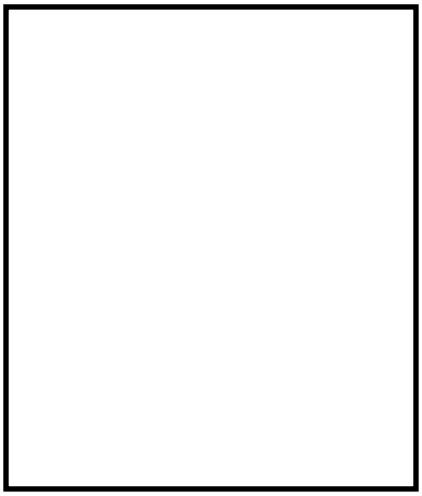
PRAVARA INSTITUTE OF MEDICAL SCIENCES (DEEMED TO BE UNIVERSITY)

RURAL MEDICAL COLLEGE, LONI

COMMUNITY MEDICINE
BIOSTATISTICS AND EPIDEMIOLOGY JOURNAL

Certificate of Completion



This is to certify that

Mr. _____

of the batch _____

has successfully completed Biostatistics and Epidemiology journal under Department of Community Medicine and has acquired the requisite competencies

Batch in charge **Head of the Department**

Basic Biostatistics

I N D E X

Completed / Not completed / Late **Signature of the Teacher in-charge**

INSTRUCTIONS FOR STUDENTS

- Read the Journal carefully and try to understand, do your own work in this Journal, don't copy from other student's Journal.
- Use graph papers for charts and graphs.
- Get the Journal checked and signed by teachers on same day. If you remain absent for particular practical then complete the Journal within one week after that practical.
- DO NOT COPY from other students' Journal. This is part of your study and internalization of the working concepts of the subject.
- You can use pocket calculator for calculations in the examinations.
- You have to carry the Journal for your oral examinations.

1. INTRODUCTION TO BIOSTATISTICS

Competency	Learning objectives	Assessment
CM6.2 Demonstration and exercises on the methods of data collection, classification, analysis, interpretation and presentation of statistical data	• Define biostatistics and know its applications. • Enumerate the common statistical terms • Enumerate the uses of Biostatistics	Written (MCQ, SAQ, LAQ)/ viva voce/ Skill assessment

Statistics is a science of figure

- **Statistic or datum** means *measured or counted fact* or piece of information stated as a figure such as

  e.g. height, age, weight, birth of a baby etc.

- **Statistics or data** would be plural of the same stated in more than one figures such as

  e.g. height of 10 persons,

- **Biostatistics: -** ***It is defined as an art & science of collection, compilation, presentation, analysis & logical interpretation of biological data which is affected by multiplicity of factors.***

- **Francis Galton (1822-1911) has been called the father of Biostatistics.** He was the first to apply statistical methods to the study of human differences and inheritance of intelligence, and introduced the use of Questionnaires and Surveys for collecting data on human communities, which he needed for genealogical and biographical works and for his anthropometric studies.

- **Types of biostatistics:-**

- **Medical Statistics:** Deals with the application of statistical methods to the study of disease, disability, efficacy of vaccine, a new regimen, etc.

  Example:

  1. Compare efficacy of a particular drug, operation or line of treatment.
  2. To find an association between 2 attributes such as cancer and smoking

- **Health Statistics:** Deals with application of statistical methods to varied information of public health importance.

  Example:

1. Test usefulness of sera and vaccines in the field- death/ attack among vaccinated and unvaccinated
2. Epidemiological study: role of causative factor is tested statistically- iodine deficiency causes goiter

- **Vital Statistics:** It is the ongoing collection by government agencies of data relating to vital events such as births, deaths, marriages, divorces and health and disease related states and events which are deemed reportable by local authorities.

❑ **Common statistical terms:**

- **Characteristics:** qualities and measurements of a person/ object.
- **Attribute:** a characteristic / label that is recorded as **text**
- **Variate /variable:** Characteristic which is recorded **as numerals**
- **Population**: It is an entire group of people or study elements – persons, things or measurements for which we have interest at a particular time. It is the sum total of all persons, objects or events about which we want to obtain information. E.g. if we want to collect information about disease status of employees of a factory, then all employees will form the population.
- **Sampling unit**: Each member of a population.
- **Sample**: It is a portion of population selected by a pre-decided and scientific method in such a way that it represents all units. A sample is used to make certain predictions and estimates about the population.
- **Parameter**: The constant which describes the population.
- **Statistic:** The constant which describes a sample
- Parametric tests
- Non parametric tests

❑ **USES OF BIOSTATISTICS:**

- **Four basic uses:**
    1. Making estimates based on observations made in sample
    2. Making forecast: making estimate about future based on the observations made presently. (trends in observations, rates of increase/ decrease in particular event)
    3. Deciding common/ uncommon/ rare observation and normal/abnormal
    4. Establishing relationship between two characteristics: Association and correlation

- **Uses of biostatistics for health administrator:**
    1. Making reasonable estimate of the problem
    2. Deciding priorities among various problems
    3. Making choice between different interventions
    4. Evaluating impact of intervention
    5. Programme planning and evaluation
    6. Forecasting the needs of various resources in future
    7. Establishing relationship between a suspected cause and the health problem
    8. Health education
- **Uses of biostatistics for a student in medicine:**
    1. Organization and planning of a clinical trial.
    2. Identification of syndromes by establishing associations and correlations.
    3. Establishing normal limits for various biological characteristics.
    4. Helpful for standardization of various techniques / instruments used for diagnosis
    5. To compare effect of two drugs or different doses of same drug
    6. Useful to find out sensitivity and specificity of a diagnostic test / kit
    7. Used to determine the risk factor for a disease

2. COLLECTION OF DATA

Competency	Learning objectives	Assessment
CM6.2 Demonstration and exercises on the methods of data collection, classification, analysis, interpretation and presentation of statistical data	• Enumerate the methods of data collection • Explain various sources of data collection • Explain How to minimize Mistakes and Errors during data collection	Written (MCQ, SAQ, LAQ)/ / viva voce/ Skill assessment

Introduction: Data collection is a crucial step in all scientific enquiries**.** Success of any statistical investigation depends upon the availability of accurate and reliable data. Collection of data is a very basic activity in decision making.

DATA COLLECTION METHODS:

1. **Measurement**: In this method the required information is collected by actual measurement in the object, element or person. If we are interested in hemoglobin percentage of the individuals, we actually measure the hemoglobin levels by appropriate method. The measurement and actual enumeration generates primary data.

2. **Questionnaire**: Here, a standardized and pre-tested questionnaire is given/sent and the respondents are expected to give the information by answering it. The success of this method depends on the quality of questionnaire, the enthusiasm of the respondents and the ability of the respondents to give accurate and complete information. By this method, the information about a large number of attributes and variates can be collected in a short time.

3. **Interview:** This method can be used as a supplement to the questionnaire or can be used independently. Here the information is collected by face to face dialogue with the respondents. The success of this method depends on the rapport established between the interviewer and the respondent, ability of the interviewer to extract the required information from the respondent and the readiness of the respondent to part with the information.

4. **Records**: Sometimes the information required can be available in various records like census, survey records, hospital records, service records, etc. The utility of the information depends on its uniformity, completeness, standardization, accuracy and the reasons for which the information was recorded.

Primary and Secondary data :

Data used in different studies is terms either ‘primary’ and ‘secondary’ depending upon whether it was collected specifically for the study in question or for some other purpose.

***Primary data*:** data which is collected under the control and direct supervision of the investigator *(investigator collects the data himself)* is called as primary data or direct data. (Direct or Primary method)

Secondary data*:* data, which is not collected by an investigator, but is derived from other sources, is called as secondary or indirect data (Indirect or Secondary method) Sources of Primary data: *Survey*

Sources of Secondary data:: *Published and Unpublished*

Published sources: National and International organizations which collects statistical data and publish their findings in terms of statistical reports etc.

N*ational Organizations**:* Census, Sample Registration System (SRS), National Sample Survey Organizations (NSSO), National Family Planning Association (NFPA), Ministry of health, Magazines, Journals, Institutional reports etc.

International Organizations: World Health Organization (WHO), United Nations Organizations (UNO), UNICEF, UNFPA, World Bank etc. Unpublished sources: Records maintained by various Govt. and private offices, studies made by research institutes, schools etc. This data based on internal records. Provides authentic statistical data and is much cheaper than primary data.

Sources for data collection:

1. Census
2. Registration of vital events
3. Sample registration system (SRS)
4. Notification of diseases
5. Hospital records
6. Epidemiological surveillance
7. Surveys
8. Research findings

The data that we collect from various sources should be:

Accurate: it measures true value of what is under study

Valid: it measures only what it is supposed to measure

Precise: it gives adequate details of the measurement

Reliable: it should be dependable

Mistakes and Errors during data collection:

Mistakes are faults which can be avoided and minimized. Mistakes are the faults committed due to: lack of skill, faulty observations, wrong recording and incorrect statistical calculations. These could be intra-observer or inter-observer.

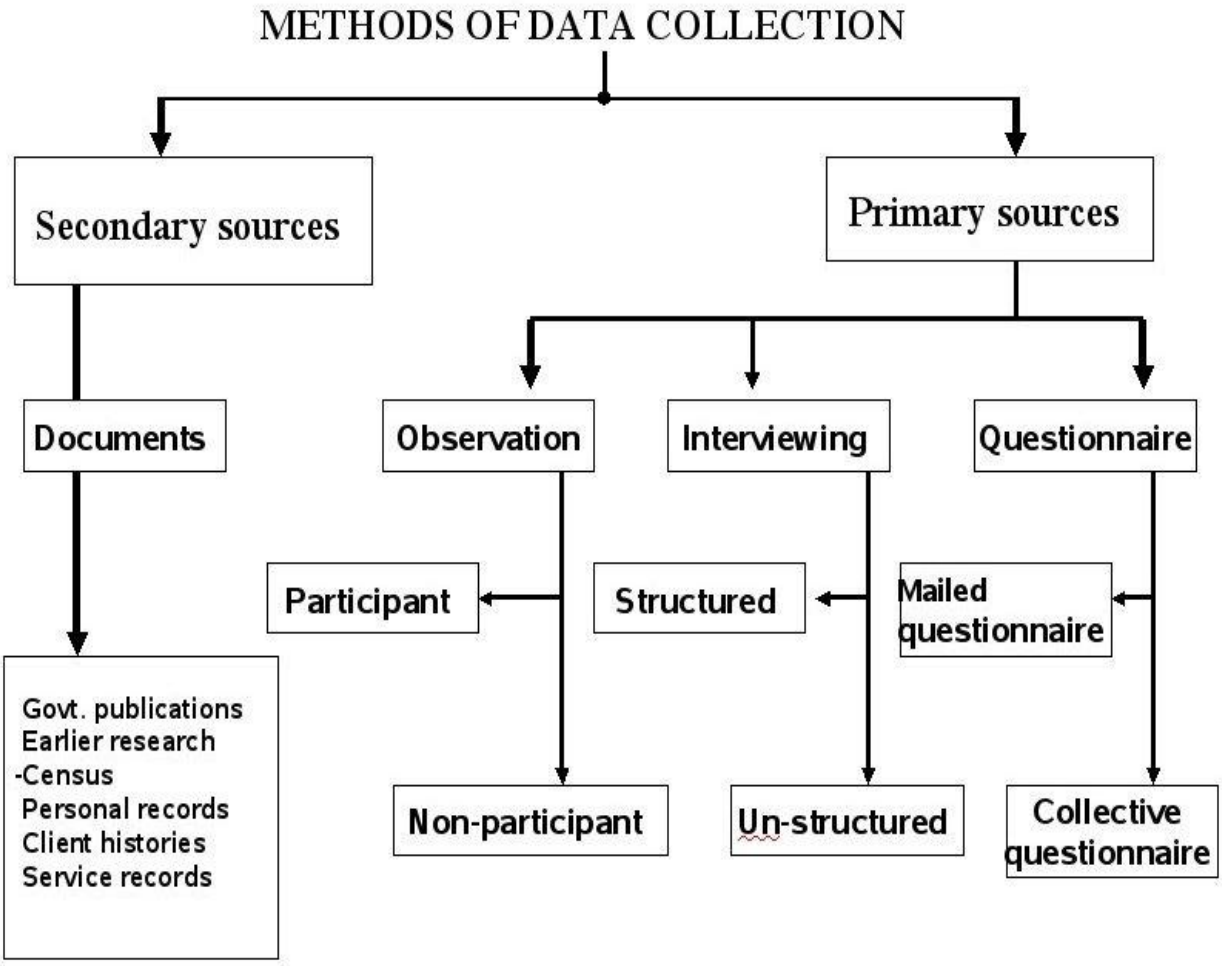
Errors are the faults which can be minimized only. The errors are of three

type:

1. **Instrumental error/technical error:** These are introduced as a result of faulty and unstandardized instruments, improper calibration, substandard chemicals, etc.
2. **Systematic error:** This is a repetitive error introduced due to a peculiar fault in the machine or technique.
3. **Random error:** This is introduced by changes in the conditions in which the observations are made or measurements are taken.

Errors and mistakes can be minimized by:

1. Using standard, calibrated instruments.
2. Using standardized, pre-tested questionnaire.
3. Using trained, skilled persons.
4. Using multiple observations and averaging them.
5. Using correct recording procedures.
6. Applying standard and widely accepted statistical manipulations.


METHODS OF DATA COLLECTION
Secondary sources
Primary sources
Documents
Observation
Interviewing
Questionnaire
Participant
Structured
Mailed questionnaire
Govt. publications
Earlier research
-Census
Personal records
Client histories
Service records
Non-participant
Un-structured
Collective questionnaire

3. Classification of data

Competency	Learning objectives	Assessment
CM6.2 Demonstration and exercises on the methods of data collection, classification, analysis, interpretation and presentation of statistical data	**The student should be able to** • Classify the data based on characteristics, source and continuous/ discrete • Identify the Scale of measurement for a particular variable	Written (MCQ, SAQ, LAQ)/ viva voce/ Skill assessment

The process of arranging data in different groups according to similarities is called as classification. The process of classification can be compared with the process of sorting out letters in post office.

❑ SIGNIFICANCE

Classification is fundamental to the quantitative study of any phenomenon. It is recognized as the basis of all scientific generalization and is therefore an essential element in statistical methodology.

❑ WHAT IS CLASSIFICATION?

Classification is a process of arranging a huge mass of heterogeneous data into homogeneous groups to know the salient features of the data.

❑ WHY CLASSIFICATION?

It facilitates comparison of data within and between the classes and it renders the data more reliable because homogeneous figures are separated from heterogeneous figures. It helps in proper analysis and interpretation of the data.

❑ Objectives

1. To condense the mass of data in such a way that salient features can readily noticed.

2. To compare two variables.

3. To prepare data this can be presented in tabular form.

4. To highlight the significance features of data at a glance.

5. It reveals pattern

6. It gives prominence to important figures.

7. It enables to analyze data.

8. It helps in drafting a report

Common types of classifications are: 1. Geographical i.e. according to area or region 2. Chronological i.e. according to occurrence of an event in time 3. Quantitative i.e. according to magnitude 4. Qualitative i.e. according to attributes

- **Classification of data:**

1) **Classification of data Based on characteristic/attribute: qualitative/ quantitative**
2) **Classification of data Based on source: primary/ secondary**
3) **Classification of data Discrete / continuous data**

1) Based on characteristic/attribute:

A. **Qualitative data:** Any statistical data, which are described only counting not by measurement, is called as qualitative data. Also known as enumeration/discrete/counted data

- It represents particular quality/attribute
- Characteristic or attribute cannot be measured but classified by counting the number of individual who is having the same characteristic
- Expressed as number without unit of measurement (only frequency, no measurement unit)
- Always discrete in nature i.e. whole number
- The statistical methods commonly employed in analysis of such data are standard error of **proportion** and chi square test.
- Example: Gender, Blood group, Births, Deaths, No. of patients suffering from a disease, SE classification such as Lower, middle and upper, No. of vaccinated, not vaccinated etc.

B. **Quantitative data:** Any statistical data, which are described both by measurement and counting is called as quantitative data. It is also known as continuous/measurement data

- Quantitative data have a magnitude
- The characteristic can be measured
- Two variable i.e. characteristic & frequency
- Expressed as number with or without unit of measurement

- Measurement can be **fractional** i.e. continuous e.g. chest circumference- 33 cm, 34.5 cm, 35.2 cm OR can be **discrete** whole numbers only e.g. blood pressure, pulse rate, blood sugar, respiratory rate
- The statistical methods employed in analysis of such data are mean, range, standard deviation, coefficient of variation and correlation coefficient.
- For example: Height, Weight, Pulse Rate, BP, BSL, Age, RR, Age, Income, etc.

Technical terms for quantitative classification:

a. Variable: a quantity which changes its values is called as variable. e.g. age, height, weight, etc *Continuous variable*: age, height, weight etc. *Discrete variable:* Population of a city, production of a machine, spare parts etc.

b. Class Limits: the lowest and highest value of the class are called as class limits.

c. Class frequency: the number of items belonging to the same class

d. Class magnitude or class interval: the length of class i.e. the difference between the upper limit and lower limit of the class.

2) **Classification of data Based on source: primary/ secondary**

A. Primary data:-

- These are the data obtained directly from an individual.
- Data derived from actual measurement
- It gives precise information.
- e.g. Height, Weight, disease of an individual interviewed is primary data

B. Secondary data:-

- These data obtained from outside source
- If we are studying hospital records and wish to use the census data, then census data becomes secondary data.

3) Classification of data Discrete / continuous data

Discrete data:

- Here we always get a whole number.
- e.g. no. of persons cured, no. of persons suffering from the disease

Continuous data:

Scales of measurement	Value assigned	Meaningful order	Meaningful interval in values	Meaningful ratios in values	Absolute zero	Possibility of negative values
Nominal data	Label/ Text	No	No	No	No	No
Ordinal data	Label / Text	Yes	No	No	No	No
Interval data	Numerical	Yes	Yes	No	No	Yes
Ratio data	Numerical	Yes	Yes	Yes	Yes	No

- Here there is possibility of getting fractions
- e.g. weight in kg can be 10.4, 43.5

❑ **Scales of measurement:**

- The concept of scale of measurement was first proposed by Staley Smith Stevens
- Each variable has a scale of measurement.
- Four types of scales used:
    i. Nominal scale
    ii. Ordinal scale
    iii. Interval scale
    iv. Ratio scale
- Each scale has name, value assigned, possibility of setting order, possibility of meaningful interval, possibility of absolute zero and possibility of negative values
- Qualitative data are measured either on a nominal or an ordinal scale.
- Quantitative data are measured on an interval or a ratio scale

- **Reasons of knowing the type of data and scales of measurement:**

1. Knowing the type of data will help in data presentation
2. You should know the type of data and scales of measurement to calculate the Descriptive statistics permissible for that particular data
3. Choice of inferential statistics (Test of significance) depends on the type of data and scales of measurement

4. PRESENTATION OF DATA

Competency	Learning objectives	Assessment
CM6.2 Demonstration and exercises on the methods of data collection, classification, analysis, interpretation and presentation of statistical data	**The student should be able to** • Enumerate principles and methods of Data Presentation • Prepare frequency distribution table, association table as per Rules and guidelines of tabular presentation • Present qualitative and quantitative data graphically	Written (MCQ, SAQ, LAQ)/ viva voce/ Skill assessment

Information collected from various sources is called as Raw data. Raw data does not lead to any understanding of the situation. Hence it should be compiled, classified and presented in a purposive manner to bring out important points clearly and strikingly.

- **Objectives of data presentation:** Data presentation can have one or more of the following objectives:

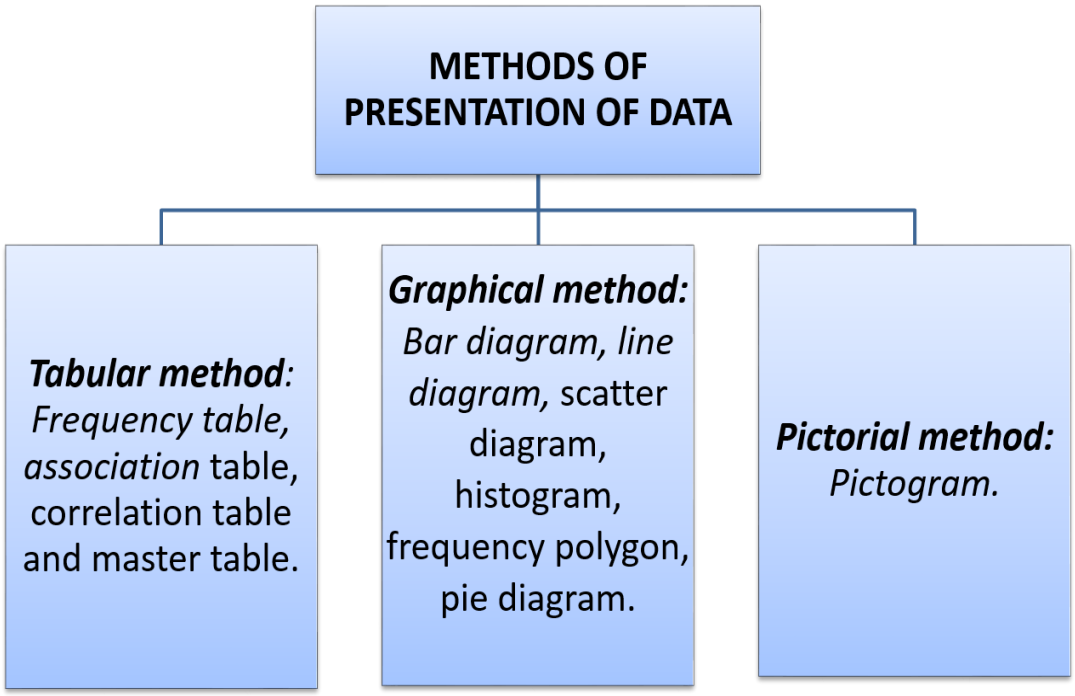
  1. It is a step before analysis/interpretation of the data.
  2. It involves reduction in the volume of the data. This facilitates the better understanding.
  3. When the data is presented in the form of tables, graphs or pictures it makes the data interesting.

- **Principles of Data Presentation:**

  It is a step before analysis/interpretation of the data.

1. The data should be arranged in such a way that it will arouse interest in a reader.
2. Data should be made sufficiently concise without losing important details.
3. The data should be presented in a simple form to enable the reader to form quick impressions and to draw some conclusions, directly or indirectly.
4. It should facilitate further statistical analysis.
5. It should define the problem and suggest its solution.

❑ **Methods of Data Presentation:**



➢ **Tabular Presentation of data:**

- In this method of data presentation data is compiled into groups and subgroups.
- Due compression of vast data in groups, it is reduced in bulk, increases its attractiveness and makes it easier to understand.

Rules and guidelines for tabular presentation

1. The table should be numbered serially. They may be arranged topicwise.
2. The title should be short, precise and self-explanatory.
3. Heading of columns and rows must be clear, sufficient and fully defined
4. Data must be presented according to size of importance, chronologically, alphabetically or geographically
5. Table should not be too large
6. Class or group interval should not be too broad or too narrow
7. Number of groups or classes should not be too many or too few

8. Class interval should be same throughout
9. Group should be tabulated in ascending or descending order
10. The groups should be mutually exclusive and should not overlap.
11. Each column and row should be appropriately demarcated.
12. Avoid short forms as far as possible
13. No cell should be left blank. Write 'Nil' if the frequency for that group is zero.
14. Total for each row and column must be given. If required, subtotal can be given.

- **Anatomy of table:**

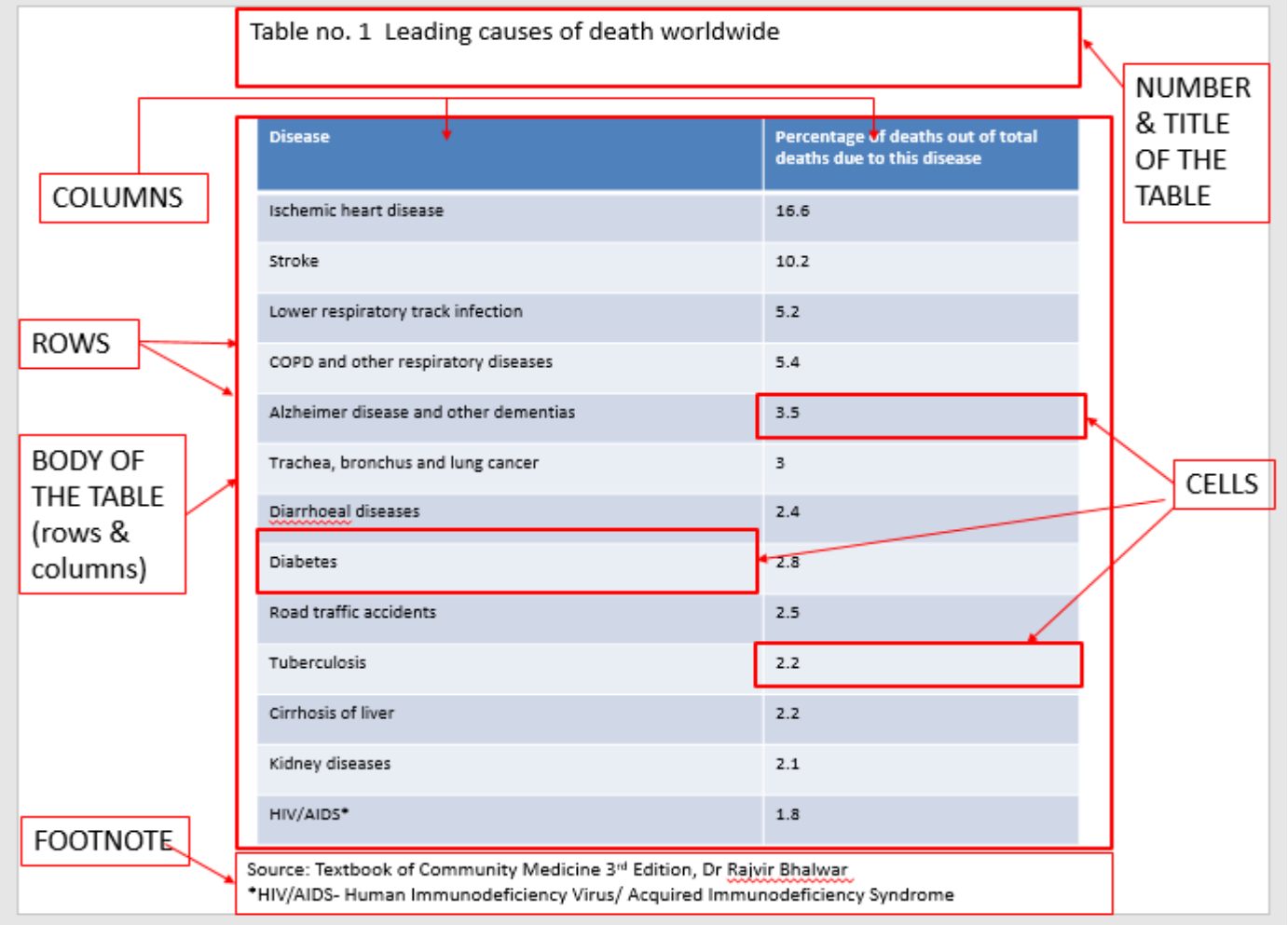
- A typical table has number, title, columns, rows, cells and footnote. Tables are numbered chronologically as they appear in the text.
    - The "body" of the table consists of columns, rows, cells and total.
    - Columns and rows indicate the demarcations of various groups/ subgroups compiled out of the data.
    - The figures in the "cells" pertain to the corresponding row and column.
    - In the 'cell' corresponding to the last column and last row grand total is given.
    - The "footnote" of the table is used for:

      Indicating the source of the data.

      Explaining the discrepancies, if any, in the data.

    Providing additional information not given in the title and body of the table (e.g. explanation of the abbreviations used).

FIG 4.1. ANATOMY OF TABLE:



Types of Tables

1. **Frequency distribution table:** Suitable for presenting frequency of nominal and ordinal variables. Each characteristic is mentioned in one column and its frequency is mentioned in the next column

e.g. Table 4.1 **Distribution of patients according to type of leprosy**

Type of leprosy	**No. of patients**
Tuberculoid	148
Lepromatous	64
Indeterminate	18
Borderline	10
Total	240

2. **Association table:** When we have to show association between two variables measured on nominal/ordinal scale we use this form of table. It is also called 2 × 2 table because it consists of two rows and two columns, excluding total. If more number of individuals are in cells *a* and *d* (than in cells *b* and *c*) there is a possibility of positive association between the attributes. On the contrary, if more individuals are represented in the cells *b* and *c* (than in the cells *a* and *d*) there is a possibility of negative association between the attributes.

e.g. table 4.2 association between smoking and lung cancer

Presence of exposure	**Cases (with lung cancer)**	**Control (without lung cancer)**
Smokers	33(a)	55(b)
Nonsmokers	2(c)	27(d)
Total	35 (a+c)	82 (b+d)

3. **Master table:** Sometimes the data which can be presented in numerous smaller tables is presented in one table only. Such table is called master table. This type of table gives maximum information at a glance.

