes or risk factors of disease.
 - This is analytical epidemiology.

□ Use of analytical epidemiology data:

- ✓ Development of scientifically sound health interventions, programmes and policies.

Aims of Epidemiology

Epidemiology has three main aims

1. To describe the distribution and magnitude of health and disease problems in human populations.
2. To identify aetiological factors (risk factors) in the pathogenesis of disease.
3. To provide the data essential to the planning, implementation and evaluation of services for prevention, control and treatment of disease and to the setting up of priorities among those services.

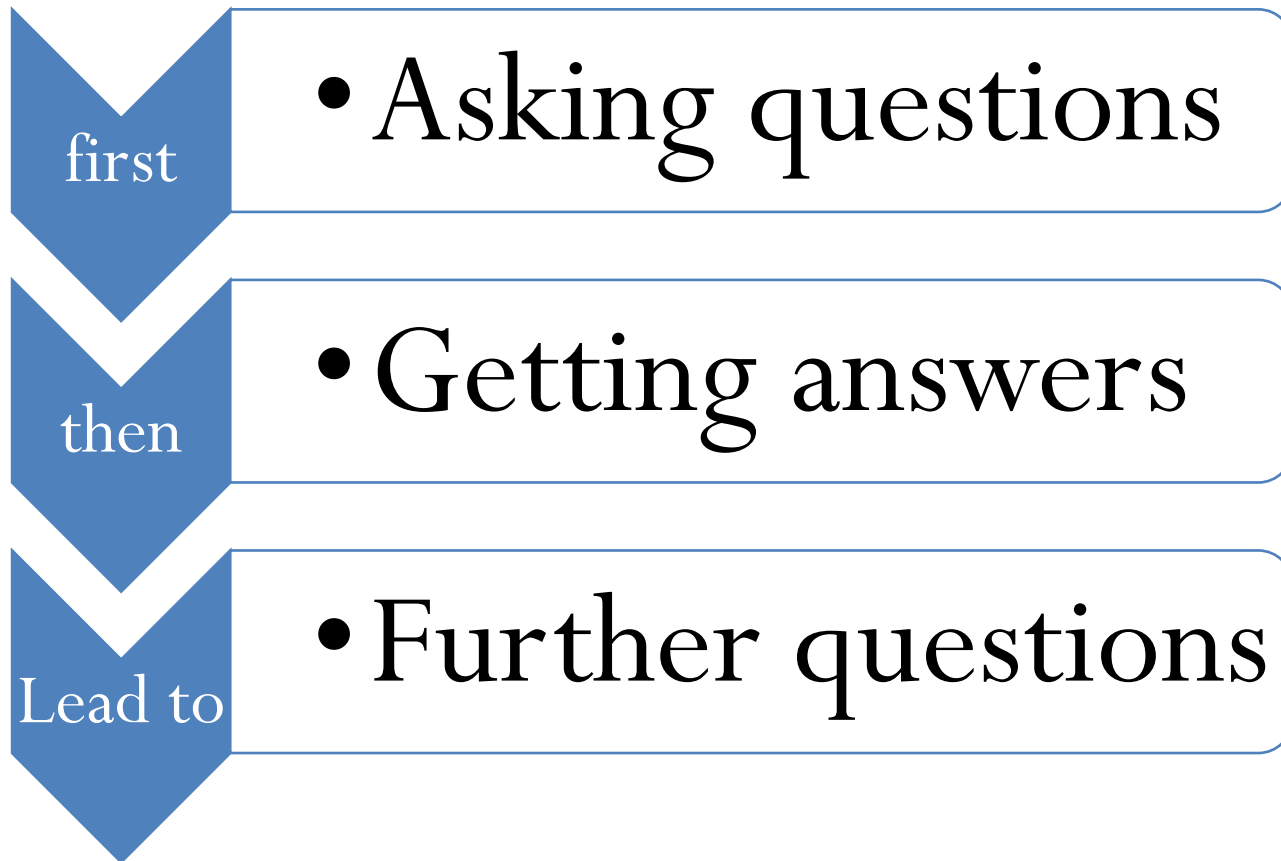
EPIDEMIOLOGICAL APPROACH

The two major foundations of epidemiological approach to problems of health and disease:

1. Asking questions
2. Making comparisons

1. Asking questions

Epidemiology a means of:



....examples of questions....

- Questions related to health events
 - ✓ What is the event or problem?
 - ✓ What is its magnitude?
 - ✓ Where did it happen?
 - ✓ When did it happen?
 - ✓ Who is affected?
 - ✓ Why did it happen?

....examples of questions....

❑ Questions related to health action

- ✓ What can be done to this problem to reduce its consequences?
- ✓ How can it be prevented in the future?
- ✓ What actions should be taken by the community, the health services, other sectors?
- ✓ What resources are required?
- ✓ What difficulties may arise?

