

## Types of data

Data classification depending upon variables

- 1) Qualitative data
- 2) Quantitative data

1) Qualitative data - It arises when observation falls into separate distinct categories.

Qualitative data consists of non-numerical information that describes qualities, characteristics, attributes or properties. It is often collected through observation, interviews, open-ended surveys, & textual sources. Qualitative data provides insight into subjective aspects of phenomena & helps to understand and explore meanings, emotions, & contexts.

- Ex! - colour of eyes: blue, green, brown etc  
Exam result: Pass / Fail  
Socio economic status - low middle class

a) Nominal data :- Nominal data is simplest form of qualitative data. It involves categorizing items into distinct groups or classes without any specific order or ranking. Each category is given a name or label, which represents its identity but does not imply any inherent value or order. This data can only be used for classification purposes.

Ex - In a research study, grouping subjects into categories like male & female. These categories are names given to different groups but don't indicate any specific ranking or order.

b) Ordinal data :- It goes beyond nominal data by introducing the concept of order or ranking among categories. It represents qualitative data in a way that reflects their relative position or preference.

- \* This type of data are discrete in which there are finite no. of possible categories into which each observation may fall
- \* It has no magnitude & cannot be measured
- \* These are classified by counting individual having same characteristics & not by measurement

There are 2 type qualitative data

- a) Nominal data:— Represents most basic form of data this form category data into certain group & gives them name  
example in study grouping sample of subject may be done by male and female
- b) Ordinal data:— It gives more information than nominal data in an ordinally  
ex- in study group male & female subject can also discriminate as oldest, older, mild aged, younger etc

∴ Quantitative data provides objective & measurable information about quantities & amt of variables

\* Here characteristic doesn't vary but only frequency vary.

\* Ex: no. of birth, no. of death etc.

\* Characteristics are measured either on an interval or on a ratio scale.

\* The data is said to be discrete if the measurement are integers & continuous if the measurement can take on any value usually within some range.

Data are characterized by

a) Variability: - It is difference that can be measured in for same feature in different subject

Eg: - group 10 subject may be 45, 48, 52, 44 wt of single characte or feature that differs in 10 different subjects

## Secondary data

Data that is already published or unpublished which is used for investigation on purpose

a) Published data:—

i) Government publication:— Many government departments such as health & family welfare department or central state government regularly published useful information with statistics.

Ex:- health statistics agriculture statistics of India trade journal etc.

ii) International organization:— Many I.O like WHO, UN, UNICEF etc published valuable data usually regarding people health & other relative areas. provide information about countries & its place in world.

iii) Semi official publication:— Local bodies such as municipal corporation, gram panchayat etc publish reports periodically which provide information about people health, birth & death rate, sanitation, literacy etc.

While the intervals b/w categories might not be uniform, ordinal data indicates that one category is higher or lower than others.

Ex:- Continuing with research study example if you group male & female subjects based on ranges like: oldest, older, middle aged, younger & youngest represent ordinal data.

The categories have an order that suggests different levels of age, even though the exact intervals b/w them might not be equal.

## 2) Quantitative data

Quantitative data is arrived when observations are counts or measurements.

Quantitative data is numerical information that can be measured or counted. It involves quantities & can be analyzed using mathematical & statistical methods. This type of data is collected through measurements, surveys with closed-ended questions, experiments & objective observations.

### b) Information from correspondents

Here local agents are correspondents are appointed in different part of investigation area ex newspaper or radio departments.

They obtain a news or article/program etc by this method

It is used when information is to be obtained from wild area & where high degree of accuracy is not required

### c) Questionnaires

It is set of printed questions usually with a choice of answer in this question sheet is provided for giving answer by 2 types.

1) Mailed questionnaires:— These to be filled by investigator. Mailed questionnaires certain questions are sent to informants or respondents by post or a mail and kept confidential. It is most popular method used.

b) Continuity:- Difference is seen in same subject of feature over a period of time.