➢ **Graphical presentation of data:**

❑ **General Precautions for Graphical presentation**

- Use simplest type of graph consistent with the purpose
- **Title*:*** This should be like the title of the table. If there are many graphs they should be numbered.
- **Scale:** Usually it should start from zero. If not, a break in the continuity may be shown. The scale selected should be such that the calculations and presentations are facilitated.
- **Use of color/shade:** The use of color and shade gives attractiveness to the graph. Key to colors must be given.
- **Dependent/independent variate*:*** By convention independent variate is presented on X-axis (i.e. horizontal axis) while the dependent variate is presented in Y-axis (i.e. vertical axis).

Graphs / Diagrams for Qualitative data:

1. Simple Bar diagram
2. Multiple Bar diagram
3. Proportional (Component) Bar Diagram
4. Pie Chart (Sector Diagram)
5. Pictogram
6. Map Diagram

I) BAR DIAGRAM: -

Indication: Comparing frequency of a variable expressed in nominal or ordinal scale. Data is qualitative or quantitative discrete type.

Method:

The data is presented in the form of rectangular bars of equal breadth. Each bar represents one attribute/variate.

The length of the bars indicates the frequency of the attribute or variate.

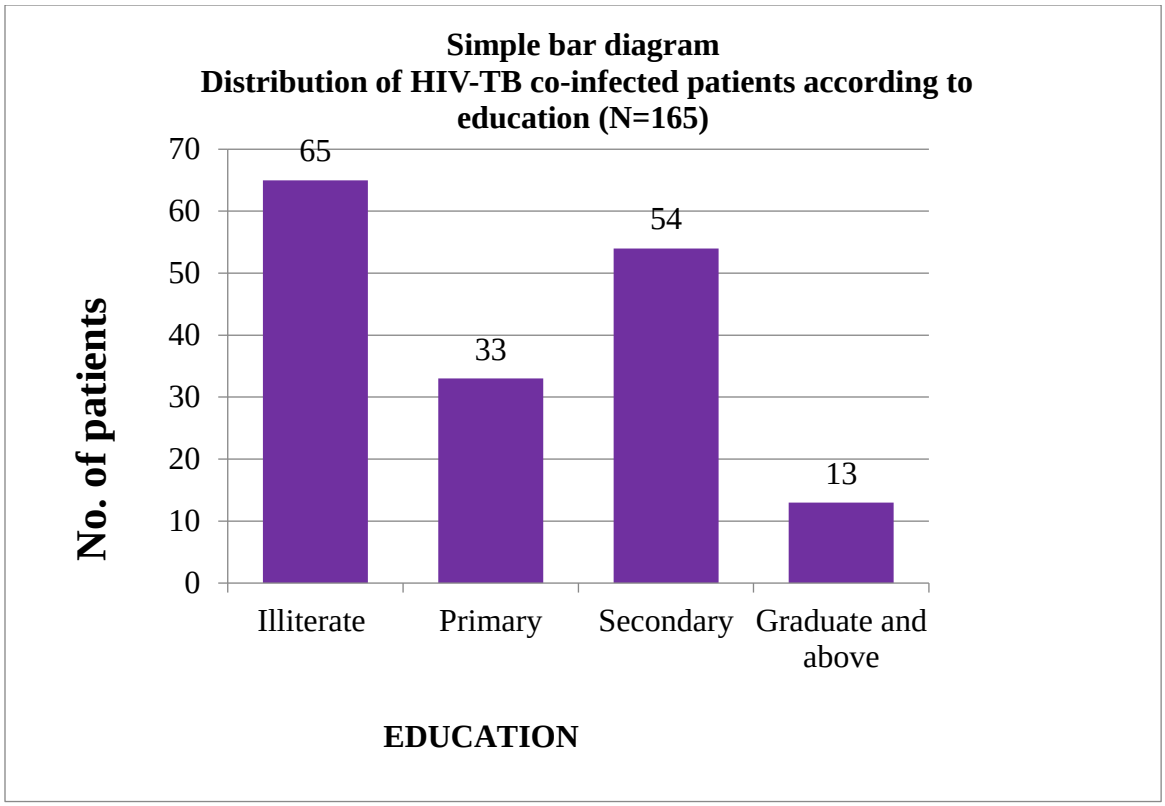
Different categories are indicated in one axis

Frequency of one data in each category is indicated in other axis

Precautions:

Scale must start from zero. If not it may be indicated by broken bar.

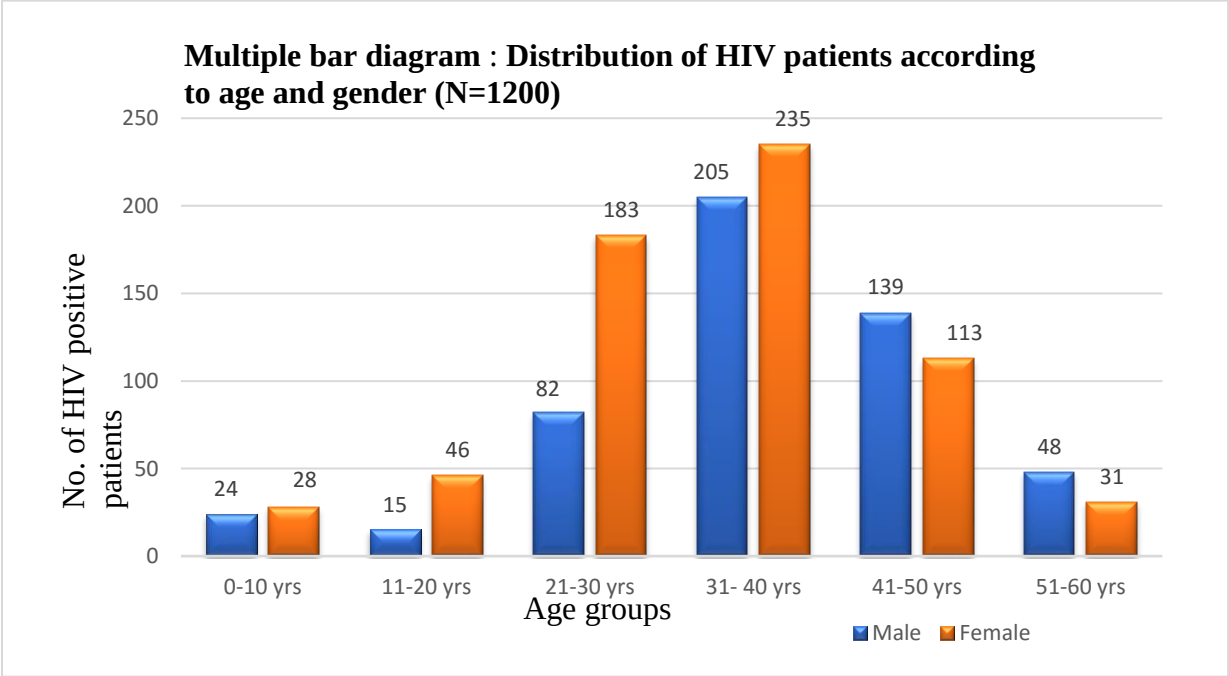
The distance between the bars should be equal to or lesser than the breadth of each bar.



MULTIPLE / COMPOUND BAR DIAGRAM

- **Indication:**

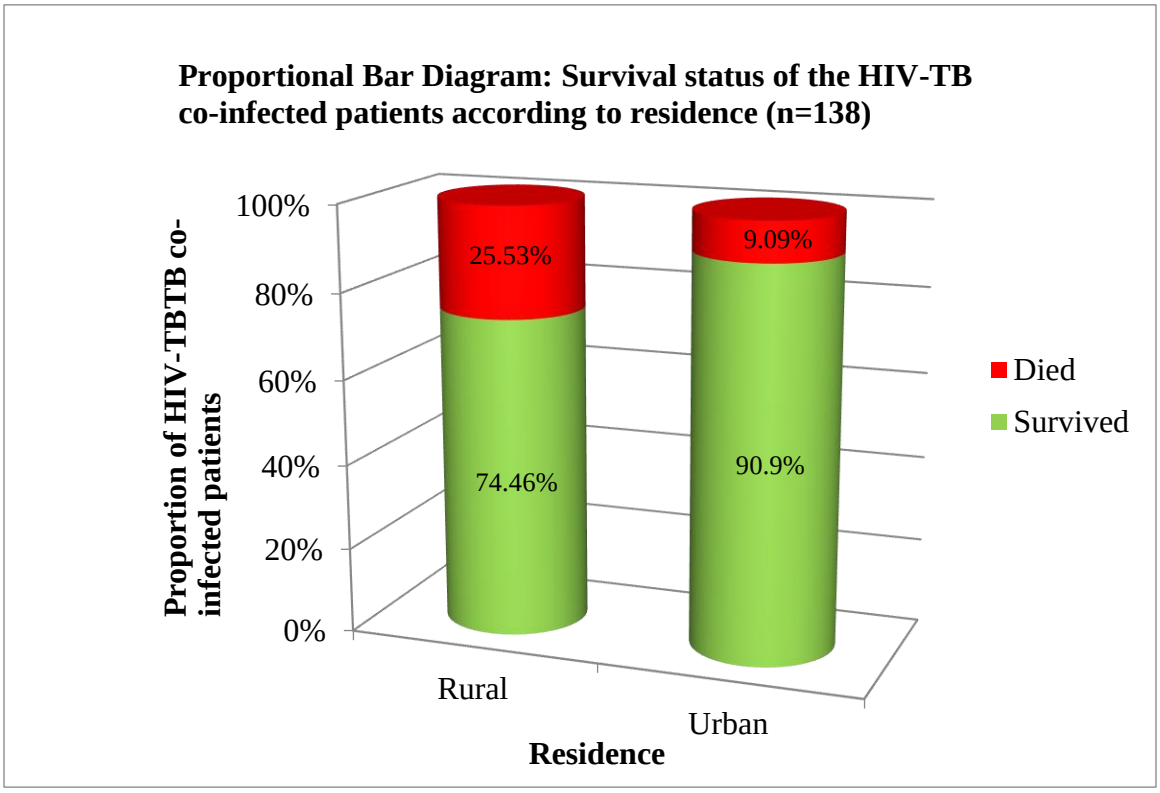
Used when we are presenting and comparing absolute numbers (frequency) of attribute/ variate in two or more groups at a time.



PROPORTIONAL /COMPONENT BAR DIAGRAM FOR 2 × 2 CROSS-TABLE:

Indication:

- Used when we are interested in showing proportion of attributes and variates in groups/subgroups and not the absolute frequency
- Bars maybe divided into two or more parts

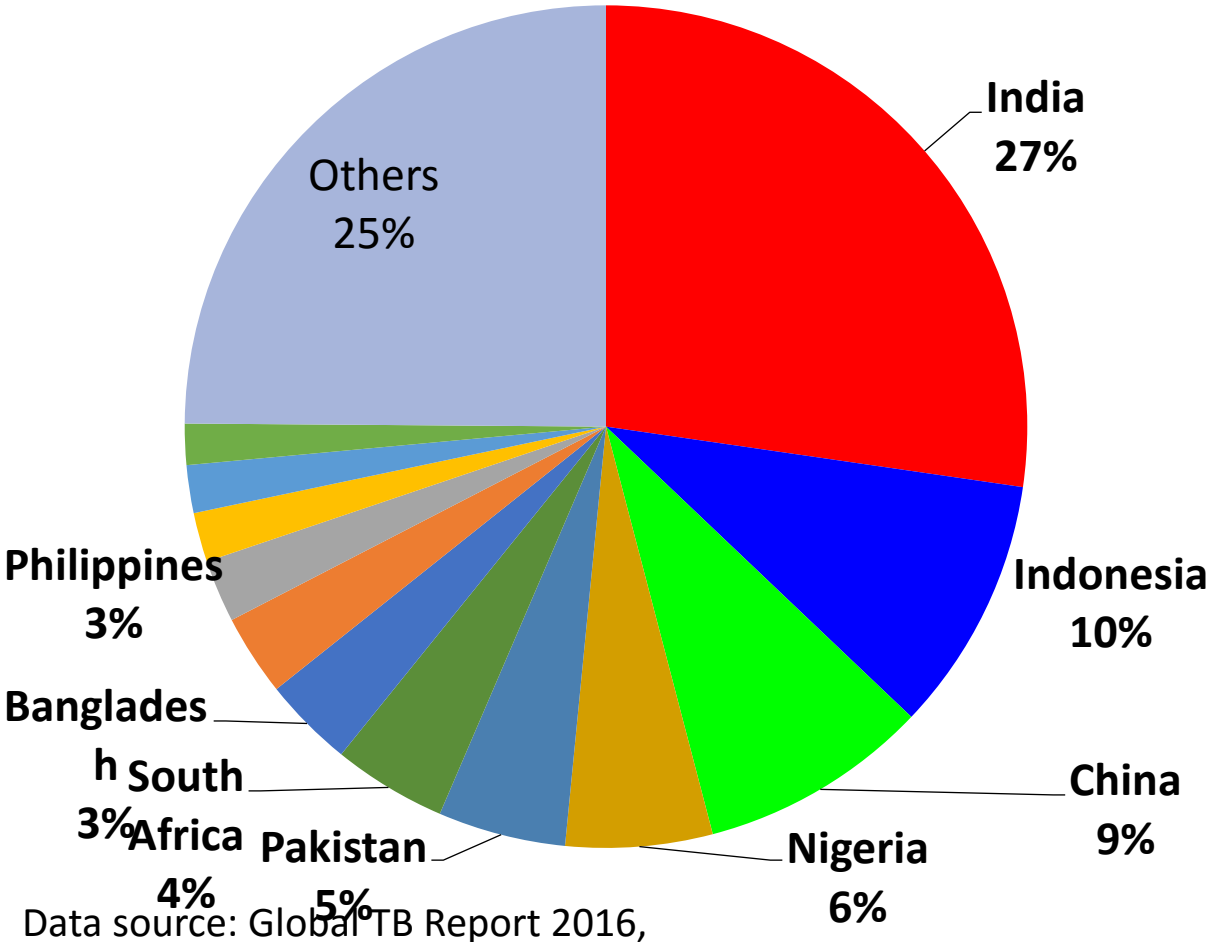


PIE DIAGRAM:

- Pie Chart is used to represent proportions.
- Area of a sectors of a circle represent different proportions where as degrees of angle denote the frequency.
- Angle can be calculated as

= (Cell frequency / Total frequency) × 360

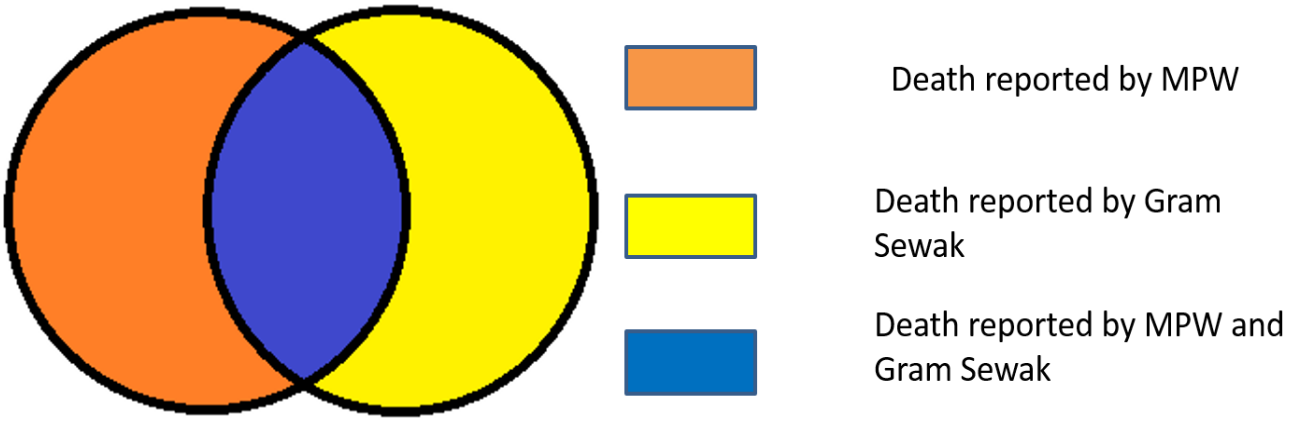
Pie chart: Worldwide incidence of Tuberculosis



Data source: Global TB Report 2016,

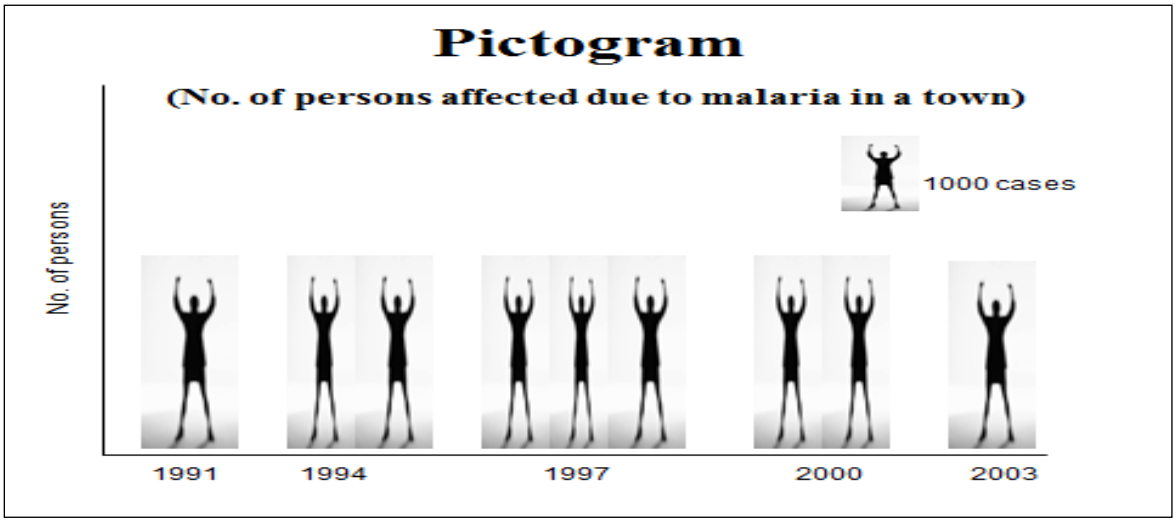
VENN DIAGRAM:

- It shows degrees of overlap and exclusivity for two or more characteristics or factors within a sample or population
- Figure : Number of deaths as per reporting agency



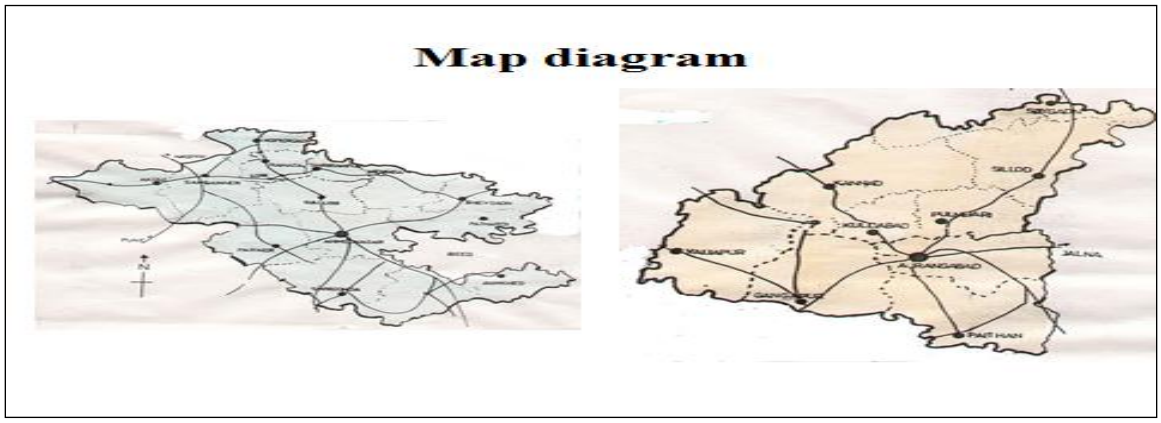
PICTOGRAM:

- **Pictogram is technique of presenting statistical data through appropriate pictures. It is popularly used when the facts are to be presented to layman and less educated masses.**



SHAPED MAPS, SPOT MAPS OR DOT MAPS/ GEOGRAPHIC COORDINATE CHARTS

- Map of an area with the location of each case of an illness, death, abnormality or condition identified by a spot, dot or other symbol on the map.
- Often used in an outbreak setting and can help the investigator to determine the distribution of cases.



GRAPHICAL PRESENTATION OF QUANTITATIVE DATA:

Graphs / Diagrams for Quantitative data:

1. Histogram
2. Frequency polygon
3. Line diagram
4. Frequency curve
5. Ogive curve (Cumulative frequency diagram)
6. Scatter diagram or dot diagram

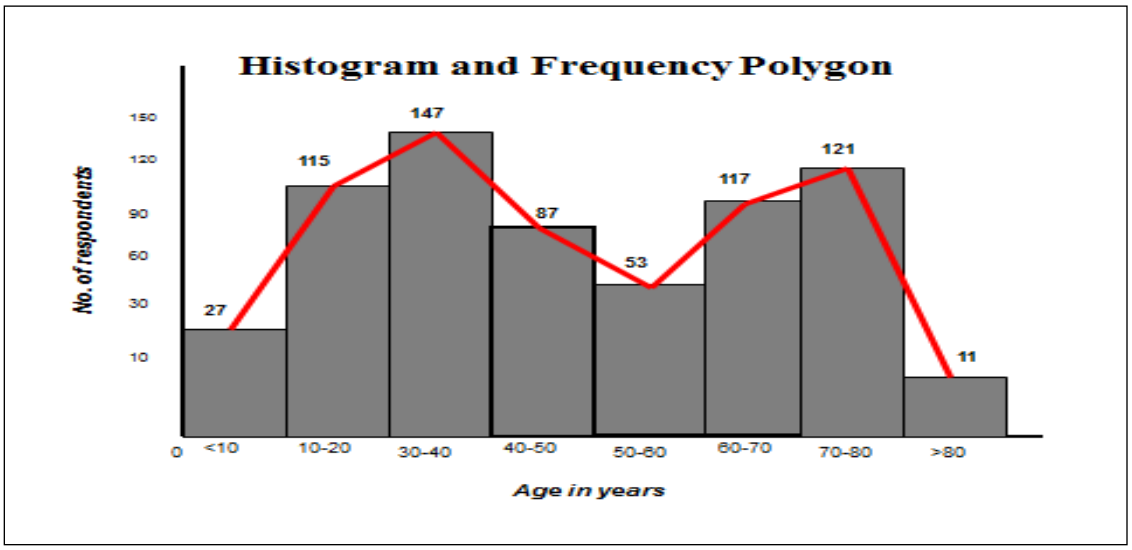
Histogram

- It is a graphical presentation of frequency distribution
- Abscissa: - Groups/class interval on horizontal X axis
- Class interval: - The interval from one subrange to the next subrange
- Ordinate: - Frequency/No of observation on vertical Y axis
- Width of the bar represents the interval of each category

- Upper limits denote up to but not including it
- If the class interval is uniform: -Height of rectangle will indicate the frequency
- If the class interval is different: -Area of rectangle alone indicate frequency

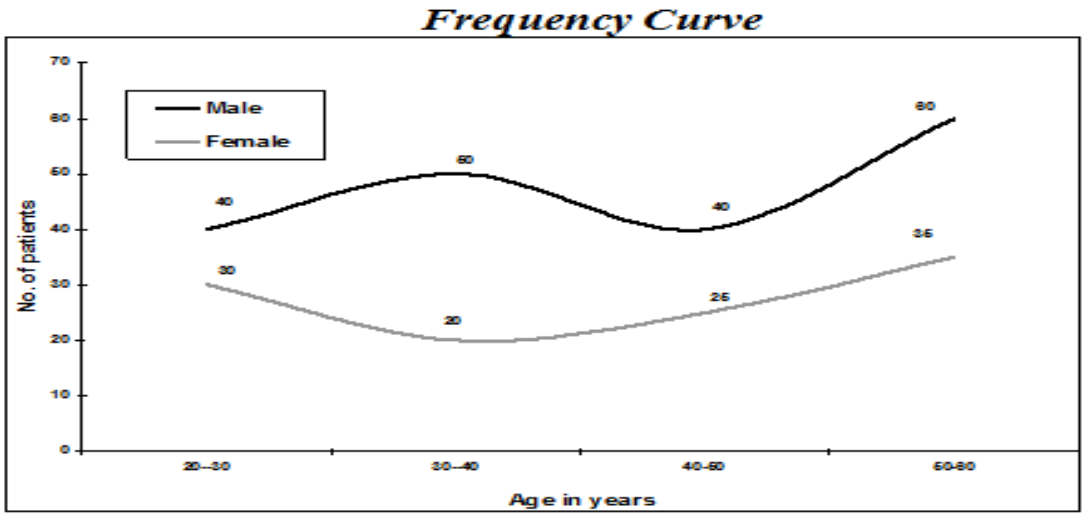
FREQUENCY POLYGON:

- Join the mid points of class interval. Figure with many angles



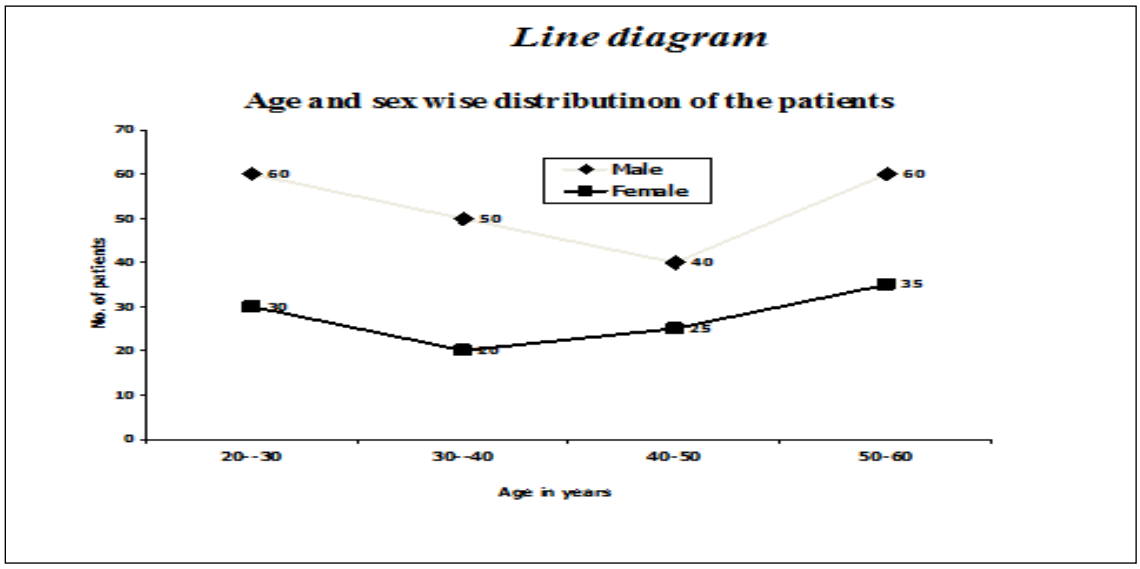
FREQUENCY OF CURVE

- Frequency polygon loses its angulations due to number of observations & class intervals are very much reduced.