Answers

Clues to disease aetiology

Guide planning and evaluation

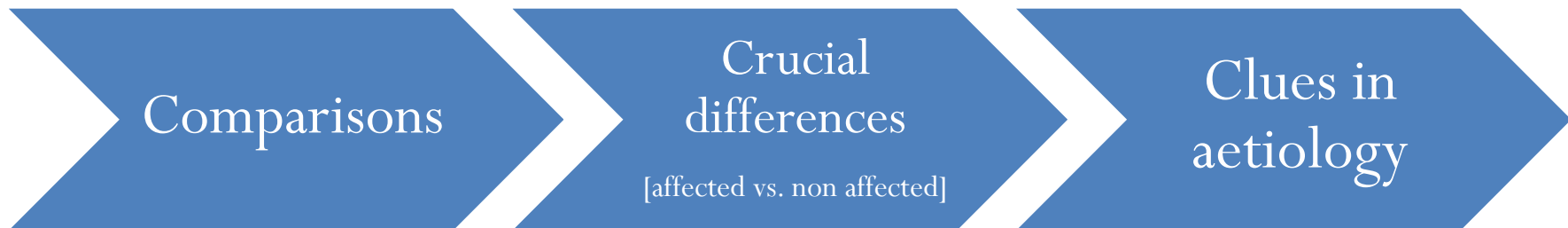
2. Making comparisons

□ The basic approach in epidemiology:

✓ Make comparisons between groups.

- Diseased vs. non-diseased
- Exposed vs. non-exposed
- Treated vs. untreated

✓ Draw inferences from the comparisons.



....important consideration in comparisons....

- ❑ The groups should be comparable.
 - ❑ Study group & control group should be similar.
 - ✓ Age
 - ✓ Sex
 - ✓ Disease severity
 - ✓ Race

- ❑ Common methods to ensure comparability
 - Randomization
 - Matching for selected characteristics
 - Standardization of definitions, classifications, criteria.

BASIC MEASUREMENTS IN EPIDEMIOLOGY

□ Scope of measurement in epidemiology is broad and includes measurements of:

❖ Mortality, morbidity and disability.

❖ Presence, absence or distribution of characteristics of disease

❖ Medical needs, health care facilities, utilization of services.

❖ Demographic variables

....requirement for measurement....

❑ Requirement for this measurement:

- To define what is to be measured
- Establish criteria or standards by which it can be measured.

❑ Definition must be:

- ❑ Precise and valid (help ID cases from non-cases).
- ❑ Acceptable and applicable for use in large populations.

Tools of measurements

Disease magnitude expressed as:

- Rate
- Ratio
- Proportion

1. RATE

- “500 deaths from motor vehicle accidents in city A during 2010”
 - Sufficient for administrators to provide necessary health services.
 - Not much meaning for epidemiologist interested in comparisons.
 - A rate allows such comparisons.

....rate....

- A rate measures occurrence of a particular event (disease/death) in a particular population during a given time period.
- A rate comprises:
 - Numerator (number of cases).
 - Denominator (population at risk or mid year population).
 - Time specification (calendar year).
 - Multiplier (1000) – included to avoid fractions.

....e.g. of rate....

$$\text{Death rate} = \frac{\# \text{ of deaths in 2010}}{\text{mid year population}} \times 1000$$

...ratio...

□ Other examples

- ✓ Sex ratio
- ✓ Doctor-population ratio
- ✓ Woman-child ratio
- ✓ Patient – bed ratio

3. PROPORTION

- Numerator is always included in the denominator.
- Usually expressed as a percentage.
- e.g.

$$\frac{\text{\# of children with scabies at a certain time}}{\text{total number of children in the village at the same time}} \times 100$$

....denominator of proportion....

- Denominator of proportions in epidemiology comprise:
 1. Mid-year population
 - Used because pop size changes daily due to:
 - Birth
 - Death
 - Migration
 - Mid-year pop estimate on 1st July of a year.

2. Population at risk

- Term applied to:

“all those to whom event could have happened whether it did or not”

- e.g.

- a. Rate of accidents for a town.

- Population at risk = all people in the town.

- b. Food poisoning investigation

- Population at risk = only those who ate the food

MORBIDITY MEASURES

- ❑ Morbidity is defined as “any departure from a state of physiological well being”.
 - ❑ Used equivalent to terms as sickness, illness, disability.

- ❑ Morbidity measured in terms of several units:
 - a. Persons who are ill.
 - b. The spells (short periods) of illness experienced.
 - c. The duration of these illnesses
 - d. Frequency (incidence and prevalence)
 - e. Severity

morbidity measures....

□ The value of morbidity data include:

- a. Describe extent and nature of disease load in community.....→.....prioritization.
- b. Provide comprehensive, accurate and clinically relevant information on patient characteristics.....→....useful for basic research.
- c. Serve as starting point for causation studies.....→....plays crucial role in prevention.
- d. Needed for monitoring and evaluation of disease control activities.

Basic Measures of Morbidity

Incidence

Prevalence

1. INCIDENCE

- Defined as “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 specified period of time

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

....incidence example....

- If there are 500 new cases of an illness in a population of 30,000 people in a year

500

- $I = \frac{500}{30,000} \times 1000 = 16.7$ per 1000 per year

- ✓ Measures the rate at which new cases are occurring in a population.
- ✓ Not influenced by duration of disease.
- ✓ Its use restricted to acute conditions.

Uses of incidence rate as health status indicator

Useful for taking action :

- a. To control diseases
- b. For research into aetiology, pathogenesis, distribution of disease and efficacy of preventive and therapeutic measures.

□ e.g. Rise in incidence rate may mean several things:

- ✓ failure of current control programs.
- ✓ Reporting practices have improved.
- ✓ Change in aetiology of disease, e.g. environmental characteristics

2. PREVALENCE

- “The proportion of all individuals who have a disease (or an attribute) at a particular point in time in relation to the population at risk.
 - Note: cases are both old and new.

$$P = \frac{\text{Number of existing cases}}{\text{Total population at risk}} \times 100$$

- This is point prevalence dealing with cases at one point in time.

Uses of prevalence

- ❑ Identification of high risk populations.
- ❑ Estimation of the magnitude of health problem.
- ❑ For administrative and planning purposes e.g. Hospital beds, manpower needs, drugs.

MEASUREMENT OF MORTALITY

❑ Mortality Data:

- ❑ Major resource for epidemiologist.
- ❑ Routine systems of collecting mortality data.
- ❑ Basis = death certificate.
 - Uniform and standardized system of recording and classifying deaths.
 - Ensures national and international comparability.

USES OF MORTALITY DATA

- ✓ Explaining trends & differentials in overall mortality.
- ✓ Prioritizing of health action & resource allocation.
- ✓ Designing intervention programmes.
- ✓ Assessment & monitoring of health problems & programs.

LIMITATIONS OF MORTALITY DATA

- ✓ Incomplete reporting of deaths.
- ✓ Inaccuracy of the data
 - ✓ E.g. on cause of death ← no diagnostic evidence, inexperience, lack of post-mortem.
- ✓ Choosing a single cause of death – the underlying cause (ignoring other causes)

Basic mortality rates & ratios

1. Crude death rate

No. of deaths during the year

$$CDR = \frac{\text{-----}}{\text{mid-year population}} \times 1000$$

- Limitations of CDR
 - Misses information on specific death rates e.g. by age group.

Population	CDR	Age-specific rates per 1000 population					
		<1	1-4	5-7	8-44	45-64	65+
A	15.2	13.5	0.6	0.4	1.5	10.7	59.7
B	9.9	22.6	1.0	0.5	3.6	18.8	61.1

basic mortality rates & ratio

2. Specific death rates

- ❑ Useful when focusing on aetiology of disease.
- ❑ Common examples:
 - a. Cause or disease specific – TB, Cancer, Malaria...
 - b. Group specific
 - Age specific
 - Sex specific
- ❑ Importance of specific rates
 - ✓ Identification of groups at risk.
 - ✓ Comparisons within and between populations.

basic mortality rates & ratio

3. Case fatality rate (ratio)

- ❑ Killing power of a disease.

Total no. of deaths due to a particular disease

$$CFR = \frac{\text{Total no. of deaths due to a particular disease}}{\text{Total number of cases due to the same disease}} \times 100$$

Total number of cases due to the same disease

- *CFR* typically used in acute infectious diseases (food poisoning, cholera, measles, etc).
- *CFR* of same disease may vary in different epidemics because of changes in host, environment or agent factors.

...basic mortality rates & ratios...

4. Proportional mortality rate (ratio)

- What proportion of deaths are due to a particular cause.
- What proportion of deaths are in a particular age group.

a. Proportional mortality from a specific disease:

$$\frac{\text{No. of deaths from the specific disease in a year}}{\text{Total deaths from all causes in that year}} \times 1000$$

b. Under-5 proportionate mortality rate:

$$\frac{\text{No. of deaths under 5 years of age in a given year}}{\text{Total deaths from all causes in that year}} \times 1000$$

FOR YOUR REFLECTIONS

- ◆ What is epidemiology?
- ◆ What is the main premise/assumptions of epidemiology?
- ◆ What are the main approaches in epidemiology?
- ◆ What are the uses of epidemiological data?
- ◆ What are the basic measurements in epidemiology?

THE END