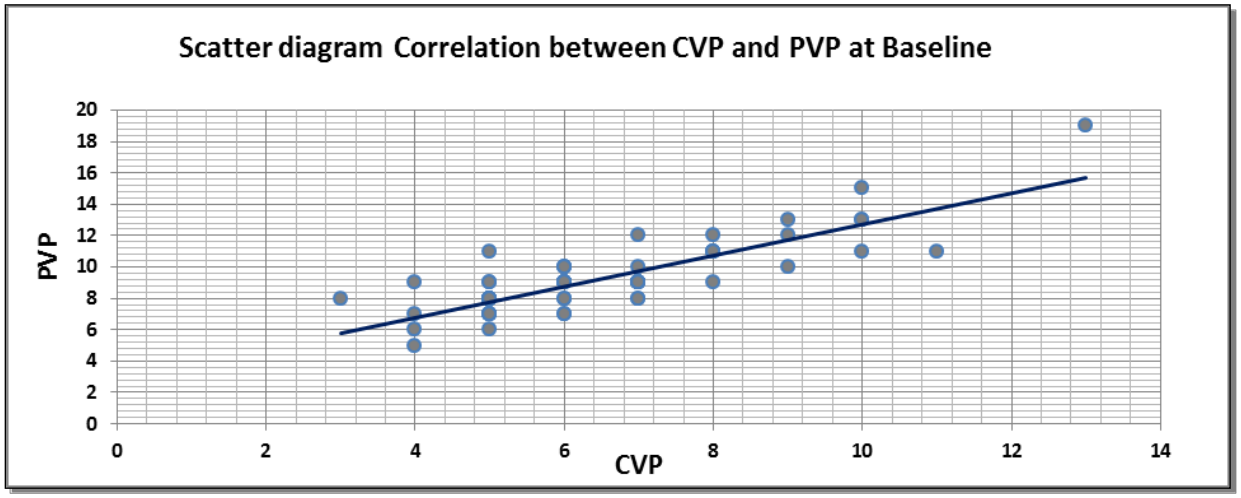
LINE DIAGRAM:

- Shows trends of events with passage of time, e.g. rising/falling/plateau/fluctuating
- It's a frequency polygon presenting variation by time
- Vertical (Y) axis may not start from zero
- Shape of line may alter depending on scale but trend indicated remain same



SCATTER DIAGRAM/ CORRELATION DIAGRAM:

- Show nature of correlation between two variable characters in the same person(s)/groups
- Nature of correlation positive/negative/no correlation



ADD 10 GRAPH PAGES

5. MEASURES OF CENTRAL TENDENCY (Centering Constants)

Competency	Learning objectives	Assessment
CM6.4 Demonstration and exercises on Common sampling techniques, simple statistical methods, frequency distribution, measures of central tendency and dispersion	**The student should be able to** • Calculate mean, mode and median • Enumerate merits and demerits of centering constants	Written (MCQ, SAQ, solving exercise)/ viva voce/ Skill assessment

Significance: The mass of data in one single value enables us to get an idea of the entire data. It also enables us to compare two or more sets of data to facilitate comparison. It represents whole data / distribution with unique value.

Characteristics of good measure of central tendency:

It should be easy to understand. It should be simple to calculate.

It should be based on all observations.

It should be uniquely defined.

It should be capable of further algebraic treatment.

It should not be unduly affected by extreme values.

- Important measures of central tendency or Centering constants which are commonly used in medical science, are:

1. Mean (Average) 2. Median 3. Mode

1. Mean:

The ratio of addition of the all values to the total number of observations in a series of data is called as Mean or Average.

*General Formula for **arithmetic mean:***

$$\text{Mean } (\bar{x}) = \frac{sum\ of\ all\ observations}{no.of\ observations} = \frac{\Sigma x}{n}$$

If $X_1, X_2, X_3, X_4, \ldots\ldots\ldots .X_N$ be the 'N' number of observations in a data then,

Mean $\bar{X}$ = $X_1+X_2+X_3+X_4+\ldots\ldots\ldots+X_N / N$ i.e.

Mean = $$\bar{x} = \frac{\Sigma X}{N}$$

GEOMETRIC MEAN (GM): This is a centering constant used in characteristics (like population size) which grow in geometric proportion. It is the nth root of the product of n numbers. It is calculated as:

$$GM = \sqrt{(x_1 \times x_2 \times x_3 \ldots x_n}$$

HARMONIC MEAN: It is the reciprocal of the arithmetic mean of the reciprocals of the values. Symbolically, it is represented as x_h and calculated as below:

$$x_h = \frac{n}{\Sigma\,[1/x_i]}$$

Harmonic mean is used to obtain valid average of certain rates of change like speed.

Merits of mean: (1) It is simplest to understand and easy to compute. (2) It is affected by the value of every item in the series. (3) It is the center of gravity, balancing the values on either side of it. (4) It is calculated value, and not based on position in the series.

2. MEDIAN:

The center most value in a series of data is called as Median. The median is the 50^{th} percentile value below which 50% of the values in the simple fall. It divides the whole distribution in two equal parts.

General formula:

Median = Size of $(N+1/2)^{th}$ observation in a series of data when the data is arranged in ascending or descending order is called as Median.

- Calculating the median:

1. If n is odd then,

$$\text{Median} = \left(\frac{n+1}{2}\right) \text{th value}$$

2. If n is even,

$$\textbf{Median} = \frac{\{\text{value of } [n/2]^{th} \text{ observation} + \text{value of } [n/2+1]^{th} \text{ observation}\}}{2}$$

Merits of median: (1) It is specially used in only the position and not the values. (2) Extreme values do not affect the median as strongly as the mean. (3) It is the most appropriate average in dealing with qualitative data. (4) The value of median can be determined graphically but value of mean cannot be determined graphically.

3. **Mode** The most commonly or frequently occurring observation in a series of data is called as Mode.

For grouped data

$$\text{Mode} = L + \frac{(fm - f1)}{(2*fm - f1 - f2)} * i$$

Modal class is the class having highest frequency among different classes

L- lcl Lowest limit of modal class

fm- frequency of modal class

f1- frequency of pre-modal class

f2- frequency of post-modal class

i - Width of modal class.

Relationship between Mean, Median & Mode: Mode = 3 Median – 2 Mean

Mean – Mode = 3(Mean – Median)

Relation in their size: Mean < Median < Mode

Example:

SN X Ascending order

1.	70	58
2.	80	60
3.	94	66
4.	70	67
5.	58	70
6.	66	70
7.	78	78
8.	67	80
9.	82	82
10.	60	94

Σ X = 725 Mean = $\bar{X}$ = Σ X / N =725/10 = 72.5

For Median:

Size of $(n+1)^{th}$ value = Size of (10+1)th value = 11/2 =5.5^{th} value

=(5^{th} +6^{th} value /2) = (70+70/2) = 70

Mode = Most frequently occurring value = 70

- **Calculating mean for grouped data**

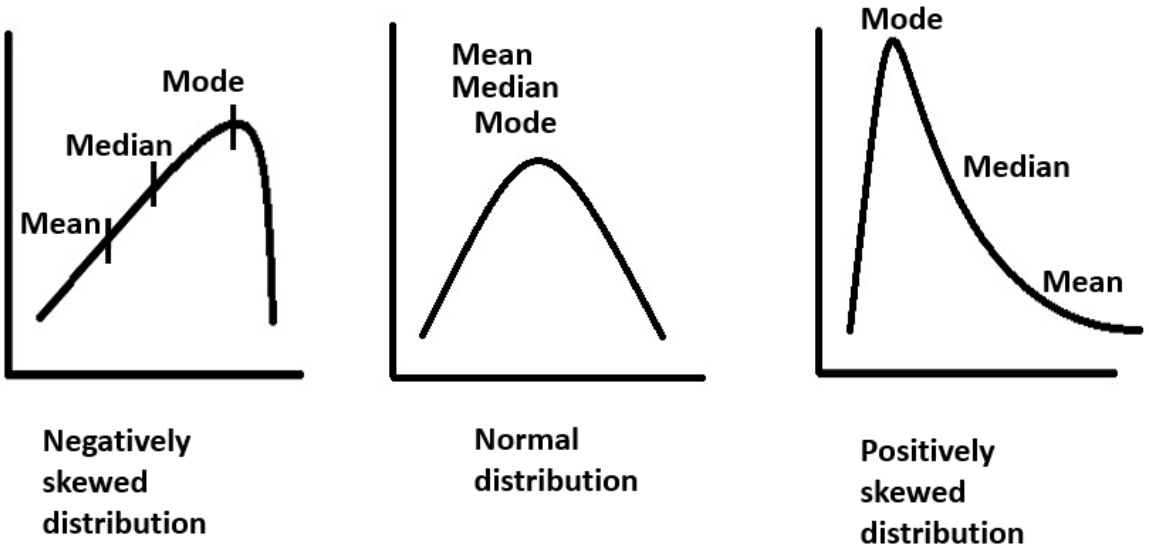
Discrete frequency distribution:

Observations (x)	Frequency (f)	Frequency X Observation (fx)	Mean X ($\bar{X}$)
X1	f1	f1 X1	$\bar{X} = \frac{\Sigma(fx)}{\Sigma f}$
X2	f2	f2 X2	
X3	f3	f3 X3	
x4	f4	f4 X4	
	∑ f = f1 + f2 + f3 + f4	**∑fx** = f1 X1 + f2 X2 + f3 X3 + f4 X4	

- For a wider class of distribution, the relation in mean, mode and median
- **Mean – Mode = 3 (Mean - Median)**

Skewness:

- Positive Skewed (Right tailed): – Mean > Median > Mode
- Negative Skewed (Left tailed): – Mean < Median < Mode
- Symmetric (Normal): – Mean = Median = Mode



Negatively skewed distribution

Normal distribution

Positively skewed distribution

6. VARIABILITY, VARIATION OR DISPERSION

Competency	Learning objectives	Assessment
CM6.4 Demonstration and exercises on Common sampling techniques, simple statistical methods, frequency distribution, measures of central tendency and dispersion	**The student should be able to** • Calculate range, interquartile range and standard deviation (SD) • Enumerate merits and demerits of measures of variation	Written (MCQ, SAQ, LAQ, solving exercises) / viva voce/ Skill assessment

To measure the variability among the different variables or distributions there are several measurements which is called as Measures of variation.

Concept:

It describes the spread or scattering of the individual values around the central value.

Objective:- The main objective of the measures of variation / variability / dispersion is "How the individual observations are dispersed around the mean".

Significance: (1) It determines the reliability of an average. (2) To determine the nature and cause of variation in order to control the variability. (3) To compare two or more than two distributions with regards to their variability. (4) It is of great importance to advanced statistical analysis. (5) To find out the variation in a distribution.

Following are some important measures of variation:

1. Range 2. Inter-quartile range 3. Mean Deviation 4. Standard Deviation (S.D.) and 5. Coefficient of Variation (C.V.)

1. **Range:** This is a crude measure of variation since it uses only two extreme values.

Definition: It is defined as the difference between highest and lowest value in a set of data. Symbolically, Range can be given as Range = X max. - X min Range is useful in quality control of drug, maximum and minimum temperature in a case of enteric fever etc.

2. **Interquartile Range:** The difference between third and first quartile.

Symbolically, $Q = Q_3 - Q_1$ Where, Q_1 = First quartile- 25% Q_3 = Third quartile- 75%

The interquartile range is superior to the range as it is based on two extreme values but rather on middle 50% observations.

3. **Mean Deviation:**

Ratio of sum of deviations from mean of individual observations to the number of observations after ignoring the sign is called as Mean Deviation. Although the mean deviation is good measure of variability, its use is limited. It measures and compare variability among several sets of data.

$$MD = \frac{\sum |X - \bar{X}|}{n}$$

4. **Standard Deviation (SD):**

Karl Pearson introduced in 1893. Most widely used & important measures of variation. It is based on all observations. Even if one of the observations is changed, SD also changes. It is least affected by the fluctuations of sampling.

Definition: SD is Root Mean Square Deviation i.e. it is the square root of the mean of squares of deviation from individual observation to mean. Generally, it is denoted by δ (sigma) Greater/smaller the value of SD in data, greater/smaller will be the variation among data.

Steps to calculate SD:

If $X_1, X_2, X_3, X_4, .,.,.,.,.,., X_N$ be the 'N' numbers of observations in a series of data then value of SD can be calculated as follows:

1.Calculate Mean (i.e. $\bar{X}$ = ΣX / N)

2.Take the differences from the mean from each value in data (i.e. $X_1-\bar{X}$, $X_2-\bar{X}$, $X_3-\bar{X}$, $X_4-\bar{X}$, ... $X_N-\bar{X}$) Do not ignore positive/negative sign

3. Take the squares of the differences taken from the mean from all individual observations {i.e. $(X_1-\bar{X})^2$, $(X_2-\bar{X})^2$, $(X_3-\bar{X})^2$,$(X_4-\bar{X})^2$,.....$(X_N-\bar{X})^2$}

4.Take the sum/ addition of the squares of the differences taken from the mean from all individual observations i. e. $\Sigma (X-\bar{X})^2$

5. Divide the sum/addition of the squares of the differences taken from the mean from all

individual observations by N-1. i. e. $\Sigma (X- \bar{X})^2 / N-1$

6. Take the square root of step no. 5. Thus, SD = $\sqrt{\Sigma} (X- \bar{X})^2 / N-1$

when n < 30

$$SD(\sigma) = \sqrt{\frac{\sum (X - \bar{X})^2}{n-1}}$$

or

$$SD = \sqrt{\frac{\sum X^2 - n\bar{X}^2}{n-1}}$$

when n ≥ 30, take denominator as 'n'

If the data represents a small sample of size N from a population, then it can be proved that the sum of the squared differences are divided by (N-1) instead by N. However, for large sample sizes, there is very little difference in the use of N-1 or N in computing the SD. SD is directly proportional to the variation in a data. i.e. if the value of SD is more / less, the variation will be more/ less. To minimize the value of SD increase the number of observations in a series of data. Thus, it is better that investigator should take more number of observations in any research study.

Uses of standard deviation:

- Most commonly used measure of variation. It gives an idea of how the observations are scattered around the mean.
- If SD of sample is known we can determine the common and uncommon observations. (observations beyond mean ± 2 SD are usually considered uncommon)
- It forms an integral part of the concept of normal distribution. For large samples

mean ± SD includes 68.26 % observations

mean ± 2 SD includes 95.46 % observations

mean ± 3 SD includes 99.73 % observations

(these are called 68%, 95% and 99% confidence limits respectively)

- It is used in various tests of significance
- Used to calculate coefficient of variation
- **Merits of standard deviation:** Based on all the observations. Does not ignore algebraic signs of deviations. Capable of further mathematical treatment. Not much affected by sampling fluctuations.
- **Demerits:** Difficult to understand and calculate. Used only for quantitative data. Unduly affected by extreme observations

Example: Find out value of SD for the following data showing DBP (mm of Hg) for 10 NIDDM patients: 70, 80, 94, 70, 58, 66, 78, 67, 82, 60.

Solution:

SN	X	$(X-\bar{X})$	$(X-\bar{X})^2$
1.	70	- 2.5	6.25
2.	80	+ 7.5	56. 25
3.	94	+ 21.5	462.25
4.	70	- 2.5	6.25
5.	58	- 14.5	210.25
6.	66	- 6.5	42.25
7.	78	+5.5	30.25
8.	67	-5.5	30.25
9.	82	+9.5	690.25
10.	60	-12.5	156.25

$\Sigma X = 725$ $\Sigma(X-\bar{X})^2 = 1090.5$

$\bar{X} = \Sigma X / N = 725/10 = 72.5 = 11$

$SD = \sqrt{\Sigma (X- \bar{X})^2 / N-1} = \sqrt{1090.5 / 9} = \sqrt{121.1666} = 11.075$

VARIANCE:

- Variance is the square of standard deviation.
- If step 6 in the calculation of *SD is omitted,* we get variance.

$$\text{Variance} = \frac{\Sigma(x-\bar{X})^2}{n-1}$$

Coefficient of Variation (CV): Frequently used relative measure of variation not the absolute variability. Definition: It is the ratio of the standard deviation (SD) to the mean expressed as the percentage (%). i.e. CV = SD / Mean x 100

$$\text{Coefficient of variation (CV)} = \frac{SD}{Mean} * 100$$

- **CV is used to compare variation of two variables with different units of measurement.**
- **Always expressed in percentage**

Example: In a distribution mean weight is 76.4 kg with a SD of 7.7 and Mean DBP is 98.8 mm of Hg with SD as 10.5. Which variable is more consistent?

Solution: CV for weight = SD/Mean x 100 = 7.7/76.4x100 = 10.08%

CV for DBP = SD/Mean x 100 = 10.5 /98.8x100 = 10.63%

Thus, CV for DBP is more than CV for weight, (10.63% > 10.08%), then variable weight shows less variation as compared to DBP. Thus, Weight is consistent variable than DBP.

7. NORMAL DISTRIBUTION AND NORMAL CURVE

Competency	Learning objectives	Assessment
CM6.4, CM6.2 **Describe and discuss the principles and demonstrate the methods of collection, classification, analysis, interpretation and presentation of statistical data**	**The student should be able to** • Enumerate properties of normal curve • Explain applications of the normal distribution • Calculate confidence limits and Find out probability or percentage for normal variables from normal distribution for given examples	Written (MCQ, SAQ, exercises)/ viva voce/ Skill assessment

A histogram of a quantitative data obtained from a single measurement or different subjects a 'bell shaped' distribution is known as Normal distribution. The Normal distribution is completely described by two parameters Mean and SD.

Confidence Intervals (limits):
A range of values within which population mean likely to lie
68% C.I. = Mean ± 1SD contains 68% of all the observations.
95% C.I. = Mean ± 2SD contains 95% of all the observations
99% C.I. = Mean ± 3SD contains 99% of all the observations.
Normal distribution can be expressed arithmetically with confidence intervals (limits) as follows:

- Mean ± 1SD limits include 68% or roughly 2-3rd of all the observations, 32% lie outside the range Mean ± 1SD.
- Mean ± 2SD limits include 95% of all the observations and 5% lie outside the range Mean ± 2SD.
- Mean ± 3SD limits include 99% of all the observations and only 1% lie outside the range Mean ± 3SD.

Normal Curve/ Gaussian Curve:

If an Area diagram of Histogram of such type of distribution is constructed then this diagram is called as Normal curve.

- Characteristics of Normal Curve:

1. It is bell shaped.

2. It is bilaterally symmetrical around the mean.

3. Mean, Median and Mode coincide.

4. It has two points of inflections.

5. Area under the curve is always equal to one.

6. It does not touch the base line.

7. first half of standard normal curve is the mirror image of the second half

8. it is also called as **'Ogive curve'**

NORMAL CURVE:

- Confidence limit:- Limits on either side of mean is called CL
- Mean -/+ 1 SD will include 68.26 % values in the distribution
- Mean -/+ 2 SD will include approximately 95.46 % of value
- Mean -/+ 3 SD includes 99.73 % of values

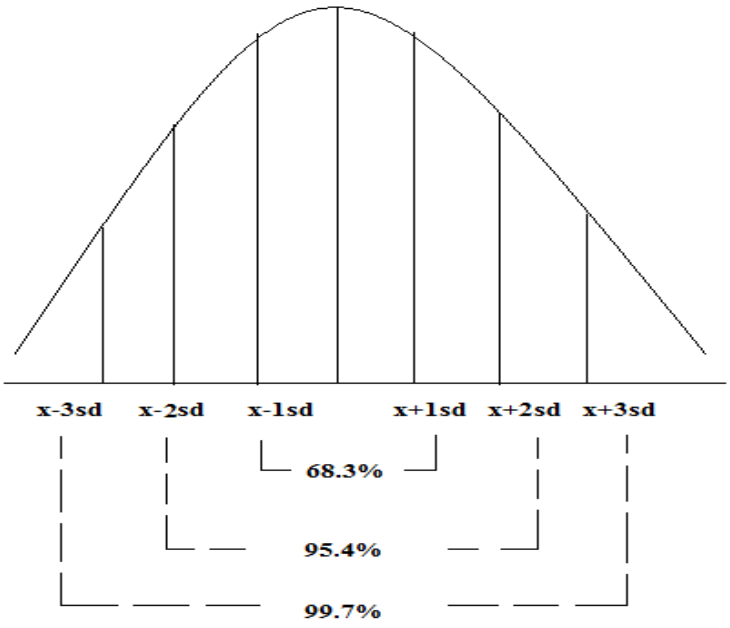


Fig. Normal curve

Standard normal curve:

In a simple frequency distribution curve, we represent the frequencies with reference to actual numbers.

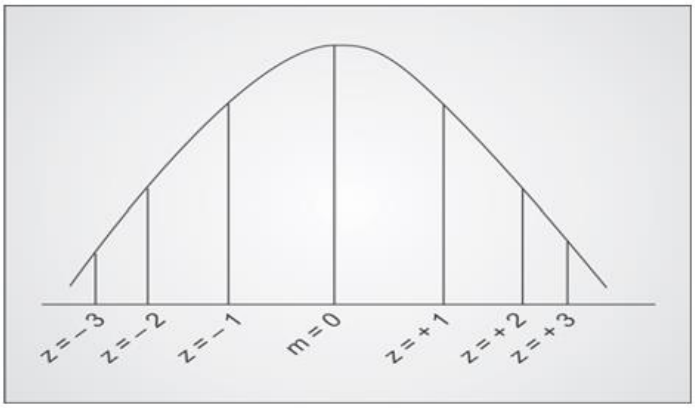
But different characteristics have different units of measurement, so the frequency distributions will not look same.

This problem is solved by what is called “standardization of normal curve”. Here, we assume mean equal to zero (i.e. x = 0) and represent on the graph, each measurement not in terms of its actual value, but in terms of “units of standard deviation” it is more or less than the mean.

This “unit of standard deviation” is expressed by letter “z” and is called “relative deviate” (RD).

Properties of standard normal curve:

1. It is bell shaped, smooth curve
2. Perfectly symmetrical curve & has two tails
3. It doesn’t touch the base line
4. Area of curve is 1 & mean is zero
5. Mean, median & mode coincide
6. Roughly Area included in m ± 1z = 68%,, m ± 2z = 95%, m ± 3z = 99%is of the total area.
7. No portion of curve is below base line



Standard normal curve

Applications/ uses of the concept of normal curve:

1. Making estimate of the number of individuals in any range of measurements.

2. Deciding common/uncommon measurements: The concept of normal distribution helps in deciding a cut-off point which can decide rare values.

For usual purposes the measurements beyond the range of m ± 2z are considered uncommon or rare. This is because only 5% individuals are likely to have such measurements.

Example:

Systolic blood pressure (mm of Hg) follows a normal distribution with mean 118 and SD as 15.5. Find out 95% and 99% confidence limits for the SBP.

Solution:

Given that mean SBP=118 and SD=15.5Then, 95% confidence limits can be given as follows:

Mean ±2SD = 118 ± 2 x 15.5 = 118 ± 31 = 87 to 149mm of Hg

Thus, SBP will be lie in between 87 to 149mm of Hg at 95% of all the cases.

Now, 99% confidence limits can be given as follows:

Mean ±3SD=118±3 x 15.5=118±46.5=61.5 to 164.5 mm of Hg

Thus, SBP will be lie in between 61.5 to 64.5 mm of Hg at 99% of all the cases.

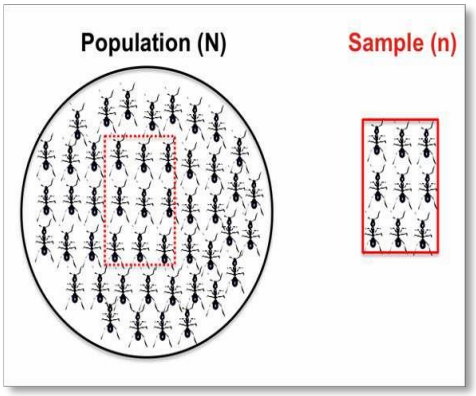
8. SAMPLING TECHNIQUES

Competency	Learning objectives	Assessment
CM6.4 Demonstration and exercises on Common sampling techniques, simple statistical methods, frequency distribution, measures of central tendency and dispersion	**The student should be able to** • Explain common sampling techniques • Demonstrate sampling techniques with appropriate example	Written (solving exercises)/ viva voce/ Skill assessment

Sampling is the process of selecting observations (a sample) to provide an adequate description and inferences of the population

Definition: sampling is the scientifically accepted method of selecting observations from a lot or group

- Sample is a unit that is selected from population
- Sample Represents the whole population
- Sample Purpose to draw the inference



❑ Need for Sampling

• Shortage of resources: Personnel, equipment, time

• Detailed examination of smaller units

• Population may be infinite

• Reasonable estimates of parameter required in short time.

❑ Sampling methods:

A. **Probability sampling:** These methods are preferred in quantitative research designs.

These are named so, because, investigators know the probability of sampling unit entering in the sample, because it is predecided.

i. Simple Random

ii. Stratified Random

iii. Systematic Random

iv. Cluster

v. Multi Stage

B. Non-Probability sampling: Non-probability sampling methods are used in qualitative methods of research.

i. Convenience

ii. Purposive

iii. Quota

iv. Snowball

A.i. Simple Random Sampling:

- All subsets of the frame are given an equal probability
- Steps in a typical simple random sampling:

i. **Enlist all sampling units:** if, the sampling unit is the students. So, we make a list of all students who are eligible to enter in the list as per inclusion/exclusion criteria. This is arranged in alphabetical order. Suppose the number is 1000. Each student is given unique number. It will be appropriate that the numbers start from 000 and end-up with 999. This will ensure that all students will have a three-digit ID.

ii. **Decide the sample size:** The sample size would be calculated as per methods recommended. Say this is 100.

iii. **Select those to be included in sample:** This can be done by 3 methods.

Lottery method, Use of random number table and Random number generators

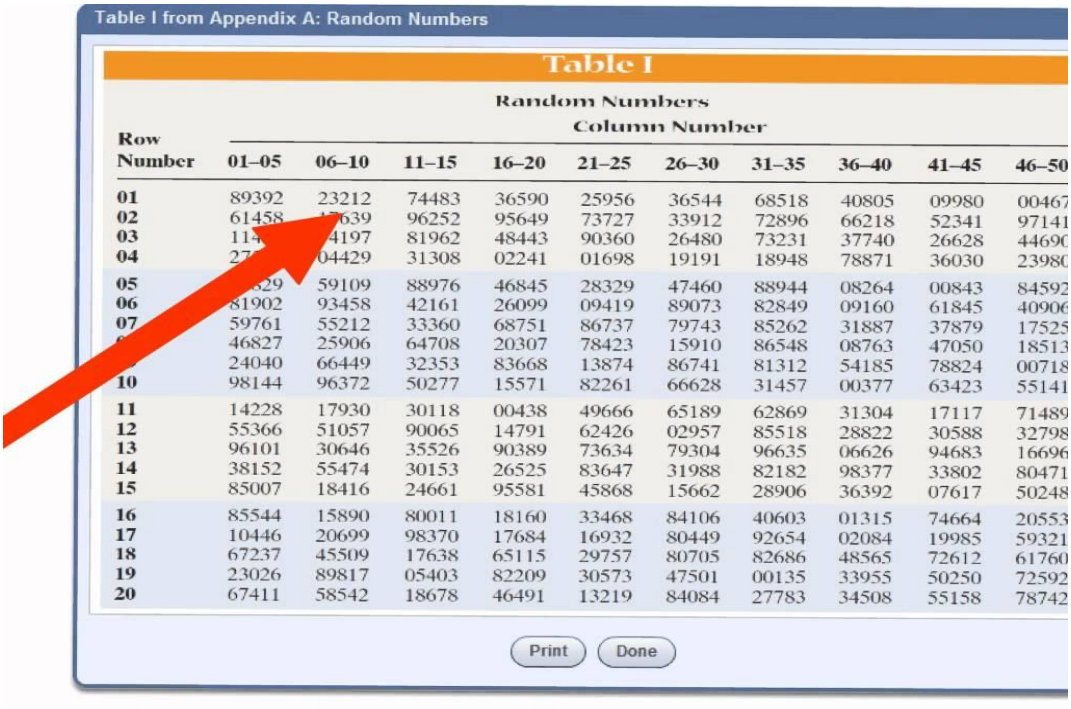


Table I from Appendix A: Random Numbers

Table I

Random Numbers

Row Number	Column Number 01–05	06–10	11–15	16–20	21–25	26–30	31–35	36–40	41–45	46–50
01	89392	23212	74483	36590	25956	36544	68518	40805	09980	00467
02	61458	17639	96252	95649	73727	33912	72896	66218	52341	97141
03	11[illegible]	4197	81962	48443	90360	26480	73231	37740	26628	44690
04	27[illegible]	04429	31308	02241	01698	19191	18948	78871	36030	23980
05	[illegible]529	59109	88976	46845	28329	47460	88944	08264	00843	84592
06	81902	93458	42161	26099	09419	89073	82849	09160	61845	40906
07	59761	55212	33360	68751	86737	79743	85262	31887	37879	17525
[illegible]	46827	25906	64708	20307	78423	15910	86548	08763	47050	18513
[illegible]	24040	66449	32353	83668	13874	86741	81312	54185	78824	00718
10	98144	96372	50277	15571	82261	66628	31457	00377	63423	55141
11	14228	17930	30118	00438	49666	65189	62869	31304	17117	71489
12	55366	51057	90065	14791	62426	02957	85518	28822	30588	32798
13	96101	30646	35526	90389	73634	79304	96635	06626	94683	16696
14	38152	55474	30153	26525	83647	31988	82182	98377	33802	80471
15	85007	18416	24661	95581	45868	15662	28906	36392	07617	50248
16	85544	15890	80011	18160	33468	84106	40603	01315	74664	20553
17	10446	20699	98370	17684	16932	80449	92654	02084	19985	59321
18	67237	45509	17638	65115	29757	80705	82686	48565	72612	61760
19	23026	89817	05403	82209	30573	47501	00135	33955	50250	72592
20	67411	58542	18678	46491	13219	84084	27783	34508	55158	78742

Print Done

- Advantages:

  The sample is representative of the population

  Population estimate is easy to calculate

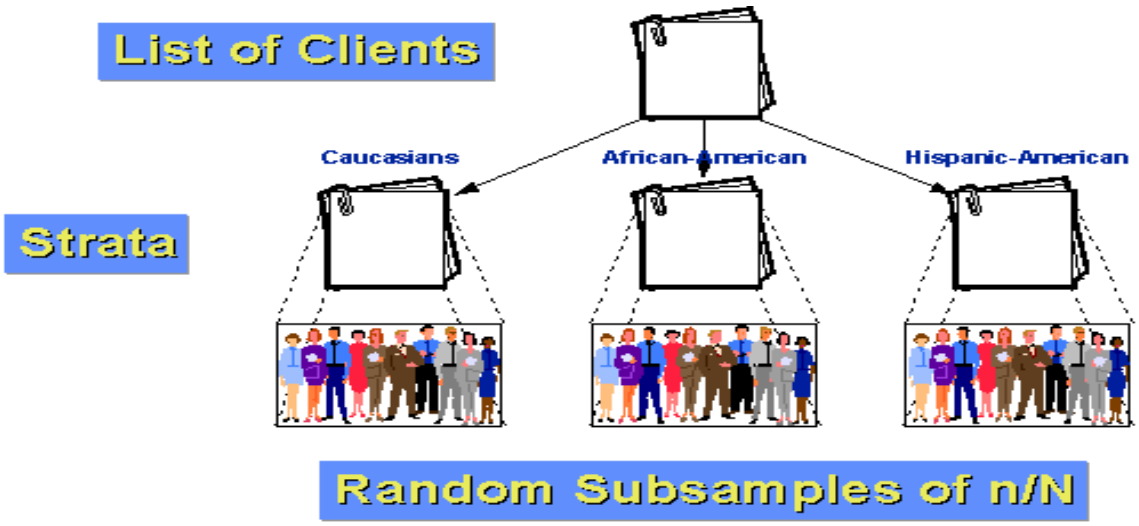
- Disadvantages:

  If N is very large, this method of sampling is impracticable

  Larger risk of random error

A.ii Stratified random sampling:

- Population is divided into two or more groups called strata
- Subsamples are randomly selected from each strata
- The elements within a stratum should be as homogeneous as possible, but the elements in different strata should be as heterogeneous as possible



- **Advantages:**
  Assures representation of all groups in sample population
  Characteristics of each stratum can be estimated and comparisons made

- **Disadvantages:**
  Requires accurate information on proportions of each stratum
  Stratified lists costly to prepare

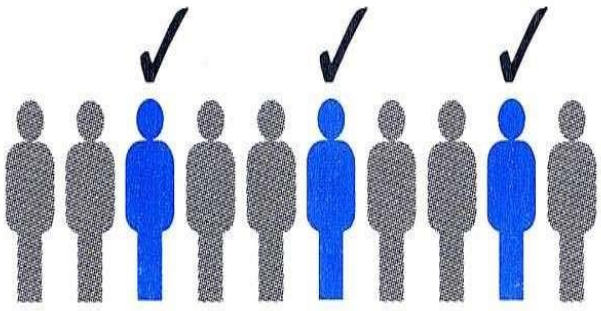
A.iii Systematic Random Sampling:

- Order all units in the sampling frame
- Then every nth number on the list is selected
- K = Sampling Interval

$$K = \frac{N}{n} \quad \text{or} \quad \frac{\text{Total population}}{\text{Desired sample size}}$$

Where,
N = Total size of the population
n = Proposed size of the sample

-



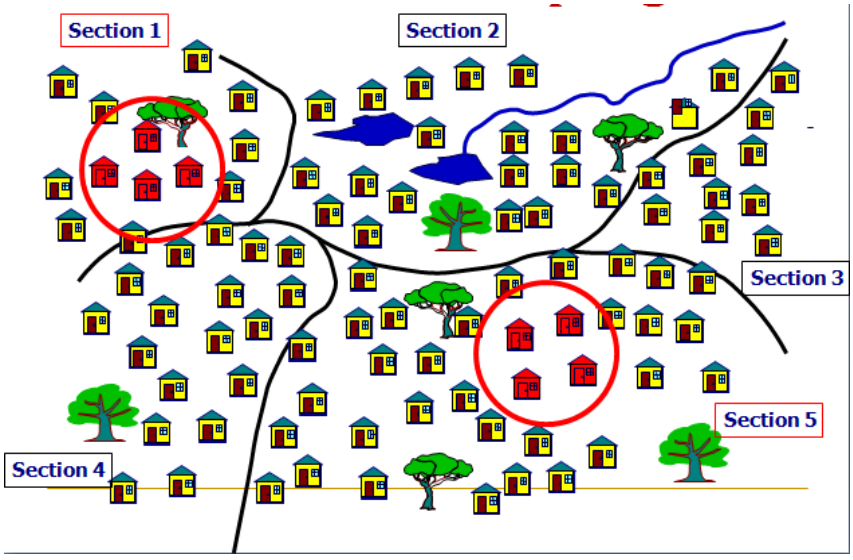
Moderate cost; moderate usage
Simple to draw sample
Easy to verify

- **Disadvantages:**

  Periodic ordering required
  Carried out in stages
  Using smaller and smaller sampling units at each stage

A.iv Cluster Sampling:

- The population is divided into subgroups (clusters) like families.
- A simple random sample is taken from each cluster



- A special form of cluster sampling called the "*30 cluster sampling", has been recommended by the WHO* for field studies in assessing vaccination coverage.
- In this a list of all villages (clusters) for a given geographical area is made.
- 30 clusters are selected using Probability Proportional to Size (PPS).
- From each of the selected clusters, 7 subjects are randomly chosen. Thus a total sample of 30 x 7 = 210 subjects is chosen.

- The advantage of cluster sampling is that sampling frame is not required and in practice when complete lists are not available.
- **Advantages:** Can estimate characteristics of both cluster and population
- **Disadvantages:**
  The cost to reach an element to sample is very high
  Each stage in cluster sampling introduces sampling error—the more stages there are, the more error there tends to be
-

A.v Multi Stage Sampling:

- Carried out in stages
- Using smaller and smaller sampling units at each stage

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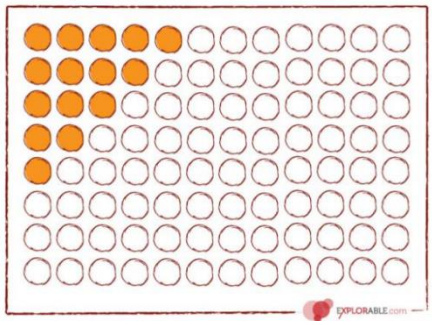
PUNE
MADHRAI
DHARAMPURI
BALANGIR
GAJAPATI

- **Advantages:** More Accurate and More Effective
- **Disadvantages**: Costly, each stage in sampling introduces sampling error—the more stages there are, the more error there tends to be

B.i Convenience Sampling/ Grab / Opportunity Sampling / Haphazard Sampling:

- Selection of whichever individuals are easiest to reach
- Done at the "convenience" of the researcher
- Used in pilot studies, because it allows the researcher to obtain basic data and trends regarding his study without the complications of using a randomized sample



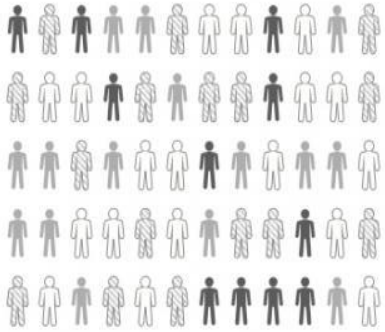
- Advantages: Fast, inexpensive, easy, subject readily available, immediately known population group and good response rate
- Disadvantages:
  Sampling Error
  Sample is not representative of the entire population
  Cannot generalise findings to the Population

B.ii Purposive/Authoritative Sampling:

- The researcher chooses the sample based on who they think would be appropriate for the study
- Selected based on their knowledge and professional judgement
- Used when a limited number or category of individuals possess the trait of interest
- It is the only viable sampling technique in obtaining information from a very specific group of people
- **Advantages:** There is a assurance of quality response. Meet the specific objective
- **Disadvantages:** Selection bias. Problem of generalizability

B.iii Quota Sampling:

- The population is first segmented into mutually exclusive sub-groups
- Then judgement/convenience used to select subjects or units from each segment based on a specified proportion
- In quota sampling the selection of the sample is non-random
- **When to Use Quota Samples**
  It allows the researchers to sample a subgroup that is of great interest to the study
  Also allows to observe relationships between subgroups
- **Advantages:**
  Contains specific subgroups in the proportions desired
  Used when research budget is limited
  Easy to manage, less time consuming
- **Disadvantages:**
  Only reflects population in terms of the quota
  Not possible to generalize

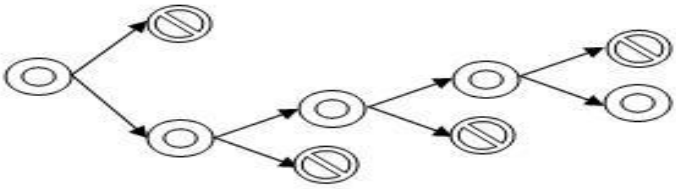


Symbol	Age Group	No.
	11-21 Years	11
	22-31 Years	16
	32-41 Years	15
	42-51 Years	18
Total	11-51 Years	60

Quota Sampling

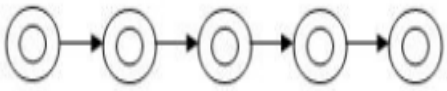
B.iv. **Snowball Sampling/ Chain Referral Sampling**

- The research starts with a key person and introduce the next one to become a chain
- The contact with an initial subject is used to make contact with others
- Useful when a population is hidden or difficult to gain access to

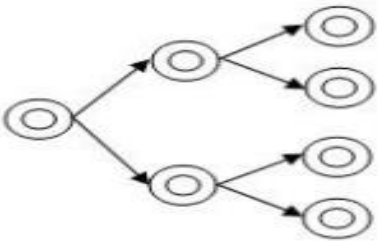


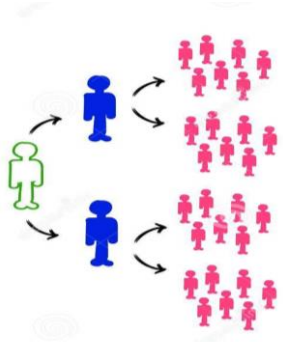
- **Types of Snowball Sampling**

- Linear Snowball Sampling



- Exponential





To identify potential subjects in studies where subjects are hard to locate

If the sample for the study is very rare or is limited to a very small subgroup of the population

- **Advantages:**

Simple & cost efficient

Useful in specific circumstances & for Identifying small, hard-to reach, uniquely defined target population

Needs little planning and fewer workforce

- **Disadvantages:**

Not independent

Projecting data beyond sample not justified (Limited generalizability)

9. PROBABILITY

Competency	Learning objectives	Assessment
CM6.2 Methods of collection, classification, analysis, interpretation and presentation of statistical data	**The student should be able to** • Define probability • Explain and demonstrate laws of probability	Written/ viva voce/ Skill assessment

- The probability of specified event is the fraction or proportion of all possible events of a specified type in a sequence of almost unlimited random trials under similar conditions.
- Probability is a measure of the likelihood of a random phenomenon or chance behavior. Probability describes the long-term proportion with which a certain outcome will occur in situations with short-term uncertainty.
- Probability may be defined as relative frequency or probable chances of occurrence with which an event is expected to occur on an average.
- An element of uncertainty is associated with every conclusion because information on all happenings is not available. This uncertainty is numerically expressed as "Probability."
- If there are 'n' equally likely possibilities, of which one must occur and 's' is regarded as favorable or as "success',
  The probability of a "success" is given by the
  Ratio= **s/n.**
- Probability is denoted by p and it ranges from 0 to 1
  'q' i.e probability of not happening event is given as
  q=1-p OR p + q =1
- Eg: the probability of getting Head or Tail in one toss are fifty-fifty or half and half, i.e., p = ½
- When the occurrence of an event is an absolute certainty then the probability of its occurrence i.e. p=1
  Eg.- Death of any living being
- Similarly chances of survival after rabies, in this case the probability of its occurrence i.e. p=0

Random experiment & sample space

Random experiment—

- All the trials conducted under same set of condition form a random experiment.
- An **event** is the result or outcome of an experiment.
- Event is denoted using capital letters such as '*E'*

SAMPLE SPACE:

- denoted by '***S'*** of a probability experiment is the collection of all possible events.
- In other words, the sample space is a list of all possible outcomes of a probability experiment.

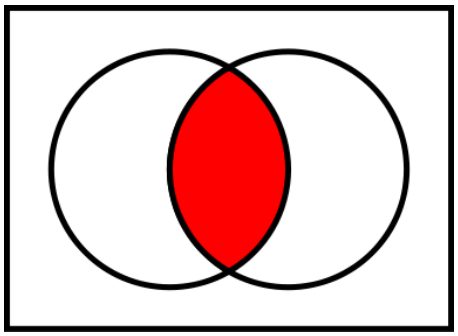
UNION

- The **union** is a basic operation in set theory that provides a way to group the elements from two sets into one new set.
- So the statement, "x is an element of A or an element of B" **means** that one of the three is possible:
  - x is an element of just A
  - x is an element of just B
  - x is an element of Both A&B

INTERSECTION

- The intersection of *A* and *B* is written "$A \cap B$".
- That is, *x* is an element of the intersection $A \cap B$ if and only if *x* is both an element of *A* and an element of *B*.
- For example:

The intersection of the sets {1, 2, 3} and {2, 3, 4} is {2, 3}.



TYPES OF EVENTS

- **MUTUALLY EXCLUSIVE EVENT**

  Only one of the event can occur and two or more events cannot happen simultaneously.

  Eg: Tossing a coin once, you get either heads or tail .

- **EXHAUSTIVE EVENT**

  Include all possible cases in experiment .

  Eg:In case of throwing two fair dice together the exhaustive events are 36.

COMPLEMENTARY EVENTS

Two events A & B said to be complementary if – A&B are mutually exclusive and also exhaustive

Eg.-tossing a coin we get head or tail,so head & tail are mutually exclusive & exhaustive events

INDEPENDENT EVENT

Events are said to be independent if the happening (or non happening) of an event is not affected by the supplementary knowledge about occurrence of remaining Events.

p-VALUE

- When you perform a hypothesis test in statistics, a *p*-value helps you determine the significance of your results.
- It helps to determine the likelihood of an event to have occurred by chance
- Hypothesis tests are used to test the validity of a claim that is made about a population. This claim that's on trial, in essence, is called the ***null hypothesis***.
- The alternative hypothesis is the one you would believe if the null hypothesis is concluded to be untrue.
- The *p*-value is a number between 0 and 1 and interpreted in the following way
  A small *p*-value (typically < 0.05) indicates strong evidence against the null hypothesis, so you reject the null hypothesis.
  A large *p*-value (> 0.05) indicates weak evidence against the null hypothesis, so you fail to reject the null hypothesis.

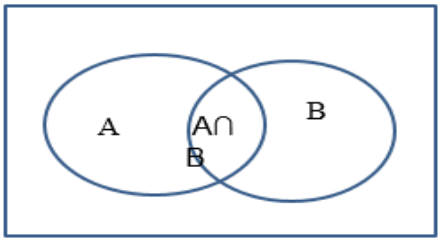
ADDITION RULE OF PROBABILITY

- The addition rule is concerned with determining the probability of occurrence of any one of several possible events.

1) There are two possible events, A and B. the probability of occurrence of A or B is equal to the probability of occurrence of A plus the probability of occurrence of B minus the probability of occurrence of both A and B

p(A or B)= p(A)+ p(B) – p (A and B)

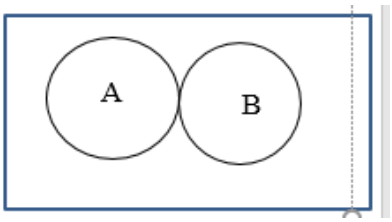
P (A U B) =P (A) + P (B) —P (A∩ B)



- When two events are mutually exclusive, the probability of both events occurring together is zero.

The addition rule becomes---

P (A U B)=P (A)+ P(B)



- Eg …Getting head excludes probability of getting tail on tossing a coin, birth of male child excludes birth of a female child, throw of 2 excludes other five events i.e 1,3 ,4 ,5 & 6

The word 'OR' is there when addition law is applied

e.g. getting Rh –ve or Rh +ve child , a drug will cure or no effect

When a die thrown ,probability of getting 2 or 6 in one throw will be 1/6+1/6=2/6=1/3

MULTIPLICATION LAW OF PROBABILITY

While applying multiplication rule it is necessary to distinguish among two conditions—

1) When the events are mutually exclusive

2) When the events are independent

When two events are Independent then Symbolically:-

$$P(A \cap B)=P(A)\times P(B)$$

- Similarly if A& B are two mutually exclusive events then

$$P(A \cap B)=P(B)\times P(A/B)$$

or

$$P(A/B) = P(A \cap B) / P(B)$$

Eg. A die thrown twice in succession what will be the probability of getting 5 in Ist & IInd throw ?

$$1/6\times 1/6=1/36$$

CONDITIONAL PROBABILITY

- The ***conditional probability*** is the probability of an event occurring given that another event has already occurred
- This probability is written *P(B|A)*, notation for the probability of B given A.

a) The probability of A given B

$$P(A/B)=\frac{P(A \text{ and } B)}{P(B)} \qquad \text{Where } P(B)>0$$

b) The probability of B given A Where P(A)>0

$$P(B/A)=\frac{P(A \text{and } B)}{P(A)}$$

BINOMIAL LAW OF PROBABILITY

- When two children are born one after the other possible sequences will be
- M& M---1/2 ×1/2=1/4
- M&F— 1/2 ×1/2=1/4
- F&M ---1/2 ×1/2=1/4
- F&F --- 1/2 ×1/2=1/4
- Chances of getting 2 males =1/4=25%

- Chances of getting 2 females=1/4=25%

BAYES' THEOREM

- Bayes' rule also called as Bayes' Theorem or Inverse Probability is named after English mathematician "Reverend Thomas Bayes."

In health sciences, it is used to compute the predictive value of probability of disease, given that particular symptoms have occurred.

According to BAYES' rule;

$$P(B/A)=\frac{P(A/B)\times P(B)}{P(A)}$$

Applied Biostatistics

I N D E X

Sr. No.	Title of	Date	Page No.	Grade	Signature of the teacher
1.	**Population Estimation** ***a. For Quantitative data*** ***b. For Qualitative data***				
2.	**Test of significance** **'Z' test** ***a. For Quantitative data*** ***b. For Qualitative data***				
3.	**Student 't' test** ***a. Paired 't' test*** ***b. Unpaired 't' test***				
4.	**Chi-Square test**				
5.	**Correlation coefficient and Rank correlation**				
6.	**Regression**				
7.	**Vital Statistics - rates and ratios**				
8.	**Applications of computer in Medical Sciences**				

Completed / Not completed / Late **Signature of the Teacher in-charge**

1. Population Estimation

Competency	Learning objectives	Assessment
CM6.2/6.3 Demonstration and exercises on the application of elementary statistical methods including test of significance in various study designs and interpretation of statistical tests.	**The student should be able to** • Estimate 95%, 99% confidence limits for population mean • Test whether sample is drawn from sample having population mean equal to some specified value	Written (MCQ, SAQ, Solve exercises)/ viva voce/ Skill assessment

- The phenomenon of variation in the sample statistics from population parameter is called **"*sampling variation*".**
- *The limits within* which sample statistics will vary from population parameter are called **"*confidence limits*".**
- The sampling variation is quantified by **"*standard error*".**
- *For quantitative variables* standard error is called **standard error of mean (SEM).**
- For qualitative variables it is called **standard error of proportion (SEP).**

❑ **SEM (**Standard error of mean**):** Standard error of mean is a measure of variation for quantitative data. To estimate population mean, S.E. of sample mean can be given as follows:

$$SEM = \sigma/\sqrt{n}$$

Where σ = Standard deviation of population
and *n = sample size.*

- If population SD (σ) not known, it is replaced

by sample SD (*s). The formula becomes*

$$SEM = s/\sqrt{n}$$

- The relative deviate (*z) for any given value* of sample mean *m1 can be calculated by* following equation

$$z = \frac{m1 - M}{SEM}$$

Interpretation/Use of SEM:

1. To find out the confidence limit within which the population mean would lie at specified level of significance.

2. To test whether the sample mean is drawn from population with known population mean (M).

➢ ***When M - the population mean* (*M) is known****:*

- *We have to decide whether a* sample with mean *m1, size = n and standard* deviation = *s is likely to have been drawn from* the population with mean *M (here we do not* know population SD, i.e. σ).
- Under such circumstances, at the outset we make following assumptions.
  i. That the sample is drawn from the population in question and then proceed to test whether the assumption is correct or wrong.
  ii. That the *s is the best estimate of S or so that SEM is calculated as below:*

$$SEM = s/\sqrt{n}$$

- Thus, now if the mean of the sample (*m1) is* within the range of *M ± 2SEM, we can say that* it is likely to be drawn from the population with mean *M. Else, it is less likely to be drawn* from the population with mean *M.*

➢ ***When M is unknown:***

- *This is a common* situation.
- Here, with the help of *mi and s we* can make a reasonable estimate of *M that is* unknown.
- Two commonly accepted estimates are of 95% and 99% confidence as given below:
  1. *M = mi ± 2SEM (estimate with 95%* confidence).
  2. *M = mi ± 3SEM (estimate with 99%* confidence

❑ **The confidence limits** for the population mean can be given as:

- 95% confidence limits for population mean = Sample mean ±2 SEM
- 99% confidence limits for population mean= Sample mean ±3 SEM

If we draw a large number of samples (say '*K' numbers) from infinite population and we* designate the means of each sample as *m1, m2, m3, m4 … mk, etc. then in such situations it has* been shown that:

- About 68% sample means would be within the range of *M ± 1SEM;*
- *95% would* be within the range of *M ± 2SEM and*
- *about* 99% would be within the range of *M* ± 3*SEM. These are called 68%, 95% and 99%* confidence limits respectively.
- A sample mean beyond the range *M* ± 2*SEM would be considered as uncommon.* The possibility of such samples would be 5% or less. So a sample with mean beyond the range of *M ± 2SEM is less likely to be* drawn from the population with mean *M.*

- **SEP (standard error of proportion):** It is a measure that describes the sampling variation of a variable that is measured in nominal/ordinal scale as a dichotomous variable.

- Suppose in a population of size *N; A is the number of persons with* an attribute, so that the number of persons who do not have that attribute is (*N – A).*
- *The* probability that a randomly selected person from the population has that attribute is designated as *P and the probability that a* person does not have the attribute in question will be (1 – *P).*
- *The value of P is obtained by:* ***P = A/N***
- For sample the equation is: ***p = a/n***

- **The confidence limits for the population proportion can be given as**:

- If we draw a large number of samples (say '*k' numbers) from an infinite population and* designate the proportion of the attribute in them as *p1, p2, p3, … pk, etc. then in this situation* it has been shown that:

1. About **68%** of samples would have *p within* the range of ***P ± 1SEP***, *about* ***95%*** *would* have within the range of ***P ± 2SEP*** *and* about **99%** would have within the range of ***P ± 3SEP***.
2. Proportion of an attribute in a sample beyond the range of *P ± 2SEP would be* rare or uncommon as it is beyond 95% confidence limit. The probability of such samples would be 5% or less.
3. **If a sample shows *p beyond the range of P ± 2SEP, then it is less likely to belong to* the population where the proportion of that attribute is equal to *P.***

- **Interpretation/Use of SEP:**
  1. To find the confidence interval for population proportion from sample.
  2. To test whether the sample is drawn from population with proportion P.

When P is known*:*

- *In this situation we have to* decide whether a sample with *p as the proportion* of the attribute in it, is likely to belong to the population in which the proportion of the attribute is *P.*
- *Here, at the outset we make the* assumption that the sample is drawn from the population under question and then proceed to test whether the assumption is correct.
- To do so we calculate the *SEP* , and find out if *p is in the range P ± 2SEP. If yes, then the sample is likely to* belong to the population in question, if not, then it is less likely to belong to the population in question.

If P is unknown:

- *Under these circumstances* we use *p to make estimate of P.*
- *Estimates of* 95% and 99% respectively are given by:

1. P(est) = p ± 2SEP …estimate *of 95%* confidence.
2. P(est) = p ± 3SEP …estimate *of 99%* confidence.

When population proportion P is known,

$$SEP = \sqrt{\frac{P(1-p)}{n}}$$

When population proportion P is unknown,

$$SEP = \sqrt{\frac{p(1-p)}{n}}$$

2. TEST OF SIGNIFICANCE

Competency	Learning objectives	Assessment
CM6.2/6.3 Demonstration and exercises on the application of elementary statistical methods including test of significance in various study designs and interpretation of statistical tests.	**The student should be able to** • Explain choice of test of significance as per the type of variable, sample size, objective of the test • State Null hypothesis and Alternate hypothesis • Perform and interpret Z-test: Test of significance of difference between two means step by step • Perform and interpret Z test: Test of significance of difference between two proportions step by step	Written (MCQ, SAQ, Solve exercises)/ viva voce/ Skill assessment

- **A test of significance is required to decide whether**

i. The observed difference/ association/ correlation in two or more variables is due to chance (sampling variation) or

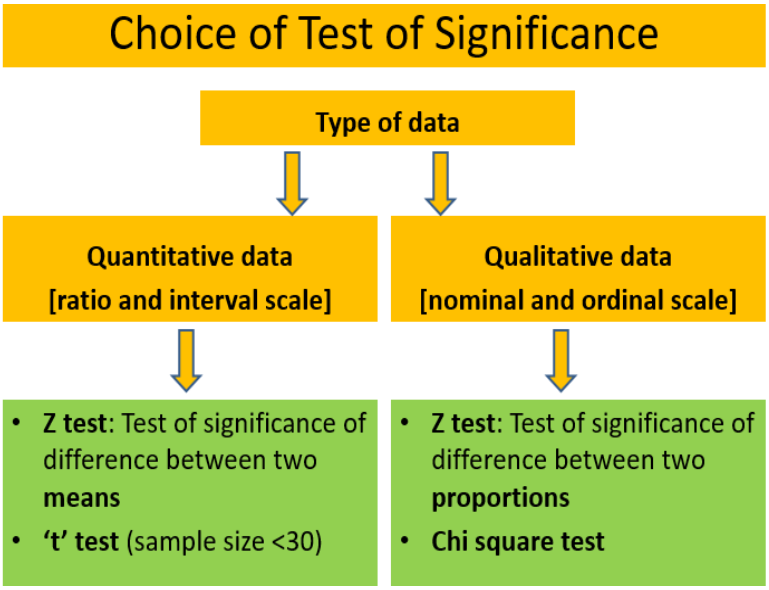
ii. It is due to the difference in the populations from which these samples are drawn.

- **Steps in a Typical Test of Significance**

1. Identify the type of data and variable
2. Choose appropriate test
3. State the *NH and AH*
4. Apply the chosen test and calculate *P*
5. Interpret (accept/reject *NH, accept/reject AH).*

- **Choice of test of significance depends on:**

A. Objective of the test
B. Type of variable
C. Distribution of variable: Normal or not
D. Sample size



Z TEST

a) **Z test: Test of significance of difference between two means (Z-test)**
b) **Z test: Test of significance of difference between two proportions (Z-test):**

a) **Z test: Test of significance of difference between two means (Z-TEST)**

- **Application:** This test is applied to find out any significant difference between two sample means in two different comparable groups under study.
- **Criteria's:**
    1. Data must be quantitative: Variable is measured on ratio or interval scale and is assumed to have normal (Gaussian) distribution.
    2. Data must be large (i.e. n > 30)
    3. Random sample drawn from the normal population.

*** Steps involving in the Z test:**

1. **Hypothesis Statement**
   State the null hypothesis (NH or H_0) ***NH: M1 = M2*** as there is no significant difference between two sample means under study. Observed difference in sample means *m1 and m2 is due to sampling variation.*

Alternate hypothesis (*AH or H1)* *could be two sided* (*AH2) i.e. AH2: M1 ≠ M2 or one-sided (AH1)i.e. AH1: M1 > M2, or M1 < M2. Means of the* samples are (i.e. *M1 and M2)* ***not equal***.

2. ***Calculate SEM: This is done using Equation.***
   SEM1 = s1/ √n1
   SEM2 = s2/ √n2
3. ***Calculate standard error of difference between two means (SEDM):*** *For this we* use following equation

$$SEDM = \sqrt{\{(SEM1)^2 + (SEM2)^2\}}$$

$$SE = \sqrt{\frac{SD1^2}{n1} + \frac{SD2^2}{n2}}$$

3. Find out the value of the Test Statistic i.e. value of 'Z' as follows:

$$\boldsymbol{Z = |m1 - m2| / SEDM}$$

Where, m1 and m2 are the sample means of the two samples n_1 and n_2 respectively and SEDM is the standard error of the difference between two sample means.

4. Determine 'p' value i.e. probability as follows:
   a **Significant difference**: If calculated value of Z > 1.96 or 2.58 (table value), then reject null hypothesis NH or H_0 at 5% level of significance (i.e. p<0.05, Significant) and at 1% level of significance (i.e. p<0.01, Highly significant) respectively.
   b ***No significant difference:*** *If the calculated Z-value < table value at l.o.s.5% or 1%: : accept NH and reject AH*

5. Determine the result according to acceptance and rejection of the null hypothesis.

b) Z test: Test of significance of difference between two proportions (Z-TEST):

- **Application:** This test is applied to find out any significant difference between two sample proportions in two different comparable groups under study.
- **Criteria's:**
  1. Data must be qualitative either nominal/ordinal scale variable
  2. Data must be large (i.e. n > 30)
  3. Random sample drawn from the normal population

*** Steps involving in the Z test:**

1. **Hypothesis statement**
   i. State the null hypothesis (NH or H_0) ***P1 = P2:*** as there is no significant difference between two sample proportions under study

ii. Alternative hypothesis (AH or H_1) ***P1 ≠ P2****: Proportion of the variable in* population from which the samples are drawn (i.e. *P1 and P2) is* ***not equal****. Alternatively,* the *AH could be AH1: P1 > P2, or P1 < P2.*

2. ***Calculate SEP1 and SEP2 using Equation*** :

$$SEP = \sqrt{\frac{P(1-p)}{n}}$$

3. ***Calculate standard error of difference in two proportions (SEDP):***

$$SEDP = \sqrt{\{(SEP1)^2 + (SEP2)^2\}}$$

4. Find out the value of the Test Statistic i.e. value of 'Z' as follows:

$$Z = \frac{|p1 - p2|}{SEDP}$$

Where, p_1, p_2 are the sample proportions of the two samples n_1 and n_2 respectively and SE ($p_1 - p_2$) is the standard error of the difference between two sample proportions

5. Determine 'p' value i.e. probability *by* referring to tables of *z-scores*
   - ***Significant difference:*** If calculated value of Z > 1.96 or 2.58 (table value), then reject null hypothesis NH or H_0 at 5% level of significance (i.e. p<0.05, Significant) and at 1% level of significance (i.e. p<0.01, Highly significant) respectively.
   - ***No significant difference:*** *If the calculated Z-value < table value at l.o.s.5% or 1%: accept NH and reject AH*

6. Determine the result according to acceptance and rejection of the null hypothesis.

3. ‘t’ Test or Student’s t test

Competency	Learning objectives	Assessment
CM6.2/6.3 Demonstration and exercises on the application of elementary statistical methods including test of significance in various study designs and interpretation of statistical tests.	**The student should be able to** • Explain Applications of paired and unpaired ‘t’ test • State Null hypothesis and Alternate hypothesis • To compare difference between paired observations and compare difference between unpaired observations • Test if two sample means are significantly different or not for small sample sizes	Written (MCQ, SAQ, Solve exercises)/ viva voce/ Skill assessment

- ‘t’ test was designed by W. S. Gossett whose pen name was ‘Student’ hence also called Student’s t test.
- Student’s ‘t’ distribution: a sampling distribution used in test of hypothesis dealing with specified value of mean (one sample problem) or equality of two population means (two sample problem)
- Properties of t distribution:
    1. It has mean 0
    2. Variance greater than one
    3. Bell shaped symmetrical distribution about mean
    4. Compared to normal distribution it is flatter with thicker tails
    5. For large values of n (> 30) t distribution approches normal distribution
- It is one of the small sample tests used **when sample size is small i.e. less than or equal to 30.**
- **‘t’ test** was designed by **W. S. Gossett** whose pen name was ‘Student’ hence also called **Student’s t test**.
- **The assumptions for t test:**
    1. Sample must be random
    2. Population standard deviation is not known
    3. Distribution of population from which sample is drawn is normal
- **Uses of t test:** Testing the significance of
    1. The mean of the sample

2. The difference between means or to compare two samples

- **Test statistic 't':** Ratio of observed difference between two means of small samples to the SE of difference in the same is denoted by letter **'t'**
- **Degrees of freedom**: the quantity in the denominator which is one less than the independent number of observations in a sample.

(a)Paired 't' test:

This test is applied when the observations are paired i.e. grouped. When the observations are made on the same individual before and after exposure or experiment to some influence one has to apply Paired 't' test.

- **Application:** This test is applied to find out there is any significant difference between mean values of before and after observations.
- **E.g.**

To study the role of a factor or cause when the observations are made before and after its play
To compare observations made at two different sites in the same body
To compare the results of two different laboratory techniques.
Testing by this method eliminates individual sampling variations because the sample is one and observations on each person in the sample are taken before and after the experiment.

- **Criteria's:**
  1. Data must be quantitative.
  2. Data must be small (i.e. n < 30)
  3. Random sample drawn from the normal population

*** Steps involving in the Paired 't' test:**

1. Stating the hypothesis
2. Find the difference in each set of paired observations before and after (X1 – X2 = x)
3. Calculate then mean of the difference ($\bar{X}$)
4. Calculate the SD of differences and then SE of mean from the same,

$$SD = \sqrt{\frac{\Sigma(x-\bar{X})^2}{n-1}}$$

$$SE = \frac{SD}{\sqrt{n}}$$

5. Determine ‘t’ value:

$$t = \frac{\bar{X}}{SE}$$

6. Find the degrees of freedom = n – 1 (as there is one and the same sample)
7. Determine ‘p’ value i.e. probability as follows:

For this first find out degrees of freedom d.f. = n-1

If calculated value of ‘t’ is more than the table value of ‘t’ at specific degrees of freedom then reject null hypothesis and accept alternate hypothesis means there is statistically significant difference between the two means. [reject null hypothesis H_0 at n_1+n_2-2 d.f. and at 5% level of significance (i.e. $p<0.05$, Significant) and at n_1+n_2-2 d.f. and at 1% level of significance (i.e. $p<0.01$, Highly significant) respectively.]

Determine the result according to acceptance and rejection of the null hypothesis.

(b) Unpaired ‘t’ test

This test is applied when the observations are unpaired i.e. ungrouped. When the observations are made on the two or more than two different samples one has to apply unpaired ‘t’ test.

- **Application:** This test is applied to find out there is any significant difference between two sample means of two different samples under study
- **Criteria’s:**
    1. Data must be quantitative.
    2. Sample size (*n1 or n2) is less than 30.*
    3. Random sample drawn from the normal population
    4. Variable is measured on ratio or interval scale assumed to show normal (Gaussian) distribution.
- **Test procedure:** Test involves calculation of test statistic ‘t’ and determining probability by referring to tables of t-values.
- **Statistics required:** ***Raw data:***
    1. Means (m1 and m2) of two groups,
    2. SDs (s1, s2) and
    3. Sample sizes (n1, n2) of two groups.

*** Steps involving in the Unpaired ‘t’ test:**

1. Statement of hypothesis:

Null hypothesis (NH0)- there is no real difference between means of two samples, if the samples are taken at random and drawn independently.

Alternate hypothesis (AH1)- there is real difference between means of two samples

2. Find the observed difference between means of two samples (m1-m2).
3. Calculate the SE of difference between the two means:

$$SE = \sigma \sqrt{\frac{1}{n1} + \frac{1}{n2}}$$

- if **σ** is not known then use combined variance or SD^2
-

$$\boldsymbol{SD^2 = \frac{\Sigma(x - \bar{x})^2 \textit{ of group one} + \Sigma (x - \bar{x})^2 \textit{ of group two}}{\textit{total number of two groups} - 2}}$$

$$SD = \sqrt{\frac{\Sigma(x - \bar{x})^2 \textit{ of group one} + \Sigma (x - \bar{x})^2 \textit{ of group two}}{\textit{total number of two groups} - 2}}$$

4. Calculate the 't' value:

$$t = \frac{\bar{x} \textit{ of group one} - \bar{x} \textit{ of group two}}{SE}$$

5. Determine the pooled degrees of freedom:

df = (n1 - 1) + (n2 - 1) = n1 + n2 – 2

6. Determine 'p' value i.e. probability as follows:

Compare the calculated value with the table value at particular degree of freedom to find the level of significance.

If calculated value of 't' is more than the table value of 't' at specific degrees of freedom then reject null hypothesis and accept alternate hypothesis means there is statistically significant difference between the two means. [reject null hypothesis H_0 at n_1+n_2-2 d.f. and at 5% level of significance (i.e. $p<0.05$, Significant) and at n_1+n_2-2 d.f. and at 1% level of significance (i.e. $p<0.01$, Highly significant) respectively.]

4. Tests of significance Chi-Square test (χ^2)

Competency	Learning objectives	Assessment
CM6.2/6.3 Demonstration and exercises on the application of elementary statistical methods including test of significance in various study designs and interpretation of statistical tests.	**The student should be able to** • Explain Applications of Chi-square (χ^2) • State Null hypothesis and Alternate hypothesis • To test whether there is association or relation between two qualitative variables	Written (MCQ, SAQ, Solve exercises)/ viva voce/ Skill assessment

This is a Non-parametric test of significance, which is used to find significant association between two variables e.g. smoking and cancer.

Application: To find out significant association between two variables under study e.g. smoking and cancer, attack rate and vaccination, occupation and literacy etc.

- **Test of proportion**: To find the significance of difference in 2 or more than 2 proportions
- **Test of association**: Test of association between two events in binomial or multinomial samples. It measures the probability of association between 2 discrete attributes. **Test for independence of attributes:** 2 possibilities: either they influence (dependent on each other)/ affect each other or they do not (independent of each other) e.g. complications and severity of disease. It can be applied to find association/ relationship between two discrete attributes when there are **more than two classes or groups** as happens in multinominal samples
- **Goodness of fit:** to test whether the difference between the theoretical and observed values can be attributed to chance or not
- **Criteria's:**
    1. Data must be qualitative
    2. Data must be large (n>30)
    3. Random samples selected from the normal population
    4. Expected frequency in any of the cell in 2x2 contingency table (two rows and two columns) should no be less than 5.

- ***Test procedure:*** Test involves calculation of test statistics of Chi-square (χ2) and determining the probability by referring to tables of Chi-square.
- ***Statistics required:***

- Raw data,
- Proportion of variable in two/ more groups (*p1, p2),*
- Sample size in two groups (*n1, n2).*

- **<u>Steps involving in the Chi-Square Test:</u>**

1. State the null hypothesis ***NH*** (H_0) as there is no significant association between two variables under study and its alternative hypothesis ***AH*** (H_1) (*NH: P1 = P2 and AH Observed difference in p1 and p2 is due to sampling variation.)*
2. . ***Calculate expected values for each observed value: Chi-square (χ2):***
   This step involves calculation of "expected values" (*E) for all 4 observed (O) values at a, b, c and d.*
3. *This is done with* following equation

   E = RT × CT/GT

   where ***RT*** *= row total,* ***CT*** *= column total for* respective observed value and ***GT*** *is grand* total.

4. Find out the value of the Test Statistic i.e. value of 'χ^2' as follows:

$$\chi 2 = \sum \left[\frac{(O-E)^2}{E} \right]$$

where O = Observed observations and E = Expected values.

Two by two (2x2) contingency table means two rows and two columns which is as follows:

	C_1	**C_2**	**Total**
R_1	O_1	O_2	**R_1 T**
R_2	O_3	O_4	**R_2 T**
Total	**C_1T**	**C_2T**	**GT**

Where O_1 O_2 O_3 O_4 are the observed values. R1, R_2, C_1, C_2 are the rows and columns respectively and R_1T, R_2 T, C_1T, C_2T are the row totals and column totals of the respective rows and columns and GT is the grant total.

The expected values of the respective observed values in each cell are given as follows:

$E_1 = R_1$ T x C_1T / GT ; $E_2 = R_2$ T x C_2T / GT

$E_3 = R_3$ T x C_3T / GT ; $E_4 = R_4$ T x C_4T / GT

3. Determine 'p' value i.e. probability as follows:

Calculate degrees of freedom (DF): The DF is defined as the total no. of observations minus the no. of independent constraints imposed on the observations. Denoted by 'neu'.

Calculated by following equation

$$DF = (R - 1)(C - 1)$$

where *R and C represent rows and columns* of expected values.

4. ***Find table value of Chi-square (TVC): For*** this we refer to Chi-square table. The first row, like table of *t test*, shows cumulative probability. First column shows degrees of freedom. Usually we refer to cell corresponding to $P = 0.05$ and our *DF*.
5. ***Interpretation***

If (*CVC)* calculated value of 'χ^2' > (*TVC)* table value of 'χ^2' then reject null hypothesis NH /H_0 and accept *AH1* at (R-1) x (C-1) d.f. and at 5% level of significance (i.e. p<0.05, Significant) and at (R-1) x (C-1) d.f. and at 1% level of significance (i.e. p<0.01, Highly significant) respectively.
If $CVC \leq TVC, P \geq 0.05$, *AH1 rejected*

6. Determine the result according to acceptance and rejection of the null hypothesis

The alternative formula for the Chi-square test is as follows:

$$\chi^2 = \frac{(ad - bc)^2 (a + b + c + d)}{(a + b)(c + d)(a + c)(b + d)}$$

where N= a + b + c + d and

	C_1	**C_2**	**Total**
R_1	a	b	**a+b**
R_2	c	d	**c+d**
Total	**a+c**	**b+d**	**a+b+c+d**

- **Yate's correction of continuity:**

If any of the expected value is less than 5, Yate's correction of continuity is applied. the formula for calculating the Chi-square with Yate's correction is

$$\chi^2 = \sum \left(\frac{(|O - E| - 0.5)^2}{E} \right)$$

5. Correlation

Competency	Learning objectives	Assessment
CM6.2/6.3 Demonstration and exercises on the application of elementary statistical methods including test of significance in various study designs and interpretation of statistical tests.	**The student should be able to** • Calculate the correlation between two qualitative variables • Interpret correlation coefficient	Written (MCQ, SAQ, Solve exercises)/ viva voce/ Skill assessment

Introduction: Correlation measures the degree of relationship between the variables.The relationship of quantitative nature, the appropriate statistical tool for discovering and measuring the relationship, and expressing it in a brief formula is known as Correlation. Correlation is a statistical device which helps us in analyzing the covariance of two or more than two variables.

TYPES OF CORRELATION Positive or negative Simple, partial and multiple Linear and Non-linear

Correlation is positive (direct) or negative (inverse) would depend upon the direction is a change of the variables. If both variables are varying in the same direction, i.e. if one variable is increasing (decreasing) the other is also increasing (decreasing) – Positive correlation If one variable is increasing (decreasing) the other is decreasing (increasing) – negative correlation

METHODS OF CO-RELATION

1. Scatter diagram (dot diagram)
2. Karl Pearson's coefficient of correlation
3. Spaerman's rank correlation coefficient

2. Karl Pearson's correlation coefficient:

It is denoted by 'r' Range of r: $-1 <= r <= 1$

Formula: $r = \Sigma xy / N \delta x \delta y$ where $x = (X-X)$ and $y=(Y-Y)$ and δx= SD of X, δy=SD of Y

Direct method:

When the number of observations are small and when the figures are not large and odd then following formula can be used :

$$\mathbf{r = \{\Sigma XY - N\bar{X}\bar{Y}\}/ \sqrt{\{\Sigma X^2 - N(\bar{X})^2\}} \sqrt{\{\Sigma Y^2 - N(\bar{Y})^2\}}}$$

Example: Find out Karl Person's correlation coefficient of the following data showing relationship between Weight (Kg) and Hb (gm %) of 7 patients admitted in a hospital:

	Weight (kg) (X)	**Hb (gm %) (Y)**
1.	53	12
2.	49	10
3.	54	11
4.	43	9
5.	45	12
6.	55	13
7.	44	10

Solution: given that, n=7, X= weight and Y= Hb Formula for Karl Pearson's correlation coefficient is

$$r = \Sigma XY - N\bar{X}\bar{Y} / \sqrt{\{\Sigma X - N(X)^2\}} \sqrt{\{\Sigma Y - N(Y)^2\}}$$

Weight (kg) (X)	Hb (gm%) (Y)	X^2	Y^2	XY
53	12	2809	144	636
49	10	2401	100	490
54	11	2916	121	594
43	9	1849	81	387
45	12	2025	144	540
55	13	3025	169	715
44	10	1936	100	440

$\Sigma X = 343$ $\Sigma Y = 77$ $\Sigma X^2 = 16961$ $\Sigma Y^2 = 859$ $\Sigma XY = 3802$

$\overline{X} = \Sigma X/N = 49$ $\overline{Y} = \Sigma Y/N = 11$

Putting the values in the formula as follows:

$r = \Sigma XY - N X Y / \sqrt{\{\Sigma X^2 - N(X)^2\}} \sqrt{\{\Sigma Y^2 - N(Y)^2\}}$

$r = 3802 - 7*49*11 / \sqrt{\{16961 - 7*(49)^2} \sqrt{859 - 7*(11)^2\}}$

$r = 3802 - 3773 / \sqrt{16961 - 16807} \sqrt{859 - 847} = r = 29 / \sqrt{154} * 12$

$r = 29 / \sqrt{1848} = 29 / 42.99 = 0.67$

Thus correlation between weight and Hb level is positive.

RANK CORRELATION COEFFICIENT

The Karl Pearson's method is based on assumptions that the population being studied in normally distributed. This method of finding out co-variability or lack of it between two variables was developed by British Psychologist Charies Edward Spearman in 1904. This measures is especially useful when quantitative measures of certain factors (such as in the evaluation of leadership ability or the judgment of female beauty) can not be fixed, but the individual in the group can be arranged in order thereby obtaining for each individual a number indicating his (her) rank in the group.

Spearman's rank correlation coefficient is defined as: $R = 1 - \{6 \sum D^2 / N (N^2 - 1)\}$
Where D = the difference of rank between paired items in two variables.

Example : Find out Pearson's Rank Correlation coefficient of the following data:

S.N.	Marks in PSM (Out of 50)	Marks in ENT (Out of 50)
1.	33	28
2.	22	17
3.	20	29
4.	14	31
5.	29	38
6.	41	26
7.	37	36
8.	25	21
9.	18	14
10.	34	24

Solution: X-Marks in PSM Y-Marks in ENT N = 10

S.N.	X	Y	Rx	Ry	D = Rx-Ry	D^2
1.	33	28	4	5	-1	1
2.	22	17	7	9	-2	4
3.	20	29	8	4	4	16
4.	14	31	10	3	7	49
5.	29	38	5	1	4	16
6.	41	26	1	6	-5	25
7.	37	36	2	2	0	0
8.	25	21	6	8	-2	4
9.	18	14	9	10	-1	1
10.	34	24	3	7	-4	16

$\sum D^2 = 132$

Applying formula for pearson's Rank Correlation coefficient as follows:

$R = 1-6 \sum D2 / N3 -N$

$= 1- \{6*132 / (103 – 10)\}$

$= 1-\{792 / (1000 – 10)\}$

$= 1-\{792 / 990\}$

$= 1-0.8$

$R = 0.2$

6. REGRESSION

Competency	Learning objectives	Assessment
CM6.2/6.3 Demonstration and exercises on the application of elementary statistical methods including test of significance in various study designs and interpretation of statistical tests.	**The student should be able to** • To predict the unknown values of one variable from known values of another variable	Written/ viva voce/ Skill assessment

Regression analysis reveals average relationship between two variables and this makes possible estimation of prediction. The meaning of the term regression is the act of returning of going back. Regression analysis is a statistical device with the help of which we are in a position to estimate (predict) the unknown values of one variable from known values of another variable. The variables which are used to predict the variable of interest is called the 'independent variable' and the variable we are trying to predict is called the 'depending variable'. The independent variable is denoted by 'X' and dependent variable is denoted by 'Y'. The analysis used is called the simple linear regression analysis. The liner means that an equation of a straight line of the form Y =a + bX.

Line of regression

There are two lines of regression for analysis of two variables under study and to estimate the unknown value.

1. Line of regression of X on Y is given as:

$X - \overline{X} = bxy\ (Y-\overline{Y})$

Where, $\overline{X}$ and $\overline{Y}$ are the means of X and Y respectively. bxy = Regression coefficient of X on Y and is calculated as follows: $bxy = r\sigma x / \sigma y$, Where, r is correlation coefficient between x and y and σx and σy are the SD's of x and y respectively.

2. Line of regression of Y on X is given as:

$$Y-\overline{Y} = b\ yx\ (X-\overline{X})$$

Where, $\overline{X}$ and $\overline{Y}$ are the means of X and Y respectively. b yx = Regression coeff. of X on Y and is calculated as follows: $byx = r\ \sigma y / \sigma x$, where, r is correlation coefficient between x and y and

σx and σy are the SD's of x and y respectively.

To estimate X when Y is known the line of regression of X on Y can be used. To estimate Y when X is known the line of regression of Y on X can be used.

Example:

1. Find out correlation coefficient and Construct two line of regression and estimate X when Y=85 for the following data:

S. No.	**Weight (kg) (X)**	**Diastolic BP (Y)(mm of Hg)**
1.	52	88
2.	57	92
3.	48	78
4.	45	72
5.	49	74
6.	51	98
7.	53	94

Solution:

Given that, n=7, X= weight and Y=DBP

X	**Y**	**X^2**	**Y^2**	**XY**
52	88	2704	7744	4576
57	92	3249	8464	5244
48	78	2304	6084	3744
45	72	2025	5184	3240
49	74	2401	5476	3626
51	98	2601	9604	4998
53	94	2809	8836	4982

$\Sigma X=355$ $\Sigma Y= 596$ $\Sigma X^2 = 18093$ $\Sigma Y^2 = 51392$ $\Sigma XY=30410$

$\bar{X} = 355/7 = 50.71$ $\bar{Y} = 596 /7=85.71$

Now, correlation coefficient will be as follows:

$r = \{\Sigma XY - N\,X\,Y\} / \sqrt{\{\Sigma X^2 - N(X)^2\}}\ \sqrt{\{\Sigma Y^2 - N(Y)^2\}}$

$=\{30410 - 7*50.71*85.71\}/\sqrt{\{18093 - 7*(50.71)^2}\sqrt{51392 - 7*(85.71)^2\}}$

$= 30410 - 30424.47/\sqrt{18093 - 18000.53}\ \sqrt{51392 - 51423.43}$

$= -14.47 / \sqrt{(92.47)*(-31.43)}$

$= -14.47/\sqrt{-2906.33}$

$= -14.47 / -53.91$

$= +0.27$

Line of regression of X (Weight) on Y (DBP) is as follows:

$$(\overline{X} - X) = b_{xy}\,(Y - \overline{Y})$$

where, $b_{xy} = r*SDx / SDy = 0.27*\sqrt{(92.47)/(-31.43)}$

$$b_{xy} = 0.27 * \sqrt{-2.94} = 0.27* - 1.71 = - 0.46$$

$(X-50.71) = -0.46 *(Y-85.71)$

$= (X-50.71) = -0.46\ Y+39.43$

i.e. $X = -0.46Y + 39.43+50.71$

Thus, $X = -0.46Y + 90.14$

Line of regression of Y (DBP) on X (Weight) is as follows:

$(Y - \overline{Y}) = b_{yx}\,(X - \overline{X})$

where, $b_{yx} = r*SDy / SDx = 0.27*\sqrt{(-31.43)/(92.47)} = 0.27 * -0.34 = -0.092 = (Y-85.71) = -0.092 *(X-50.71)$

$(Y-85.71) = -0.092\ X+4.66 =$ i, e. $Y = -0.092\ X + 4.66 + 85.71$

Thus, $Y = -0.092\ X + 90.37$

Now, to estimate X (weight) when Y (DBP) is given as 85 use Line of regression of X (Weight) on Y (DBP) as follows:

$X = -0.46Y + 90.14$

X estimate $= - 0.46 * 85 + 90.14 = - 39.10 + 90.14$

Thus, X estimate = 51.04

Thus, the estimated weight=51.04Kg when DBP =85mm of Hg

7. VITAL STATISTICS

Competency	Learning objectives	Assessment
CM9.2 Calculation and interpretation of demographic indices including birth rate, death rate, fertility rates	**The student should be able to** • Define vital statistics • Calculate and interpret important vital rates and ratios • Discuss current National Vital statistics	Written/ viva voce/ Skill assessment

DEFINITION

"Vital Statistics" has been used to denote facts systematically collected and compiled in numerical form relating to or derived from records of vital events, namely live birth, death, foetal death, marriage, divorce, adoption, legitimating, recognition, annulment, or legal separation. In essence, vital statistics are derived from legally registerable events without including population data or morbidity data.

USES OF VITAL STATISTICS

1) To describe the level of community health. 2) To diagnose community ills and determine the met and unmet health needs, 3) To disseminate reliable information on the health situation and health programmes. 4) To direct or maintain control during execution of program. 5) To develop procedures, definitions and techniques such as recording system, sampling schemes etc. 6)To undertake overall evaluation of health programmes and public health work.

For instance, carefully compiled causes of death in a city can provide answers to

1) The leading cause of death in the city? (Malaria, TB etc.) 2) At what age is the mortality highest and from what disease?
3) What sections of the city (women or children or individuals following certain occupation) are the unhealthiest and what is the outstanding cause of death there. 4) Comparison of cities in relation to their health status, health facilities to cope with the problem

IMPORTANT VITAL RATES AND RATIOS

A) FERTILITY RATES/INDICES

1) <u>Crude birth rate</u> : An index of the relative speed at which additions are being made to the population through child birth.

$$\text{Crude Birth rate} = \frac{\text{No. of live births during the year}}{\text{Estimated mid} - \text{year population}} \text{ x } 1000$$

2) **General Fertility Rate:** The number of births in a population depends on the proportion of women of child-bearing age. Thus a more appropriate measure of fertility would be obtained if we relate the live births to the total women in the reproductive age period viz., 15-44 years.

$$\text{General fertility rate} = \frac{\text{No.of live births in the year}}{no.of\ women\ of\ 15{-}44\ year} \text{ x } 1000$$

3) **General Marital Fertility Rate (GMFR):** If only the married women of 15-44 years age group, are considered, it is called as General Marital Fertility Rate.

$$\text{GMFR} = \frac{\text{Number of live births in a year}}{\text{Mid-year married female population in the age-group 15–49 years}} \times 1000$$

4) Age specific fertility rates: These take account of age-sex composition of population and are used to analyze the trend of the live birth rate for various ages.

$$\text{Age specific fertility rate} = \frac{\text{No. of live births in specific age group}}{\text{Estimated mid} - \text{year population}\ of\ females\ of\ same\ age} \text{ x } 1000$$

4) **Total Fertility Rate (TFR)**: Average number of children that would be born alive to a woman during her lifetime, who would be subjected to age-specific fertility rates of a given year.

$$\text{Total fertility rate} = \frac{sum\ of\ all\ age\ specific\ fertility\ rate}{1000} \text{ x } 10$$

(10 is the age group interval in a year)

5) **Gross Reproduction Rate (GRR):** Average number of female live births that would be borne to a woman during her lifetime who would be subjected to age- specific fertility rates of a given year.

$$GRR = \frac{5 \times \sum_{15\text{-}19}^{45\text{-}49} \text{ASFR for female live births}}{1000}$$

7) <u>Net Reproduction Rate (NRR):</u> Average number of female live births that would be borne to a woman during her lifetime who would be subjected to age specific fertility and mortality rates of a given year.

B) MORTALITY RATES:

1. **<u>Crude death rate (CDR)</u>:** To measure the decrease of population due to death.

$$\text{Crude death rate} = \frac{\text{No. of deaths in a given year}}{\text{Estimated mid} - \text{year population}} \text{ x } 1000$$

2. **<u>Specific Death rates:</u>** Specific death rates include age-specific (infants, neonates, geriatric), sex-specific, vulnerable group-specific (maternal cases), disease- specific etc

$$\text{Specific death rate} = \frac{\text{Number of specific deaths}}{\text{mid} - \text{year population}} \text{ x } 1000$$

$$\text{Specific death rate due to TB} = \frac{\text{no. of deaths due to tuberculosis during a calender year}}{\text{mid} - \text{year population}} \text{ x } 1000$$

$$\text{Specific death rate for males} = \frac{\text{no. of deaths among males}}{\text{mid} - \text{year population}} \text{ x } 1000$$

$$\text{death rate in january} = \frac{\text{no.of deaths in january x } 12}{\text{mid-year population}} \text{ x } 1000$$

3. **PROPORTIONAL MORTALITY RATE:**

$$\text{Proportional mortality from a specific disease} = \frac{\text{no. of deaths from the specific disease in a year}}{\text{total deaths from all causes in that year}} \text{ x } 100$$

4. **CASE FATALITY RATE:**

$$\text{Case fatality rate} = \frac{\text{total no. of deaths due to a particular disease}}{\text{total no. of cases due to the same disease}} \text{ x } 100$$

5. **MATERNAL MORTALITY RATE** : The risk of dying from causes associated with childbirth is measured by the maternal mortality rate. MMR =

$$\text{Maternal mortality ratio} = \frac{\text{Total no. of female deaths due to compications of pregnancy, childbirth or within 42 days of delivery from puerperal causes in an area during a given year}}{\text{Total no. of live births in the same area and year}} \text{ x } 1000$$

6. **AGE SPECIFIC DEATH RATES**:

$$\text{Age specific death rates} = \frac{\text{No of deaths in a particular age group}}{\text{Mid year population in that age group}} * 1000$$

a) **INFANT MORTALITY RATE** : It is one of the most sensitive indexes of health conditions of the general population. It is sensitive measure because a baby in its extrauterine life is suddenly exposed to a multitude of new environmental factors and their reactions are reflected in this rate. Under ideal conditions of social welfare no normal baby should die.

$$\text{infant mortality rate} = \frac{\text{Number of deaths of children less than 1year of age in a year}}{\text{Number of live births in the same year}} \text{ x } 1000$$

b) **NEO-NATAL MORTALITY RATE** : For deaths occurring under 28 days .

$$\text{Neonatal mortality rate} = \frac{\text{Number of deaths of children under 28 days of age in a year}}{\text{Total live births in the same year}} \times 1000$$

c) POST-NEONATAL MORTALITY RATE :

$$\text{Post-neonatal mortality rate} = \frac{\text{Number of deaths of children between 28days and one year age in a given year}}{\text{Total live births in the same year}} \times 1000$$

d) **FETAL DEATH RATIO :** This ratio related the number of late fetal deaths to the number of live births.

Fetal Death Ratio: {No. of fetal deaths of 28 or more completed weeks of gestation / No. of live births} x 1000

e) STILL BIRTH RATE:

$$\text{STILL BIRTH RATE} = \frac{\text{Foetal deaths weighing over 1000gm at birth during the year}}{\text{Total live+ sillbirths weighing over 1000gm at birth during the year}} \times 1000$$

1000gm body weight corresponds to 28 weeks of gestation.

f) **PERINATAL MORTALITY RATE:** Many late foetal deaths and early neo-natal deaths may be attributed to similar underlying conditions, so this rate is calculated.

$$\text{Perinatal mortality rate} = \frac{\text{Late foetal and early neonatal deaths weighing over 1000gm at birth}}{\text{Total live births weighing over 1000gm at birth}} \times 1000$$

g) 1-4 YEAR MORTALITY RATE:

$$1-4 \text{ year mortality rate} = \frac{\text{No. of deaths of children aged } 1-4\text{years during a year}}{\text{Total no. of children aged } 1-4\text{years at the middle of the year}} \text{ x } 1000$$

h) CHILD MORTALITY RATE:

$$\text{Child mortality rate} = \frac{\text{Number of deaths of children less than 5years of age in a given year}}{\text{Number of live births in the same year}} \text{ x } 1000$$

8. COMPUTERS IN MEDICINE

Competency	Learning objectives	Assessment
CM7.9 Demonstration and hands on training of application of computers in epidemiology. Demonstration and hands on exercises of application of MS- Excel, Epi Info etc.	**The student should be able to** • Enter the data into excel sheet • Analyse the data using MS-Excel and Epi Info	Written/ viva voce/ Skill assessment

Computers play a key role in almost every sphere of life. They facilitate huge amount of data, they enable speedy processing of information and they possess an in-built intelligence, which if supplemented with human intellect, can make wonders.

Computers are excellent means for storage of patient related data. Hospitals often employ computers systems to maintain patient's records like medical history, complaints of patient, prescribed medicine etc.

Computers helpful to keep track of prescriptions and billing information. Computers enable an efficient storage of huge medical data such as medical journal, research and diagnosis papers, important medical document and reference books etc.

Computers in surgical field

Computers are helpful to visualize internal organ of body. Some of the complex surgeries can be performed with help of computers.

Computers assisted surgery (CAS) is a fast advancing field in medicine , which combines medical expertise with computer intelligence to give faster and more accurate results in surgical procedure

Computers in diagnostic field

Medical imaging deals with technique to create images of the human body for medical purpose.

Modern methods of scanning and imaging are largely based on computer technology

Computers in Pharmacogenomics

Pharmacogenomics is compiling all gene types with corresponding toxic medications. Doctors soon be able to swipe a DNA sample from the patient blood onto a computer chip that contains gene information .The DNA would be absorbed by the patient that it matched to inform the doctor which medications would be absorbed by patient's gene.

Internet

Internet has enabled the growth of telemedicine

PUBMED is an online database of medical journal citations used extensively by researchers

Health information is available on the World Wide Web, enabling consumers to research their own symptoms

Also helpful in biomedical research

Classification of medical software

 Educational Medical Software
 Medical Diagnostics software
 Therapeutic Medical software
 Medical Design Software
 Statistical software: SPSS, Microsoft Excel, Graph Pad InStat, Open- Epi, Epi Info, Minitab, SAS (Statistical Analysis Software), R (R Foundation for Statistical Computing)

- **Smartphones:**

Smartphones are now used widely in community medicine primarily (a) as a handheld computer device for Google search, word or excel, stattodo site, ope-epi etc (b) more importantly with help of apps for several epidemiological and related functions such as environmental reports, surveys, analytic tasks, reporting etc.

Hence apps are the major tool for executing various tasks appropriate to community medicine. Taking the example of COVID 19 pandemic, here are some basic tasks available on smartphones: latest geo-mapping of cases, country status, WHO & ICMR reports, helplines, Health education resources, local availability of personal protective measures (PPMs), epidemiological reporting etc. You can add to this list by exploring various helps/apps developed for COVID19 or any such temporal issue at hand.

- **Microsoft Excel:**

Microsoft Excel is a spreadsheet program included in the Microsoft Office suite of applications. Spreadsheets will provide you with the values arranged in rows and columns that can be changed mathematically using both basic and complex arithmetic operations. Microsoft Excel was first released for Macintosh systems in the year 1985, followed by the first Windows version in 1987.

A spreadsheet is an electronic tool which consists of rows and columns. By convention columns are labeled as A, B, C… Z, AA, AB, AC … IT, IU, IV, etc. and rows are labeled as 1, 2 3, …etc. A typical spreadsheet consists of 256 columns (A to IV) and (256 × 256) 65536 rows. By convention rows represent a record and columns (also called fields) represent variables. One can give the titles to the rows to identify what variable it represents.

Uses of Microsoft Excel:

1. Preparing customized database
2. Data validation
3. Statistical functions
4. Preparing customized graphs

- **Epi Info:**

Epi Info is statistical software for epidemiology developed by Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia (US). Epi Info has been in existence for over 20 years and is currently available for Microsoft Windows, Android and iOS, along with a web and cloud version. The program allows for electronic survey creation, data entry, and analysis. Within the analysis module, analytic routines include t-tests, ANOVA, nonparametric statistics, cross tabulations and stratification with estimates of odds ratios, risk ratios, and risk differences, logistic regression (conditional and unconditional), survival analysis (Kaplan Meier and Cox proportional

hazard), and analysis of complex survey data. The software is an open-source project with limited support.

- **SPSS**:

  SPSS means **"Statistical Package for the Social Sciences"** and was first launched in 1968. Since SPSS was acquired by IBM in 2009, it's officially known as IBM SPSS Statistics but most users still just refer to it as "SPSS". SPSS is a widely used program for statistical analysis in social science. It is also used by market researchers, health researchers, survey companies, government, education researchers, marketing organizations, data miners, and others. SPSS is software for **editing and analyzing all sorts of data**. The data can be from any source: scientific research, a customer database, Google Analytics or even the server log files of a website. SPSS can open all file formats that are commonly used for structured data such as

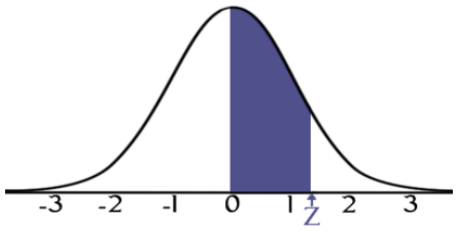
  - spreadsheets from MS Excel or OpenOffice;
  - plain text files (.txt or .csv);
  - relational (SQL) databases;
  - Stata and SAS.

  Statistics included in the base software:

  - Descriptive statistics: Cross tabulation, Frequencies, Descriptives, Explore, Descriptive Ratio Statistics
  - Bivariate statistics: Means, t-test, ANOVA, Correlation (bivariate, partial, distances), Nonparametric tests, Bayesian
  - Prediction for numerical outcomes: Linear regression
  - Prediction for identifying groups: Factor analysis, cluster analysis (two-step, K-means, hierarchical), Discriminant
  - Geo spatial analysis, simulation
  - R extension (GUI), Python

ANNEXURES

ANNEXURE 1: Area under normal curve



STANDARD NORMAL TABLE (Z)

Entries in the table give the area under the curve between the mean and *z* standard deviations above the mean. For example, for *z* = 1.25 the area under the curve between the mean (0) and *z* is 0.3944.

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0190	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2969	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3513	0.3554	0.3577	0.3529	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

ANNEXURE 2: **Chi square distribution table**

Percentage Points of the Chi-Square Distribution

Degrees of Freedom	Probability of a larger value of x^2								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	0.554	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09
6	0.872	1.635	2.204	3.455	5.348	7.84	10.64	12.59	16.81
7	1.239	2.167	2.833	4.255	6.346	9.04	12.02	14.07	18.48
8	1.647	2.733	3.490	5.071	7.344	10.22	13.36	15.51	20.09
9	2.088	3.325	4.168	5.899	8.343	11.39	14.68	16.92	21.67
10	2.558	3.940	4.865	6.737	9.342	12.55	15.99	18.31	23.21
11	3.053	4.575	5.578	7.584	10.341	13.70	17.28	19.68	24.72
12	3.571	5.226	6.304	8.438	11.340	14.85	18.55	21.03	26.22
13	4.107	5.892	7.042	9.299	12.340	15.98	19.81	22.36	27.69
14	4.660	6.571	7.790	10.165	13.339	17.12	21.06	23.68	29.14
15	5.229	7.261	8.547	11.037	14.339	18.25	22.31	25.00	30.58
16	5.812	7.962	9.312	11.912	15.338	19.37	23.54	26.30	32.00
17	6.408	8.672	10.085	12.792	16.338	20.49	24.77	27.59	33.41
18	7.015	9.390	10.865	13.675	17.338	21.60	25.99	28.87	34.80
19	7.633	10.117	11.651	14.562	18.338	22.72	27.20	30.14	36.19
20	8.260	10.851	12.443	15.452	19.337	23.83	28.41	31.41	37.57
22	9.542	12.338	14.041	17.240	21.337	26.04	30.81	33.92	40.29
24	10.856	13.848	15.659	19.037	23.337	28.24	33.20	36.42	42.98
26	12.198	15.379	17.292	20.843	25.336	30.43	35.56	38.89	45.64
28	13.565	16.928	18.939	22.657	27.336	32.62	37.92	41.34	48.28
30	14.953	18.493	20.599	24.478	29.336	34.80	40.26	43.77	50.89
40	22.164	26.509	29.051	33.660	39.335	45.62	51.80	55.76	63.69
50	27.707	34.764	37.689	42.942	49.335	56.33	63.17	67.50	76.15
60	37.485	43.188	46.459	52.294	59.335	66.98	74.40	79.08	88.38

ANNEXURE 3: 't' distribution table

t-test table

cum. prob											
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

Epidemiology

I N D E X

Sr no.	Title of	Date	Page No.	Grade	Signature of the teacher
1.	Epidemiological exercises based on water				
2.	Epidemiological exercises based on nutrition				
3.	Epidemiological exercises based on mortality and morbidity indicators				
4.	Exercises based on Communicable diseases				
5.	Immunization				
6.	Disinfection and sterilization				
7.	Concept of research				
8.	Epidemiological study designs				
9.	Exercises based on screening				
10.	Investigation of an epidemic				
11.	Emporiatrics				
12.	Writing a research				

Completed / Not completed / Late **Signature of the Teacher in-charge**

1. Epidemiological exercises based on water

Competency	Learning objectives	Assessment
CM3.2 Exercise on interpretation of water analysis report **DOAP- water collection, estimation of chlorine demand/ residual chlorine content of drinking** **water, OT test**	**The student should be able to** • Estimate water volume in the given well • Estimate chlorine demand of the water, using Horrock's apparatus • Calculate amount of bleaching powder required for disinfection of the water volume.	Written (MCQ, SAQ)/ viva voce/ Skill assessment

❑ **Estimation of bleaching powder for disinfection of required amount of water**

STEPS:

1. **Calculate volume of the well water:**
   VOLUME OF WELL

$$\text{Volume of well} = \frac{3.14\ X\ d^2\ X\ h}{4}$$

Where d- diameter of the well
h- depth of the well

VOLUME OF TANK= l x b x h
Where l- length
b- breadth
h- depth

1 m^3 = 1000 liters of water

2. **Calculate the amount of bleaching powder required:**
   a) Calculated using Horrocks Test:

Bleaching powder required to disinfect 455 litres of water is
2 x n gms
where n- Earliest cup showing blue color in Horrocks Test.

b) EMPIRICAL FORMULA:

APPROX. 2.5 gms bleaching powder is required for disinfecting 1000 litres of water.
But, during epidemics approx. 5 gms bleaching powder for 1000 litres of water.

3. **Preparation of chlorine solution:**
   Mix the bleaching powder in a bucket and mix with water to make a paste and add water till 3/4th full. Allow the solution to stand for 5-10 mins. The supernatant fluid is the chlorine solution used for disinfection.

4. **Delivery of chlorine solution into the well**
5. **Contact period:** 1 HOUR of contact period is required for disinfection
6. **OT test (Orthotolidine Test):** Used to determine free and combined chlorine in water
   Yellow color produced within 10 seconds is due to free chlorine in water.
   Color produced after 15-20mins is due to action of both free and combined chlorine.

- **Agents used for disinfection of water:**

- **Bleaching powder:** APPROX. 2.5 gms / 1000 litres of water
- **5 % Hypochlorite Solution:** 14 ml / 1000 litres of water.
- **High Test Hypochlorite Solution (70% Available Chlorine) :** 1 ml / 1000 litres of water.
  During an epidemic superchlorination is followed by dechlorination using Sodium Thiosulphate or use lemon juice.

- **Water analysis:**

Physical parameters of water:

PARTICULARS	DESIRABLE LEVEL	EFFECTS AND INDICATIONS OF UNDESIRABLE LEVEL
Turbidity	1 NTU (Nephelometric Turbidity Units)	If > 4 NTU is noticeable to the naked eyes and it interferes with disinfection and microbiological determination
Colour	15 TCU (True Colour Units)	Coloured water indicates presence of coloured organic matter (primarily humic substances), metals such as iron and manganese or highly coloured industrial waste
Taste and odour	No health based guideline value	It originates from natural and biological sources or processes, from contamination by chemicals or as a by-product of water treatment (e.g. chlorination)
Temperature	No guideline value	Low water temperature tends to decrease the efficiency of treatment process, including disinfection. High water temperature enhances the growth of micro-organisms and taste, odour, colour and corrosion problem may increase

Inorganic constituents of water:

PARTICULARS	DESIRABLE LEVEL	EFFECTS AND INDICATIONS OF UNDESIRABLE LEVEL
Chlorides	200 mg/litre to 600 mg/litre	water contamination
Hardness	50 – 150 mg/litr	**Higher range causes** scale deposition in the distribution system and will result in excessive soap consumption and subsequent scum formation. On heating, hard water forms deposits of calcium carbonate scale. **Soft water,** with a hardness of less than 100 mg/litre is more corrosive for water pipes
Ammonia	below 0.2 mg/litre	Ammonia in water is an indicator of possible bacterial, sewage and animal waste pollution. Compromise disinfection efficiency, result in nitrite formation in distribution systems, can cause the failure of filters and cause taste and odour problems.
pH	6.5 and 8.5	pH levels of less than 7 may cause severe corrosion of metals in the distribution pipes and elevated levels of certain chemical substances, such as lead, may result. At pH levels above 8, there is a progressive decrease in the efficiency of the chlorine disinfection process
Hydrogen sulphide	0.05 and 0.1 mg/litre	The "rotten eggs" odour of hydrogen sulphide is particularly noticeable in some ground waters and in stagnant drinking water in the distribution system, as a result of oxygen depletion and the subsequent reduction of sulphate by bacterial activity
Iron	< 0.3 mg/litre	Brown colour to the water, iron stains laundry and plumbing fixtures Promotes the growth of "iron bacteria", which derive their energy from the oxidation of ferrous iron to ferric iron, and in the process deposit a slimy coating on the pipe.
Total dissolved solids (TDS)	Upto 1000 mg/lit	Excessive scaling in water pipes, heaters, boilers and household appliances.
Fluoride	0.5 – 0.8 mg/litre	High levels: dental or skeletal fluorosis Low levels: dental caries
Nitrate Nitrite	50 mg/litre 3 mg/litre Combined nitrate + nitrite: should not exceed 1	Protective against methaemoglobi- naemia and thyroid effects in the most sensitive subpopulation, bottle-fed infants,

Microbiological aspects:

Organism	Guideline value
All water intended for drinking **E. coli or thermotolerant-coliform bacteria**	**Must not be detectable -in any 100 ml sample**
Treated water entering the distribution system **E. coli or thermotolerant coliform bacteria** **Total coliform bacteria**	 **Must not be detectable -in any 100 ml sample** Must not be detectable -in any 100 ml sample
Treated water in the distribution system **E. coli or thermotolerant coliform bacteria** **Total coliform bacteria**	 **Must, not be detectable in any 100 ml sample** **Must not be detectable in any 100 ml sample. In the Case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12 month period.**

2. Epidemiological exercises based on nutrition

Competency	Learning objectives	Assessment
5.4 Diet planning at individual level **Diet planning at family level**	**The student should be able to** • Define various terms used while assessing nutritional requirement • Prescribe balanced diet	Written (MCQ, SAQ)/ viva voce/ Skill assessment

Various terms used to define the amount of nutrients needed by the body

1. **ADEQUATE INTAKE:** A recommended average daily intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people, that are assumed to be adequate
2. **TOLERABLE UPPER INTAKE LEVEL:** The highest average daily nutrient intake level that is likely to pose no risk of adverse health effects for almost all individuals in the general population.
3. **ESTIMATED AVERAGE REQUIREMENT:** The average daily nutrient intake level estimated to meet the requirement of half of the healthy individuals in a particular life stage and gender group
4. **RECOMMENDED DIETARY ALLOWANCE:** The average daily dietary nutrient intake level, sufficient to meet the nutrient requirement of nearly all (97-98%) healthy individual in a particular life stage & gender group.
5. **RECOMMENDED ENERGY CONSUMPTION UNIT(CU):**

	MALE	FEMALE
SEDENTARY WORK	1.0	0.8
MODERATE WORK	1.2	0.9
HEAVY WORK	1.6	1.2

1 CU = 2400 kcal

6. **ADDITIONAL REQUIREMENTS:**

PREGNANCY: ENERGY- +350 kCal/day

PROTEINS- for 10 kg gestational weight gain

1st TRIMESTER- +1 gm/day

2nd TRIMESTER- +7 gm/day

3rd TRIMESTER- +23 gm/day

LACTATION: ENERGY-

1st 6 months- +600 kCal/day

Next 6 months- +520kCal/day

PROTEIN-

1st 6 months- +13 gm/day

ENERGY OBTAINED FROM MACRONUTRIENTS:

PROTEIN	-	4 kcal/gm
FAT	-	9 kcal/gm
CARBOHYDRATE	-	4 kcal/gm
DIETARY FIBRE	-	2 kcal/gm

- **Recommended dietary allowance (RDA):-** The average daily dietary nutrient intake level, sufficient to meet the nutrient requirement of nearly all (97-98%) healthy individual in a particular life stage & gender group.
- **Balanced diet:** Diet which contains a variety of foods in such quantities and proportions that the need for energy, proteins, carbohydrates, vitamins etc. is adequately met for aintaining health well being& vitality along with small provision of extra nutrients to withstand short duration of leanness.
- **Dietary goals (Prudent diet) recommended by various expert committies of WHO:**

1. Dietary fat should be 15-30% of total daily intake.
2. Saturated fats should not be more than 10% of total energy intake.
3. Excessive consumption of refined carbohydrates should be avoided.
4. Sources rich in energy (fats/alcohol) should be restricted
5. Salt intake should not be more than 5g/day
6. Protein should be 10-15% of daily energy intake.
7. Empty calories should be avoided e.g. junk foods, colas, ketchups, etc.

Recommended Dietary Allowances(RDA) for Indians - 2020

SUMMARY OF RDA FOR INDIANS – 2020

Age Group	Category of work	Body Wt	Protein	CHO	Cal cium	Magne sium	Iron	Zinc	Iodine	Thiamine	Ribo flavin	Niacin	Vit B6	Folate	Vit B12	Vit C	Vit A	Vit D
		(kg)	(g/d)	(g/d)	(mg/ d)	(mg /d)	(mg/ d)	(mg /d)	(µg/ day)	(mg /d)	(mg /d)	(mg /d)	(mg/ d)	(µg /d)	(µg/ d)	(mg/ d)	(µg/ d)	(IU/ d)
Men	Sedentary	65	54.0	130	1000	385	19	17	150	1.4	2.0	14	1.9	300	2.5	80	1000	600
	Moderate									1.8	2.5	18	2.4					
	Heavy									2.3	3.2	23	3.1					
Women	Sedentary	55	45.7	130	1000	325	29	13.2	150	1.4	1.9	11	1.9	220	2.5	65	840	600
	Moderate									1.7	2.4	14	1.9					
	Heavy									2.2	3.1	18	2.4					
	Pregnant woman	55 + 10	+9.5 (2^{nd} trimester) +22.0 (3^{rd} trimester)	175	1000	385	40	14.5	250	2.0	2.7	+2.5	2.3	570	+0.25	+15	900	600
	Lactation 0-6m		+16.9	200	1200	325	23	14	280	2.1	3.0	+5	+0.26	330	+1.0	+50	950	600
	7-12m		+13.2	200						2.1	2.9	+5	+0.17	330				
Infants	0-6 m*	5.8	8.1	55	300	30	-	-	100	0.2	0.4	2	0.1	25	1.2	20	350	400
	6-12m	8.5	10.5	95	300	75	3	2.5	130	0.4	0.6	5	0.6	85	1.2	27	350	400
Children	1-3y	11.7	11.3	130	500	135	8	3.0	90	0.7	0.9	7	0.9	110	1.2	27	390	600
	4-6y	18.3	15.9	130	550	155	11	4.5	120	0.9	1.3	9	1.2	135	1.2	32	510	
	7-9 y	25.3	23.3	130	650	215	15	5.9	120	1.1	1.6	11	1.5	170	2.5	43	630	
Boys	10-12y	34.9	31.8	130	850	270	16	8.5	150	1.5	2.1	15	2.0	220	2.5	54	770	600
Girls	10-12y	36.4	32.8	130	850	255	28	8.5	150	1.4	1.9	14	1.9	225	2.5	52	790	600
Boys	13-15y	50.5	44.9	130	1000	355	22	14.3	150	1.9	2.7	19	2.6	285	2.5	72	930	600
Girls	13-15y	49.6	43.2	130	1000	325	30	12.8	150	1.6	2.2	16	2.2	245	2.5	66	890	600
Boys	16-18y	64.4	55.4	130	1050	405	26	17.6	150	2.2	3.1	22	3.0	340	2.5	82	1000	600
Girls	16-18y	55.7	46.2	130	1050	335	32	14.2	150	1.7	2.3	17	2.3	270	2.5	68	860	600

* AI

SUMMARY OF RECOMMENDED INTAKES FOR OTHER MINERALS AND TRACE ELEMENTS

SNo.	Minerals/Trace Element	Recommended intake
1	Phosphorous	1000 mg/day
2	Sodium	2000 mg/day
3	Potassium	3500 mg/day
4	Copper	2 mg/day
5	Manganese	4 mg/day
6	Chromium	50 µg/day
7	Selenium	40 µg/day

	PREVIOUS	RECENT
AGE OF REFERANCE MAN & WOMAN	20-39 YEARS	19-39 YEARS
PROTEIN	1GM/KG	0.83GM/KG
SODIUM	5 GM/DAY	2 GM/DAY
FIBRE		40GM/2000KCAL
VITAMIN A	800 MICROGRAM	900 MICROGRAM
VITAMIN D	400 IU	600 IU
VITAMIN E	8-10 MG/DAY	7.5-10 MG /DAY
VITAMIN K	30 MICROGRAM/KG	55 MICROGRAM /KG
VITAMIN B9	ADULT – 200 mcg PREGNANCY – 500 mcg LACTATION – 300 mcg	ADULT – 300mcg PREGNANCY – 600 MCG LACTATION – 400mcg
VITAMIN C	40MG/DAY	80MG/DAY
MAGNESIUM	340MG/DAY	385 MG /DAY
POTASSIUM	5 GM/DAY	3.5GM/DAY

3. Mortality and morbidity indicators

Competency	Learning objectives	Assessment
CM 7.4 Exercises on calculation of morbidity and mortality indicators based on given set of data and their interpretation	**The student should be able to** • Calculate and interpret the mortality and morbidity indicators	Written (MCQ, SAQ, Exercises)/ viva voce/ Skill assessment

MORTALITY INDICATORS:

1. **Crude death rate (CDR):** To measure the decrease of population due to death.

$$\text{Crude death rate} = \frac{\text{No. of deaths in a given year}}{\text{Estimated mid} - \text{year population}} \text{ x } 1000$$

2. **Specific Death rates:** Specific death rates include age-specific (infants, neonates, geriatric), sex-specific, vulnerable group-specific (maternal cases), disease- specific etc

$$\text{Specific death rate} = \frac{\text{Number of specific deaths}}{\text{mid} - \text{year population}} \text{ x } 1000$$

$$\text{Specific death rate due to TB} = \frac{\text{no. of deaths due to tuberculosis during a calender year}}{\text{mid} - \text{year population}} \text{ x } 1000$$

$$\text{Specific death rate for males} = \frac{\text{no. of deaths among males}}{\text{mid} - \text{year population}} \text{ x } 1000$$

$$\text{death rate in january} = \frac{\text{no.of deaths in january x 12}}{\text{mid-year population}} \text{ x } 1000$$

3. **PROPORTIONAL MORTALITY RATE:**

$$\text{Proportional mortality from a specific disease} = \frac{\text{no. of deaths from the specific disease in a year}}{\text{total deaths from all causes in that year}} \text{ x } 100$$

4. **CASE FATALITY RATE:**

$$\text{Case fatality rate} = \frac{\text{total no. of deaths due to a particular disease}}{\text{total no. of cases due to the same disease}} \text{ x } 100$$

5. **SURVIVAL RATE:**

$$\text{Survival rate} = \frac{\text{total no. of patients alive after 5 years}}{\text{total no. of pts diagnosed or treated}} \text{ x } 100$$

Survival rate = 100 – case fatality rate

6. **MATERNAL MORTALITY RATE** : The risk of dying from causes associated with childbirth is measured by the maternal mortality rate. MMR =

$$\text{Maternal mortality ratio} = \frac{\text{Total no. of female deaths due to compications of pregnancy, childbirth or within 42 days of delivery from puerperal causes in an area during a given year}}{\text{Total no. of live births in the same area and year}} \text{ x } 1000$$

7. **AGE SPECIFIC DEATH RATES**:

$$\text{Age specific death rates} = \frac{\text{No of deaths in a particular age group}}{\text{Mid year population in that age group}} * 1000$$

INFANT MORTALITY RATE : It is one of the most sensitive indexes of health conditions of the general population. It is sensitive measure because a baby in its extrauterine life is suddenly exposed to a multitude of new environmental factors and their reactions are reflected in this rate. Under ideal conditions of social welfare no normal baby should die.

$$\text{infant mortality rate} = \frac{\text{Number of deaths of children less than 1year of age in a year}}{\text{Number of live births in the same year}} \times 1000$$

NEO-NATAL MORTALITY RATE : For deaths occurring under 28 days .

$$\text{Neonatal mortality rate} = \frac{\text{Number of deaths of children under 28 days of age in a year}}{\text{Total live births in the same year}} \times 1000$$

POST-NEONATAL MORTALITY RATE :

$$\text{Post-neonatal mortality rate} = \frac{\text{Number of deaths of children between 28days and one year age in a given year}}{\text{Total live births in the same year}} \times 1000$$

FETAL DEATH RATIO : This ratio related the number of late fetal deaths to the number of live births.

Fetal Death Ratio: {No. of fetal deaths of 28 or more completed weeks of gestation / No. of live births} x 1000

STILL BIRTH RATE:

$$\text{STILL BIRTH RATE} = \frac{\text{Foetal deaths weighing over 1000gm at birth during the year}}{\text{Total live+ sillbirths weighing over 1000gm at birth during the year}} \times 1000$$

1000gm body weight corresponds to 28 weeks of gestation.

PERINATAL MORTALITY RATE: Many late foetal deaths and early neo-natal deaths may be attributed to similar underlying conditions, so this rate is calculated.

$$\text{Perinatal mortality rate} = \frac{\text{Late foetal and early neonatal deaths weighing over 1000gm at birth}}{\text{Total live births weighing over 1000gm at birth}} \times 1000$$

1-4 YEAR MORTALITY RATE:

$$1-4 \text{ year mortality rate} = \frac{\text{No. of deaths of children aged } 1-4\text{years during a year}}{\text{Total no. of children aged } 1-4\text{years at the middle of the year}} \text{ x } 1000$$

CHILD MORTALITY RATE (U 5 MR):

$$\text{Child mortality rate} = \frac{\text{Number of deaths of children less than 5years of age in a given year}}{\text{Number of live births in the same year}} \text{ x } 1000$$

MORBIDITY INDICATORS:

INCIDENCE RATE: The no. of NEW cases occurring in a defined population during a specified period of time

$$\textbf{Incidence} = \frac{\textbf{No. of new cases of a specific diseases during a given time period}}{\textbf{Population at risk during that period}} \textbf{ x 1000}$$

PREVALENCE: the number of both OLD & NEW cases occurring at a given point of time or over a given period in a given population

$$\text{Point prevalence} = \frac{\text{no. of all current cases(old \& new)of a specified disease at a given point in time}}{\text{estimated population at that same point in time}} \text{ x } 100$$

$$\text{Period prevalence} = \frac{\text{no. of all existing cases(old \& new)of a specified disease during a given period of time interval}}{\text{estimated mid} - \text{interval population at risk}} \text{ x } 100$$

Prevalence = Incidence x Duration

4. Exercises based on communicable diseases and Non-communicable diseases

Competency	Learning objectives	Assessment
CM 7.4 Exercises on calculation of morbidity and mortality indicators based on given set of data and their Interpretation CM 8.2 Epidemiological and control measures including the use of essential laboratory tests at the primary care level for Non Communicable diseases (diabetes, Hypertension, Stroke, obesity and cancer etc.)	**The student should be able to** • Calculate and interpret the morbidity indicators based on communicable diseases • Calculate and interpret the morbidity indicators based on Non-communicable diseases	Written (MCQ, SAQ, Exercises)/ viva voce/ Skill assessment

FOOD POISONING:

$$\text{Attack rate} = \frac{\text{No.of persons affected}}{\text{No.of persons exposed}} \times 100$$

$$\text{Case fatality rate} = \frac{\text{No.of deaths}}{\text{No.of persons affected}} \times 100$$

SECONDARY ATTACK RATE: Used for infectious diseases in which primary case is infective for a short period of time

$$\text{Secondary attack rate} = \frac{\text{No. of exposed persons developing the disease within the range of incubation period}}{\text{Total no. of exposed or susciptible contacts}} \times 100$$

SERIAL INTERVAL: The gap in time between the onset of primary case and the secondary case is called serial interval. From the serial we can guess the incubation period.

TUBERCULOSIS:

$$\text{Incidence of infection} = \frac{\text{No. of new people showing tuberculin positive}}{\text{Population under study}} \text{ x } 1000$$

$$\text{Incidenceof disease} = \frac{\text{No. of new sputum positive cases (new)}}{\text{Population under study}} \text{ x } 1000$$

$$\text{Prevalence of infection} = \frac{\text{no. showing tuberculin positive (old + new)}}{\text{population under study}} \text{ x } 100$$

$$\text{Prevalence of disease} = \frac{\text{no. of all sputum positive (old + new)}}{\text{population under study}} \text{ x } 100$$

MALARIA:

$$\text{Annual parasite incidence} = \frac{\text{confirmed cases during one year}}{\text{population under surveillance}} \text{ x } 1000$$

$$\text{Annual falciparum incidence} = \frac{\text{no.of falciparum cases}}{\text{population under surveillance}} \text{ x } 1000$$

$$\text{Annual blood examination rate} = \frac{\text{no.of slides examined}}{\text{population under surveillance}} \times 100$$

$$\text{Slide positivity rate} = \frac{\text{no.of slides positive of malaria}}{\text{no.of slides examined}} \times 100$$

$$\text{Slide falciparum rate} = \frac{\text{no.of slides positive forfalciparum}}{\text{no.of slides examined}} \times 100$$

$$\text{P.falciparum rate} = \frac{\text{no.of falciparum cases}}{\text{total malaria cases}} \times 100$$

FILARIASIS:

$$\text{Microfilarial rate(mf)} = \frac{\text{no.showing mf positivity}}{\text{no.of slides examined}} \times 100$$

$$\text{Filarial disease rate} = \frac{\text{no. showing filarial disease symptoms}}{\text{no. of persons examined}} \times 100$$

$$\text{Filarial endemicity rate} = \frac{\text{no. having disease signs} + \text{no. of slide positive} + \text{both}}{\text{no. of persons examined}} \times 100$$

POLIO:

Prevalence of lameness due to polio (Lameness rate- LR)

$$\text{LR} = \frac{\text{no. of lame children}}{\text{no. of children examined}} \times 100$$

- Prevalence of residual paralysis due to polio= LR x 1.25

- Prevalence of all clinical cases of poliomyelitis= prevalence rate of residual paralysis x 1.33
- Annual incidence of paralytic cases= prevalence rate of residual paralysis x 1.25
- Annual rate of poliomyelitis incidence= LR x 0.2

Assessment of obesity:

Body mass index (Quetlet's index)

$$BMI = \frac{Weight\ (in\ Kg)}{Height\ square\ (in\ Meters)}$$

Ponderal index

$$Ponderal\ Index = \frac{Height(in\ Cm)}{Cube\ root\ of\ body\ weight(in\ Kg)}$$

Brocca index = height in cm – 100

Lorentz's formula

$$Lorentz's\ Formula = Height\ (cm) - 100\ - \frac{Height(in\ Cm) - 150}{2\ (women) or\ 4\ (men)}$$

Corpulence index

$$Corpulence\ Index = \frac{Actual\ weight}{Desirable\ weight}$$

Classification of adults according to BMI:

Classification	BMI	Risk of comorbidities
Underweight	< 18.5	Low; risk of other clinical problems increased
Normal	18.5-24.99	Average
Overweight:	> Or = 25	
Preobese	25- 29.99	increased
Obese class I	30-34.99	Moderate
Obese class II	35-39.99	Severe
Obese class III	> Or = 40	Very severe

Categories of visual impairement:

Presenting distance visual acuity		
category	**Worse than**	**Equal to /better than**
Mild/no visual impairment 0		6/18
Moderate 1	6/18	6/60
Severe 2	6/60	3/60
Blindness 3	3/60	1/60 or finger counting at 1 metres
Blindness 4	1/60 or finger counting at 1 metres	Light perception
Blindness 5	No light perception	
9	Undetermined Or unspecified	

Revised (2002-2003 WHO) categories for diagnosis of rheumatic fever based on revised Jones criteria

Jones revised criteria

Type	Evidence
Major	Carditis,polyarthritis,chorea,erythma marginatum,subcutaneous nodules
Minor	clinical -fever, polyarthralgia Labotatory- elevated ESR, leukocyte count
Supporting evidence of preceding streptococcal infection within last 45 days	ECG-prolonged PR interval Elevated/rising ASO titre Positive throat culture Rapid antigen test for group A streptococci Recent scarlet fever

Diagnostic categories	Criteria
Primary episode of Rheumatic fever	TWO major/ONE major+ TWO minor +evidence of preceding group A streptococcal evidence
Recurrent attack of rheumatic fever in a patient without established RHD	TWO major/ONE major+ TWO minor +evidence of preceding group A streptococcal evidence
Recurrent attack of rheumatic fever in a patient with established RHD	TWO minor +evidence of preceding group A streptococcal evidence
Rheumatic chorea, incidious oncet rheumatic carditis	Other major manifestations or evidence of group A streptococcal infection NOT REQUIRED
Chronic valve lesions of RHD(patients presenting for the first time with pure mitral stenosis or mixed mitral valve disease and/or aortic valve disease	Do not require ANY OTHER CRITERIA to be diagnosed as RHD

5. IMMUNIZATION

Competency	Learning objectives	Assessment
CM10.5 Universal Immunization Program; Integrated Management of Neonatal and Childhood Illness (IMNCI) and other existing Programs	**The student should be able to** • Know National Immunization Schedule • Answer and solve various Immunization scenarioes	Written (MCQ, SAQ, Exercises)/ viva voce/ Skill assessment

Q.1 If the mother/caregiver permits administration of only one injection during an infant's first visit at 9 months of age, which vaccine should be given?
Q.2 Which vaccine can be given to a child between 1-5 years of age, who has never been vaccinated?
Q.3.Which vaccine can be given to a child between 5-7 years of age, who has never been vaccinated?
Q.4. Should one re-start with the first of a vaccine if a child is brought late for a dose?
Q.5 Why is it not advisable to clean the injection site with a spirit swab before vaccination?
Q.6 If a child could not receive DPT 1,2,& 3 according to the schedule, upto what age can the vaccine be given?
Q.7 Why should there be a minimum gap of 4 weeks between two doses of DPT?
Q.8 Why give the DPT vaccine in the antero-lateral mid thigh and not the gluteal region?
Q.9. What should one do if the child is found allergic to DPT or develops encephalopathy after DPT?
Q.10 Why DT is replaced by DPT vaccine for children above 2 years of age?
Q.11.Why give the measles vaccine only on the right upper arm?
Q.12.If a child has received the measles vaccine before 9 months of age, is it necessary to repeat the vaccine later?
Q.13. What is measles catch-up campaign ?
Q.14. Why second dose of measles vaccine introduced in the National Immunization Programme?
Q15.If child comes late for the first dose of measles , then can h/she get the second dose?
Q.16 If a child received one dose of measles vaccine during an SIA campaign , should it receive the routine dose of measles vaccine.
Q.17 Why give BCG vaccine only on left upper arm?
Q.18 Why do we give 0.05 ml dose of BCG to newborn?
Q.19.Why is BCG given only upto one year of age?
Q.20.If no scar appears after administering BCG, should one re-vaccinate the child?
Q.21 Till what age can a child be given OPV?
Q.22. Can OPV and vitamin A be given together with DPT booster dose?
Q.23. Can an infant be breastfed immediately after OPV?

Q.24 If a girl has received all doses of DPT and TT as per the NIS till 16 years of age and she gets pregnant at 20 years, should she get one dose of TT during pregnancy?
Q.25. Can TT be given in the first trimester of pregnancy?
Q.26 Up to what age can hepatitis B vaccine be given?
Q.27 Why give the birth dose of hepatitis B vaccine only within 24 hours of birth?
Q.28 Up to what age can hepatitis B vaccine be given?
Q.29 Why give the birth dose of hepatitis B vaccine only within 24 hours of birth?
Q.30 If a with child 16-24 months of age has been immunized with JE vaccine during an SIA, can it receive the JE vaccine again, as part of routine immunization?
Q31.If a child above 2 years of age has not received the JE vaccine through either RI or an SIA should she/he be given the JE vaccine?

6. DISINFECTION AND STERILIZATION

Competency	Learning objectives	Assessment
CM 7.2 Modes of transmission and measures for prevention and control of communicable	**The student should be able to** • Define disinfectant, antiseptic, deodorant, disinfection and sterilization • Classify disinfectants • Disinfect the given sample or object	Written (MCQ, SAQ, Exercises)/ viva voce/ Skill assessment

- **DEFINE WITH ONE EXAMPLE OF EACH**
  - **Disinfectant**
  - **Antiseptic**
  - **Deodorant**
  - **Disinfection**
  - **Sterilization**
  - **Detergent**
- **GIVE TYPES OF DISINFECTION WITHEXAMPLES**
  - **Concurrent**
  - **Terminal**
  - **Precurrent**
- **GIVE CLASSIFICATION OF DISINFECTANTS WITH EXAMPLE**
- **DISINFECTION OF FAECES & URINE OF CHOLERA PATIENT?**

Disinfectant	Amount per litre	Per cent
Bleaching powder	**50gm**	**5%**
Crude phenol	**100ml**	**10%**
Cresol	**50ml**	**5%**
Formalin	**100ml**	**10%**

- **How will you disinfect sputum of tuberculosis patient?**
- **How will you disinfect operation theatre?**
- **How to disinfect room?**
- **How will you disinfect water at household level?**
- **How will you disinfect floor in wards?**
- **How will you disinfect glassware, syringes, swabs, dressings and sharps?**
- **Which method of sterilization is used for plastic & sharps?**
- **How to disinfect blankets, beds , books & other valuable articles?**
- **How to disinfect thermometer?**

- **How to disinfect inexpensive articles such as contaminated dressings, rags and swabs etc?**
- **Which method is used for sterilization of bandages, dressings, catgut and Cu T?**
- **Oils and powders are sterilized by.**
- **How to disinfect ambulance which was used to transport covid 19 positive patient.**
- **How will you disinfect your mobile phones and labtops?**
- **How to disinfect spectacles, pens and stethoscopes.**
- **How to carry and dispose of dead body of Covid 19 positive patients?**
- **How to clean blood spillage or infective discharges on the floor.**

7. CONCEPT OF RESEARCH

Competency	Learning objectives	Assessment
CM6.1 Demonstration and exercises on Formulation of a research problem, research question & research hypothesis for a study	**The student should be able to** • Formulate a research problem, research question & research, hypothesis	Written/ viva voce/ Skill assessment

Research is a systematic process aimed at obtaining new knowledge through verifiable examination of data and empirical testing of hypothesis. Research activities are directed towards finding answers, seeking solutions or looking for improved designs of functioning. Very often, no positive results emerge and a probable hypothesis may be negated. This in no way undermines the effort. In general, research activities in community medicine are more concerned with 'applied' aspects but basic research can also be undertaken.

Designing Research Protocol:

It is essential to formulate a detailed research protocol so that the research effort is meaningful and productive. The research protocol should follow a systematic format. This does not mean that the subsequent step can only be undertaken after completion of the preceding step, because there is often an overlap. However, following the format ensures that every aspect is carefully addressed. The essential steps are given below. Selecting a Researchable Topic A general topic of study or broad area of research may present itself in relation to some practical concern or a scientific or intellectual interest. The decision-making process may be guided by the following:

1. Need for additional information on some specific disease, health care facility or service.
2. Need for evaluation of the effects of a particular component of health care facilities or services.
3. Need for comparing alternative treatment modalities.
4. Need for future projections of the magnitude of specific health problems or health care infrastructure or services.

Formulating the Research Problem:

Once the research topic is selected, the research problem needs to be formulated in detail. The following steps are useful for this purpose and have been abridged from the WHO/WPRO format:

- ***Statement of the problem:***

The first step in the development of a research project is a clear enunciation of the research problem. The statement of the problem is essential for constructing a research protocol. It guides and puts into sharper focus the research design being considered for solving the problem. It allows the investigator to describe the problem systematically and to reflect on its importance, its priority in the country or region and the rationale for undertaking the research.

- ***Relevance of the problem****:*

It should be ensured that the problem to be researched is relevant to national, regional or local health needs and activities. It should preferably fall under the priority areas in reference to national health.

- ***Field of application:***

One must clearly spell out how the findings of the proposed research would benefit policy makers, health administrators or health services research scientists. It should also be indicated as to how the results would be transmitted to them.

Search for Related Work:

A thorough scan of all available literature or information on the research problem should be undertaken. A review of existing information is important for the following reasons:

• It helps in further understanding of the proposed research problem and may lead to refining of the
statement of the problem.

• It helps in identifying the study variables and conceptualizing their relationships.

• It helps in the formulation and selection of research hypotheses.

• It helps in finding out what others have already reported on the topic, so that account can be taken
of this in the design of research.

• It provides familiarity with various methods that might be used in research.

The search can be undertaken in the following ways:

– Thorough literature scan for related work.

– Discussion with experts in the specific area of interest.

– First hand experience or observation.

The sources of information include:

a. Library catalogues, literature.
b. Indices (e.g. Index Medicus and Excerpta Medica, which identify articles appearing in selected journals by subject, author and title), computer search facilities (such as Medline, Medlar, Popline).
c. Bibliographies (e.g. current contents).
d. Statistical reports.

Statement of Objective:

Before undertaking any research investigation, its purpose should be clearly spelled out in the research
protocol in terms of goals, objectives and targets.

A ***goal*** is a broad definition of policy, not constrained by time. For example, an applied research project related to school health may state its goal as: "Health care facilities will be provided to maintain and improve health status of preschool children". No mention need be made as to how the goal is to be fulfiled. This is addressed by the objectives.

Objectives are defined more precisely than the goal. An *objective* is a broad statement of purpose reflecting the conditions one wants at some future time. The relationship between goals and objectives is that objectives are essentially steps towards a goal. The specific objectives are the specific aims of the
research project. What is to be accomplished is often broken down into smaller logical components. Specific objectives relate to specific research questions, which the investigator wants to answer through the proposed research. For example, the general objective "To improve ocular health of preschool children" may have the following specific objectives:

• To provide vitamin A supplementation to all underfives

• To screen eyes of preschool children at 'anganwadis' at six monthly intervals

• To provide nutrition education to mothers.

A *target* is an indicator with a magnitude. It points out what should be realised by a specific date. Targets should be quantitatively measurable. They represent the measurable and attainable aims directed towards objectives which, in turn, are directed towards the ultimate goal. For example, a target may be "100 percent coverage of preschool children by vitamin A prophylaxis."
At this stage, while objectives and targets, etc. are outlined by the investigator, it is also necessary to clarify the concepts related to the study and to give working definitions of the terms used.
It should be borne in mind that each study rests on earlier ones and provides a basis for future research
efforts. More the links that can be established between a given study and other studies or a body of theory, greater the probable contribution of the study.

Selection of Variables:

Variables that are sought to be measured should be clearly spelled out. The different types of variables are:

• ***Independent variables (Input, antecedent, etc):***

These are manipulated under study conditions to see what effect differences in them will have on those
variables proposed as being dependent on them.

• ***Dependent variables (Outcome, effect, etc):***

These are the ones in which changes result due to the effect of the independent variables.

• ***Confounding variables (Intervening variables):***

These should be studied because they may influence or confound the effect of the independent variables on the dependent variable.

• ***Background variables:***

Variables like sex, age, race, literacy, SES, marital status, etc. are so often of relevance in investigations of groups or populations that they should be considered for possible inclusion in all studies.
The variables in a study should be clearly identified and their method of measurement as well as the
unit of measurement should be cleary indicated.

Formulation of Research Hypothesis:

A hypothesis can be defined as a tentative prediction or explanation of the relationship between two or more variables. Formulation of hypothesis requires the investigator to predict an answer to the research question based on knowledge of the field and logical analysis. The *formulation of a hypothesis* should:

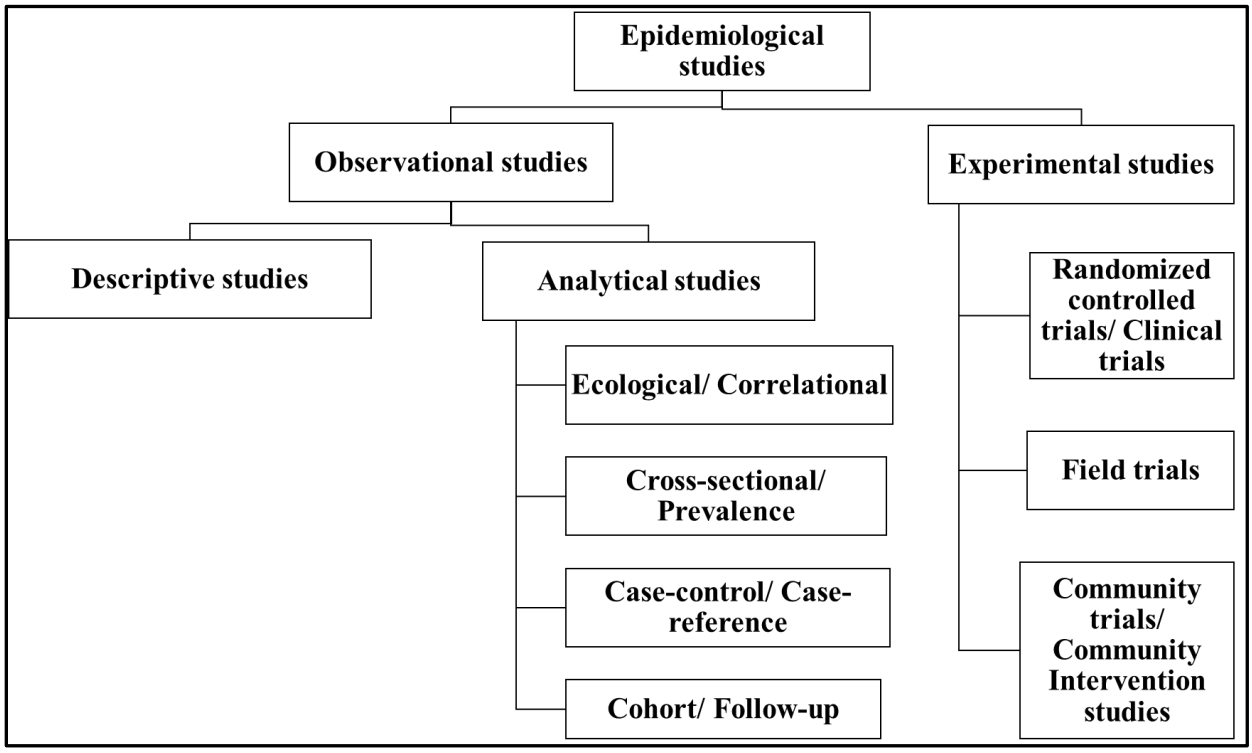
• Suggest explanations for certain facts
• Guide in investigation of related facts
• Investigate characteristics that determine the occurrence of disease.

A hypothesis translates the problem statement into a precise, unambiguous prediction of expected outcomes.
A hypothesis is not meant to be a haphazard guess. Rather, it should reflect the depth of knowledge, imagination and experience of the investigator.
The formulation and verification of a hypothesis is the major goal of scientific enquiry. The researcher should try to identify alternative competing or rival hypotheses which should then be carefully considered. Purely descriptive studies do not need a formal hypothesis.

8. Epidemiological study designs

Competency	SLOs(Core)	Assessment
CM 7.5 Exercise on developing appropriate epidemiological study design and method for a given public health problem.	The student should be able • Enumerate and classify various epidemiological study designs • Describe and discuss epidemiological study designs • Analyze and interpret the study results	Written (MCQ, SAQ, LAQ), Practical Skill assessment, viva voce

Types of epidemiological studies:



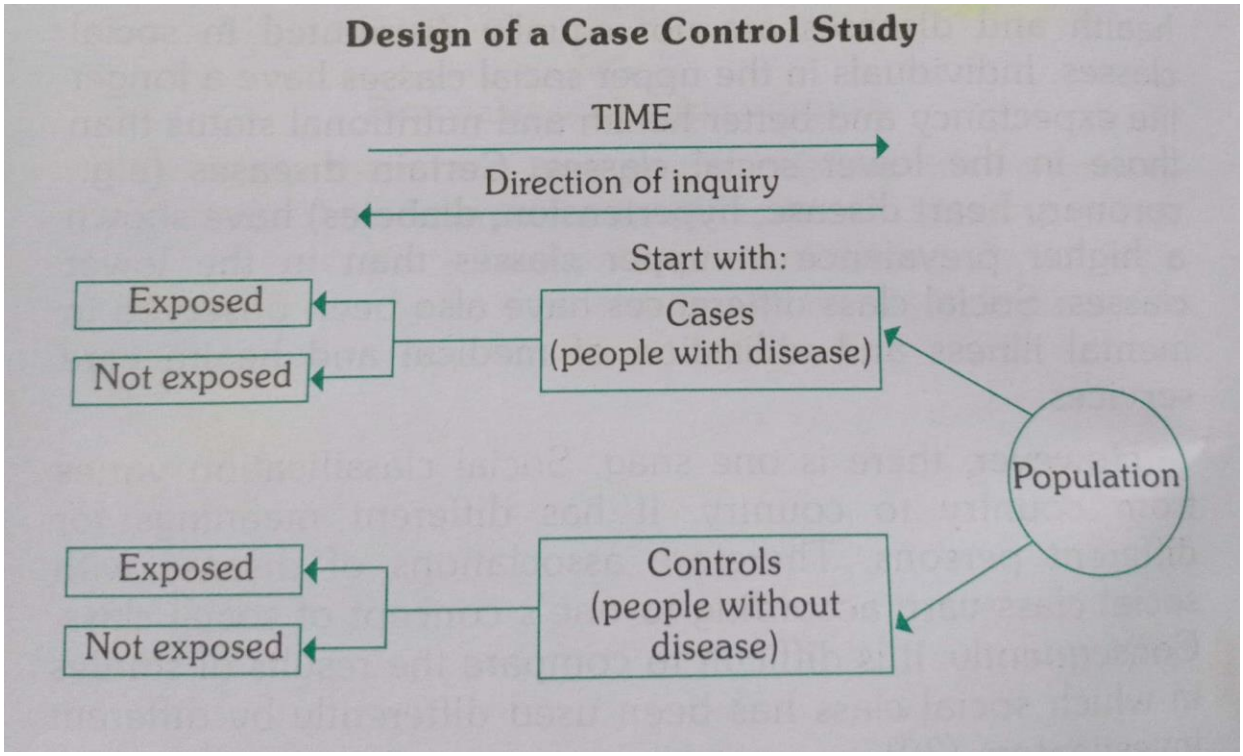
1. **DESCRIPTIVE STUDIES:**

Descriptive studies are usually the first phase of an epidemiological investigation.

Procedures in descriptive studies:

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

2. **THE DESIGN OF CASE-CONTROL RESEARCH:**



Basic steps in case-control study:

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

Risk factor/ Suspected cause	Cases (Disease present)	Controls (Disease absent)
Present	a	b
Absent	c	d
Total	a+c	b+d

Exposure rates
1.Cases=a/a+c
2.Controls=b/b+d

Test for statistical association between 1 & 2

Odds ratio or cross product ratio: gives idea about strength of association

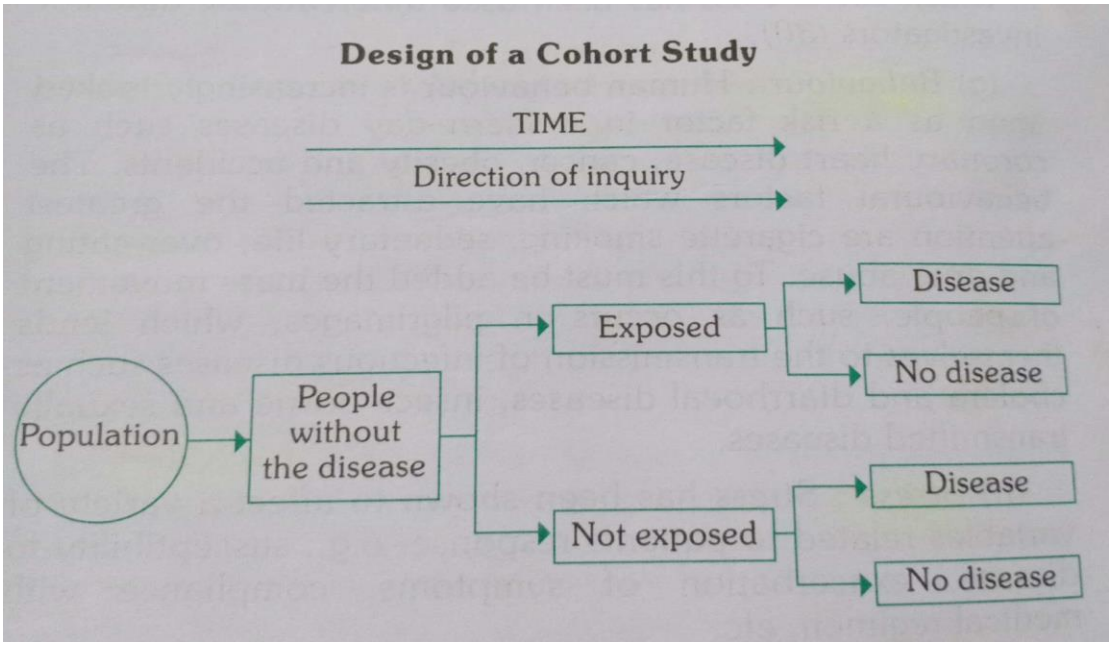
Odds ratio = $\frac{ad}{bc}$

Interpretation: "risk of disease is __ times in exposed than non exposed"

3. FRAME WORK OF COHORT STUDY:

Elements of a cohort study:

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



Risk factor	Disease		Total
	Yes	No	
Risk Factor present	a	b	a + b
Risk factor Absent	c	d	c + d

Incidence rate among exposed group = a / a + b
Incidence rate among not exposed group = c / c + d

RELATIVE RISK: Ratio of the incidence of the disease among exposed & incidence among non exposed. It is Index of strength of association

$$\text{Relative Risk} = \frac{\text{Incidence among exposed}}{\text{Incidence among non-exposed}}$$

Interpretation: "exposed are ___ times at greater risk of having disease"

ATTRIBUTABLE RISK: Indicates the extent the disease under study can be attributed to the exposure.

$$\text{Attributable risk} = \frac{\text{Incidence(exposed)} - \text{Incidence(non-exposed)}}{\text{Incidence(exposed)}} \times 100$$

Interpretation: "___ % of the disease can be attributed to the exposure"

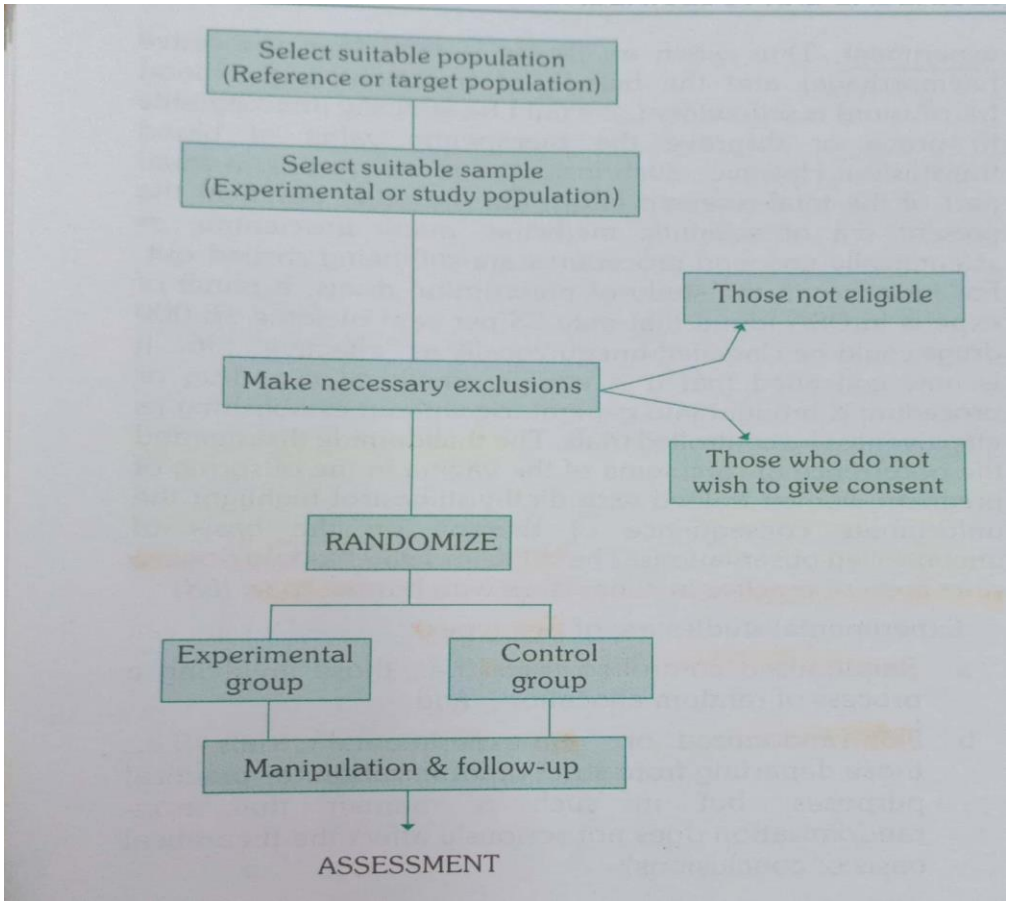
POPULATION ATTRIBUTABLE RISK: provide an estimate of the amount by which disease could be reduced in that population if the suspected factor was eliminated/modified

Population attributable risk=

$$\frac{death\ in\ total\ population - death\ rate\ among\ non-exposed\ group}{death\ rate\ in\ total\ population} \text{ X } 100$$

4. RANDOMIZED CONTROLLED TRIALS:

Design of randomized controlled trials:



Basic steps in conducting a RCT include the following:

1. Drawing up a protocol
2. Selecting reference and experimental populations
3. Randomization
4. Manipulation or intervention
5. Follow-up
6. Assessment of outcome

9. **Screening**

Competency	SLOs (Core)	Assessment
CM 7.6 **Screening**	The student should be able • Define, calculate and interpret sensitivity • Define calculate and interpret specificity	Written (MCQ, SAQ, LAQ), Practical Skill assessment, viva voce

2 x 2 TABLE

Screening test results	**Diagnosis**		**Total**
	Diseased	**Not Diseased**	
Positive	**a** (true positive)	**b** (false positive)	**a + b**
Negative	**c** (false negative)	**d** (true negative)	**c + d**
Total	**a + c**	**b + d**	**a + b + c + d**

SENSITIVITY: Identify the true positives

$$\text{Sensitivity} = \frac{a}{(a + c)} \text{ x } 100$$

SPECIFICITY: Identify the true negatives

$$\textbf{Specificity} = \frac{\mathbf{d}}{(\mathbf{b} + \mathbf{d})} \textbf{ x 100}$$

PREDICTIVE VALUE OF A POSITIVE TEST:

$$\text{Predictive value of a positive test} = \frac{a}{(a+b)} \text{ x } 100$$

PREDICTIVE VALUE OF A NEGATIVE TEST:

$$\text{Predictive value of a negative test} = \frac{d}{(c + d)} \text{ x } 100$$

PERCENTAGE OF FALSE POSITIVES:

$$\text{Percentage of false positives} = \frac{b}{(b + d)} \text{ x } 100$$

PERCENTAGE OF FALSE NEGATIVES:

$$\text{Percentage of false negatives} = \frac{c}{(a+c)} \text{ x } 100$$

10. Investigation of an epidemic

Competency	SLOs (Core)	Assessment
CM 7.7 **Describe and demonstrate the steps in the Investigation of an epidemic of communicable disease and describe the principles of control measures** **8.4 DOAP- Analysis & interpretation of disease outbreak data** **8.4 DOAP- Preparation of epidemic curve / spot map with the help of given data and its interpretation**	The student should be able • Enlist and describe the steps in investigation of a epidemic • Describe the methods in hypothesis formulation • Describe the tools like epidemic curve, spot map, age/ gender wise distribution	Written (MCQ, SAQ, LAQ), Practical Skill assessment, viva voce

- **Definition of epidemic**

The term epidemic refers to "an increase, often sudden, in the number of cases of a disease above what is expected in that population in that area" (1,CDC) Word outbreak has the same meaning, but is used when we are referring to a small geographic area.

- **Steps in investigation of an epidemic:**

The steps in investigations of an epidemic are not necessarily in chronological order. Activities related to some of the steps will be required to be undertaken simultaneously.

1. Diagnosis of the disease
2. Confirmation of existence of epidemic:
3. Develop an initial line listing of cases:
4. Define and redefine population at risk:
5. Search for all cases of the disease:
6. Evaluation of ecological factors:
7. Analysis of the data: *Spot map, Epidemic curve, Subgroup-wise attack rates, Supplementary investigations*
8. Hypothesis formation:
9. Report writing: The report should include comments on pre-epidemic situation, mode of onset, progress and waning of epidemic, investigations performed with results and interpretation, source of infection and modes of transmission. It should also contain short and long term measures, with prioritisation matched to resources available.

Types of epidemic curve:

Fig-1

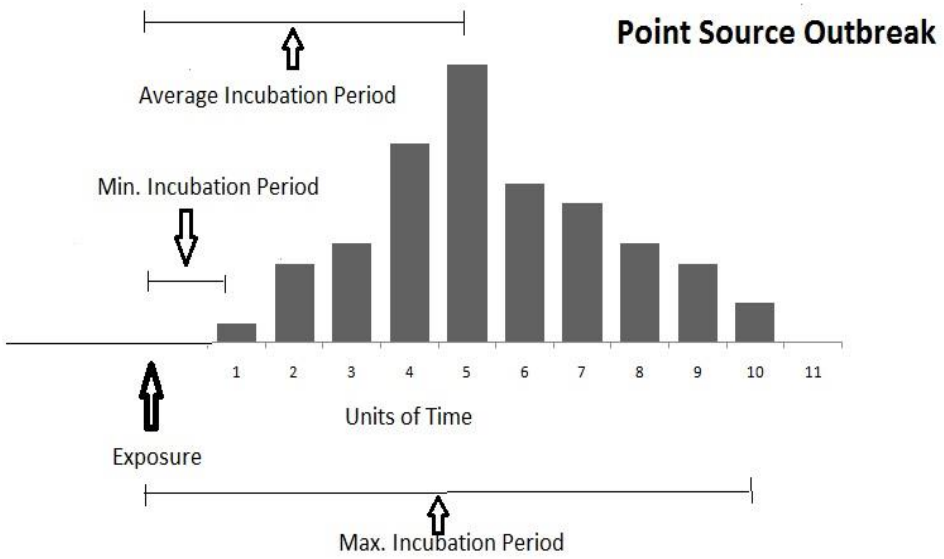


Fig-2

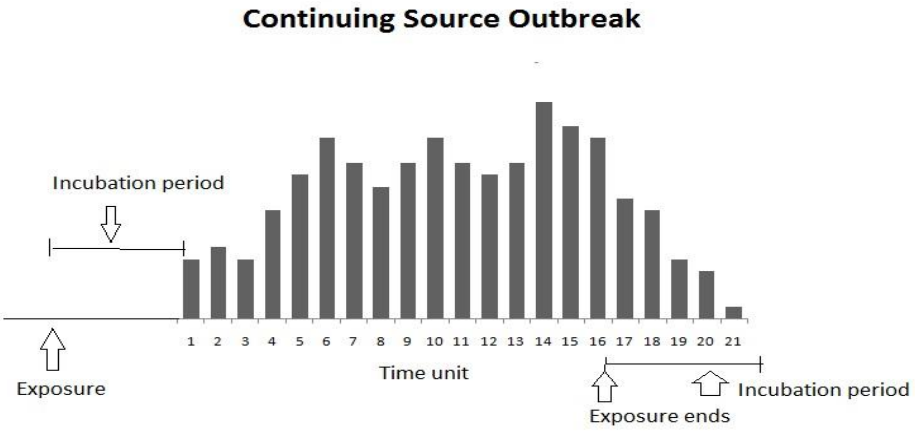


Fig-3

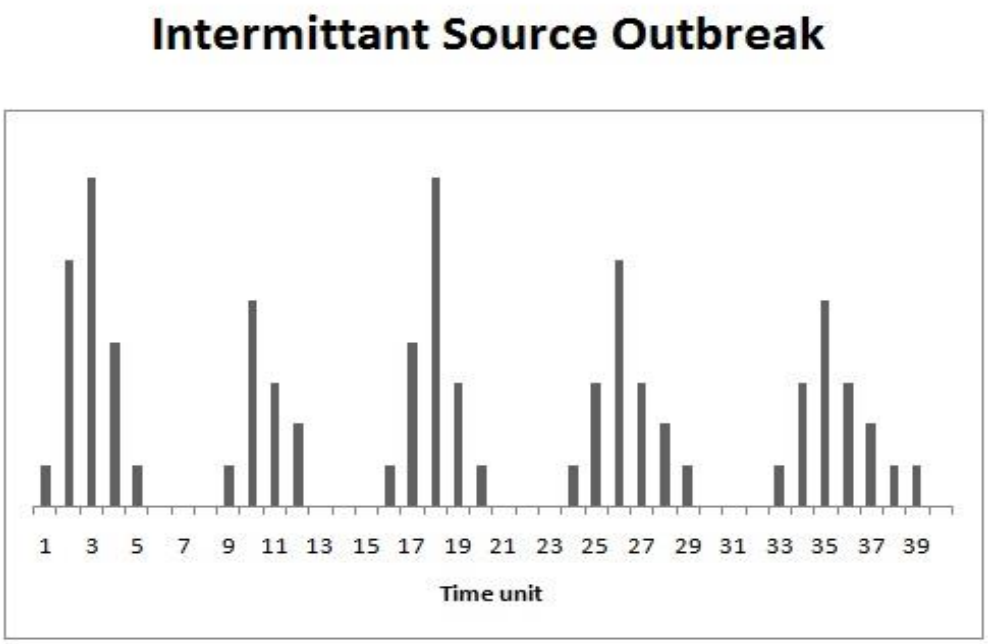

Intermittant Source Outbreak
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
Time unit

Fig-4

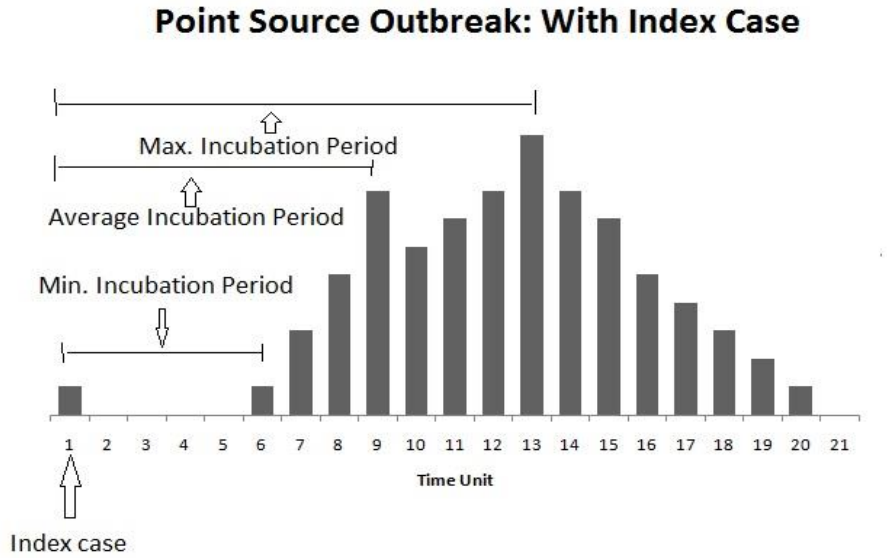
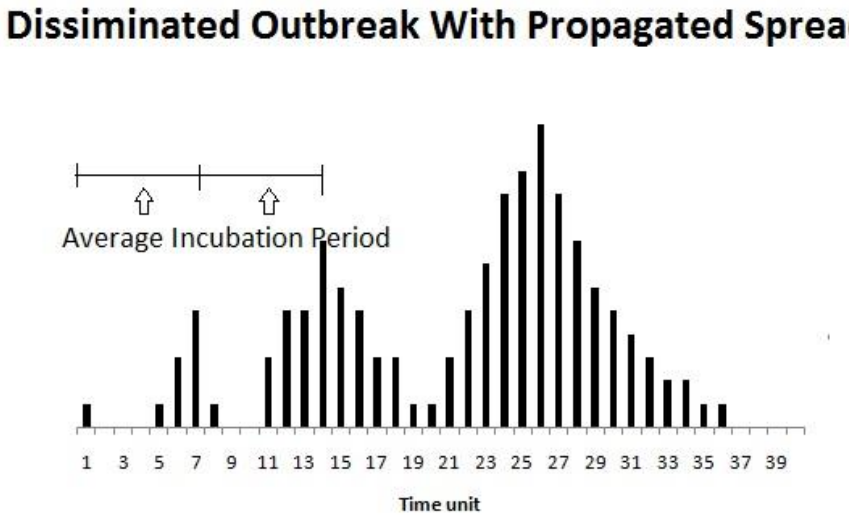

Point Source Outbreak: With Index Case
Max. Incubation Period
Average Incubation Period
Min. Incubation Period
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Time Unit
Index case

Fig-5


Dissiminated Outbreak With Propagated Spread
Average Incubation Period
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
Time unit

11. Emporiatrics

Competency	SLOs (Core)	Assessment
CM 7.1 **Epidemiology- definition , principles, concepts and uses**	The student should be able • Define Emporiatrics • Enumerate Recommendations to travelers • Enumerate contents of a basic medical kit	Written (MCQ, SAQ, LAQ), Practical Skill assessment, viva voce

- **Emporiatrics:**

Emporiatrics is the term coined to describe the science of the health of travelers. Travellers face special health risks. In the age of jet travel, international travellers are subject to various forms of stress that may reduce their resistance to disease, e.g., crowding, long hours of waiting, disruption of eating habit, change in the climate and time zone. Travel on a global scale exposes many people to a range of health risks varying from exposure to different disease agents to changes in the physical/biological environment, all of which can lead to ill-health. many of these risks can be minimized by appropriate travel planning and precautionary measures.

The mitigation measures should start right from the assessment of the determinants of the health risks to which travelers are exposed: e.g., health status before undertaking travel (viz. underlying chronic disease/low immunity); place of travel (viz. facility of accommodation/ hygiene-sanitation/provision of medical services); purpose and duration of travel and travelers' behavior.6 Preventive strategies can be planned based on the risks to which travelers can be exposed. The travel must be planned well in advance and safeguard measures should be taken before, during and after travel.

Actions which the traveler must take prior to the commencement of the journey should be learning about the destination (ascertaining health risks prevalent in the area, climate, availability of health care facilities, etc.); medical consultation for necessary immunizations or for an ongoing health concern;7 obtaining special travelers health insurance for destinations where health risks are significant and medical care is expensive/not readily available; and carrying a medical/first-aid kit.

- **Recommendations to travelers:**

(1) Avoid bathing with polluted water as this may result in ear, eye and skin infections. Excessive heat and humidity or over—exertion in these conditions may lead to exhaustion from loss of water and salt.

(2) The measures for prevention of insect bites.

(3) **Diarrheal Diseases:** "Be careful what you eat" is common advice to travelers, Contaminated food drinks are the most common source of these infections. Careful

selection and preparation of food and drink offer the best protection. The food should be thoroughly and freshly cooked. Use boiled water or bottled mineral water (now available everywhere). Travellers should be aware of the importance of oral rehydration fluids containing salt and glucose for countering dehydration.
(4) **Malaria:** There is a high risk of acquiring malaria in endemic areas. Travellers are advised to protect themselves by chemoprophylaxis. Drug prophylaxis should begin at the latest on the day of arrival in the malarious areas and continued for 4—6 weeks after leaving the malarious areas.
(5) **Hepatitis A:** Normal human immunoglobulin in a dose of 0.02—0.05 mg/kg of body weight has been recommended every 4 months. Ideally immunoglobulin should not be given within 3 weeks before, or until 2 weeks after administration of a live vaccine. A highly safe, inactivated HAV vaccine is available in several European countries.
(6) **Hepatitis E:** There is no vaccine against hepatitis E. Avoidance of contaminated food and water is the only effective protective measure.
(7) **Hepatitis B:** Hepatitis B vaccines are available and are safe. Three doses of vaccine constitute the complete course. The first two doses are given one month apart and the third dose about 6 months later.
(8) **STD and HIV:** Measures for preventing STD are the same whether the individual is travelling abroad or not, i.e., avoidance of sex altogether or limit it to a single faithful, uninfected partner. Use of condom is an important preventive measure. To reduce the risk of acquiring HIV and hepatitis B from syringes and needles, travellers should avoid injectable drugs and if an injection is essential they should make sure that the needle and syringe come from sterile pack.
(9) **Yellow fever:** Vaccination certificate for yellow fever is the only certificate required for international travel. Yellow fever vaccine is recommended for travellers to countries designated as yellow fever endemic zone.
(10) **Tetanus**: It is a wise precaution for the traveller to have a booster dose of tetanus toxoid if 10 years or more have elapsed since the last injection of a complete course or booster.

- **Medical kit and toilet items:**

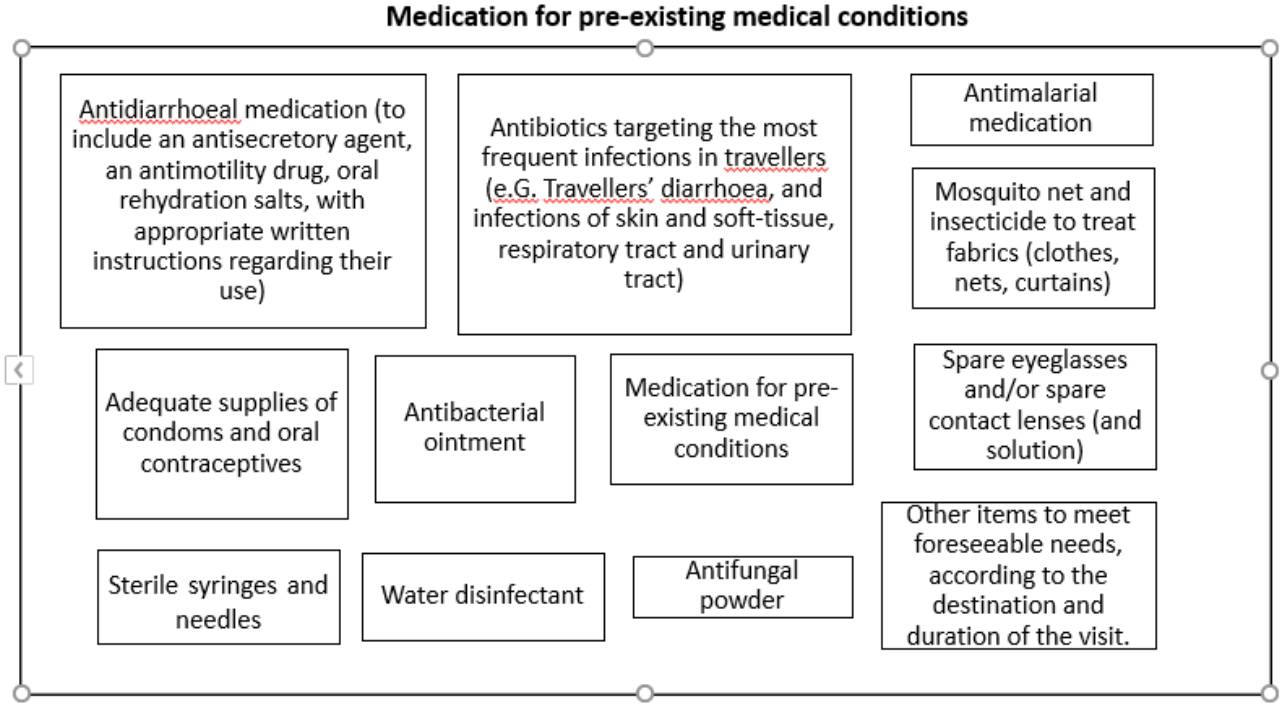
Sufficient medical supplies should be carried to meet foreseeable needs for the duration of the trip. A medical kit should be carried for all destinations where there may be significant health risks, particularly those in developing countries and/or where the local availability of specific medications is uncertain. This kit will include basic medicines to treat common ailments, first-aid articles, and any other special medical items, such as syringes and needles (to minimize exposure to bloodborne viruses), that may be needed and can in some cases be used by the individual traveller.
Certain categories of prescription medicine or special medical items should be carried together with a medical attestation on letterhead, signed by a physician, certifying that the traveller requires the medication or the items for a medical condition. Some countries require that this attestation be signed not only by a physician but also by the national health administration.
Toilet items should also be carried in sufficient quantity for the entire visit unless

their availability at the travel destination is assured. These will include items for dental care, eye care (including contact lenses), skin care and personal hygiene, including alkaline soap for washing wounds suspected of rabies contamination.

Contents of a basic medical kit
First-aid items:

First-aid items					
Adhesive tape	Antiseptic wound cleanser or alkaline soap	Bandages	Scissors	Safety pins	Emollient (Lubricant) eye drops
Insect repellent	Insect bite treatment	Antihistamine tablets	Nasal decongestant	Oral rehydration salts	Simple analgesic (e.g. paracetamol)
Sterile dressing	Clinical thermometer	Sunscreen	Earplugs	Tweezers	Adhesive strips to close small wounds.

Additional items according to destination and individual needs:



- **<u>Medical examination after travel</u>**

The active measures should not be confined to the period of travel. Rather, all travelers, after return, must undergo medical examination. Travellers should be advised to have a medical examination on their return if they:

- Return with a fever from a country where malaria is or may be present, so that malaria can be excluded as a cause of their illness
- Suffer from a chronic disease, such as cardiovascular disease, diabetes mellitus, or chronic respiratory disease or have been taking anticoagulants;
    - Experience illness in the weeks following their return home, particularly if fever, persistent diarrhoea, vomiting, jaundice, urinary disorders, skin disease or genital infection occurs;
    - They received treatment for malaria while travelling;
    - May have been exposed to a serious infectious disease while travelling;
    - Have spent more than 3 months in a developing country.

      Travellers should provide medical personnel with information on recent travel, including destination, and purpose and duration of visit. Frequent travellers should give details of all journeys that have taken place in the preceding weeks and months including pre-travel vaccinations received and malaria chemoprophylaxis taken.

      Note. Fever after returning from a malaria-endemic area is a medical emergency and travellers who develop fever should seek medical attention immediately, explaining that they may have contracted malaria.

    - For the benefit of travellers, the WHO publishes every year a booklet, now entitled "**International Travel and Health, Vaccination requirements and Health advice"** provides guidance on some of the main health risks to which travellers may be exposed in different parts of the world and advice on precautions that may be taken against them.

12. Writing a research

Competency	Learning objectives	Assessment
CM6.1 Demonstration and exercises on Formulation of a research problem, research question & research hypothesis for a study	**The student should be able to** • Write a research study in recommended format	Written/ viva voce/ Skill assessment

IMRAD structure

Introduction, Methods, Results, Analysis, Discussion.

1. **Title of the study:**

Should be Concise, but informative and don't use abbreviations in the title. It should indicate

- Objective of the study. E.g. Prevalence of Tuberculosis
- Type of the study i.e. study design e.g.an observational study; a case-control study, a randomized controlled trial etc.
- Place the study e.g. RMC, Loni

2. Introduction:

Introduction or background should be brief, but, at the same time clear.

It should bring out Definition of the disease/health problem. Magnitude of the problem in study in terms of morbidity, mortality and suffering. It should give Brief note on:

a -What is already known.

b -What is unknown.

Mention gaps in the present knowledge which prompted the present research work. Should answer - why present study? Need for the study. The purpose of the study. The hypothesis being tested and Likely scientific contribution.

3. **Aims and objectives:**

Aim of the study point out the general purpose of the study.

Objectives spell out specifically what one intends to do in the study. Define the objectives clearly and in measurable terms; mention as primary and secondary objectives if necessary. Do not write too many objectives.

4. Materials & Methods:

In methodology give

- **Study design/ Details of study** - Descriptive cross sectional, Analytical case control or cohort, randomized controlled trials, etc. Proposed study design should be appropriate to fulfill all the objectives
- **Study setting and Study period –** Mention **the** Place or setting where the study is planned or will be conducted e.g. RMC, Loni. Mention the study period i.e. Duration of the study. E.g. March 2020 to December 2020.

- **Study population/ Details of subjects -**adequate description of study population should be provided. Explain the rationale of selection of the research participants and controls (humans or laboratory animals), whether chosen randomly, consecutively etc. with inclusion and exclusion criteria, rules for discontinuation, definitions of cases, controls and lost to follow up etc.
- **Sample size**- Details of sample size and/or power calculation should be described with references where needed. A flow chart indicating study design with number of participants should be given where applicable.
- **Details of procedures-** In case of Intervention studies a detailed description of Intervention (drug/device/behavioral intervention) should be given.
- **Details of data collection-** Describe in detail the procedure of data collection and tools used such as the method of data collection whether it is Interview method, observations, or record based, etc. Describe the key variables of the study, how will they be measured and unit of measurement.
- **Details of statistical methods-** Present data analysis plan comprehensively mentioning appropriate statistical methods to be used such as descriptive statistic like mean and standard deviation for quantitative data whereas percentage for qualitative data; mention various statistical tests applicable like Chi square test, t test, etc.
- **Details of ethical issues-** Give details of obtaining informed consent and its documentation should be described along with risks and benefits to the participants Address review requirements including ethics review [human or animal], approval for use of stem cells, biologicals etc. and other regulatory reviews/approvals.

5. Results:

Should precisely state – Present the Findings or observations in the form of Tables, Diagrams, Charts and Photographs. These must have Number (usually in Arabic numerals), Title, Content & Foot note and should be referred clearly at the appropriate place in the text. Indicate the percentages along with the numbers. Write in detail Analysis, Statistical measures employed, Confidence intervals, Level of significance, etc.

6. Discussion:

Summarise main results at the beginning. Include What do the result mean?

Present- principles, relationships & generalizations shown by the results. Point out *NEGATIVE FINDINGS.* Compare or Indicate agreement/disagreement with other study results. State the implications of results. Mention limitations. Indicate scope for future work.

7. **Conclusion and recommendations:** Give reasons for conclusions and recommendations should be based on your study results only and *NOT from possible factors which you have NOT studied and should NOT be simply a repetition of standard recommendations from the text book.* Mention why research hypothesis (if any) -Accepted or rejected.

8. REFERENCES:

Quote the References as they appear in text. Give the references preferably in Vancouver style (Number in superscript). Other method is Harvard method (Names & year)

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