Ex: a person may be measured for wt at 5 different occasions with he show following value 54.8, 51.1, 55.3, - - -

## Source / Collection of data

- i) Internal data
- ii) External data

i) Internal data:- it is information generated or collected from within organisation; business etc

ii) External data:- Information collected from outside of institution or organisation

## Two characters of external data

- i) Primary data
- ii) Secondary data



3) Class interval :- If no. of observations having wide range diff. characteristics are expressed in numerical value then they are classified into a no. of groups within interval

Kirti  
25/5/20

## Presentation of data

The way or method of presenting collected information for statistical analysis called presentation of data

### Methods of presentation

- 1) Tabular "
- 2) Diagrammatic "
- 3) Graphic "

① Tabular " :- Classified data as putting in table having a row & column

### Types of tabular presentation

- a) Simple tabular (one set of data) (one way table)
- b) Complex " (two way table)

i) Primary data: That is collected by researcher from 1st hand source.  
 primary data can be collected from following method:

a) Personal interview

There are 2 types

1) Direct method

2) Indirect

i) a) Direct personal interview? —

\* Researchers collect data personally from person who are subject to enquiry. Research should be skilled & pleased.

Eg If a teacher want to know personality of student in class she may interview her " personally one by one.

ii) b) Indirect personal interview —

If person refuse to provide information to investigator then this method can be used here information can be collected from person who nearest to him

eg - alcoholic drinks may not provide accurate ans so we may ask their family

iv) Reports of committees or commissions:—

There are " " & committee & commission of enquiry appointment by central & state government for some special purpose & study. These reports have very high value.

v) Private publications:— These include journals articles & newspapers research institute like ICMR, NIMH etc

Private company like Honda, Tata steel company etc.

b) Unpublished data:—

Its many department like atomic research department information & technology " medical research institute etc. never published their data without government permission or they head of department or also personal diary notes etc.

2) Two dimension diagram -

Here area instead length are proportional

1) Rectangle -

2) Square

3) Pie diagram

4) Pie chart

3) 3-d diagram -

a) Cube

b) Rectangular solid

c) Pictogram

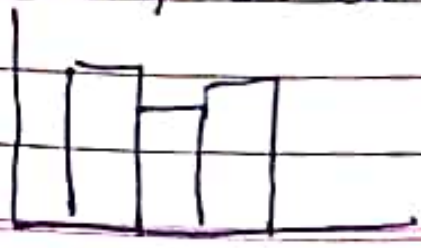
d) Cartogram

3) Graphical representation

They are made to represent data of fig dist relation over a period of time

1) Graph of frequency graph: 2 variables are used on y-axis & other y axis independent

2) Histogram - freq of diagram distribution which consist of series of block drawn adjecently on same horizontal



Types of research based on different classification criteria

(1) Qualitative research :- It involves gathering non-numerical data such as opinions, perceptions, experience & narrative

eg:- Conducting in-depth interviews to explore participants attitude towards a particular social issue.

(2) Quantitative Research :- Deals with numerical data & employs statistical method for analysis. It focuses on measuring variables & establishing patterns or relationship

eg:- Using surveys to collect the data on % of people who prefer different brand of product

15000  
11000  
3000  
350

91000  
17000  
30000  
11000

30000  
17000  
00

43000  
22000  
21000  
18000  
5000  
3000

11900  
3000

18700  
18000  
7000  
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## 2) Extensive

Once the problem is formulated, a brief summary of it should be written down.

At juncture the researcher should undertake extensive literature survey connected with problem. For this purpose, abstracting & indexing journals and published or unpublished bibliographies are 1<sup>st</sup> place to go to.

Academic journals, conference proceedings, government reports, books etc must be tapped depending on nature of problem.

## 3) Development of working hypothesis

After extensive literature survey,

<sup>inter term</sup>  
<sup>to</sup>  
<sup>positive</sup>  
<sup>column</sup>  
researcher should state in clear terms the working hypothesis. WH is tentative assumption made in order to draw out, test its logical or empirical consequence. As such manner in which ~~the~~ <sup>the</sup> R/H are developed particularly imp. since they provide <sup>propt</sup> ~~for~~ <sup>for</sup> research. They also affect manner in which tests must be conducted in analysis data & indirectly quality of data which requires for analysis hypothesis should be very specific & limited to piece of research in hand bcz it has to be tested.

Formal reports involve being in situation. Scientific organizations & technical establishments. Annual reports of institutions, formal reports of committee, commissions, public & private enterprises fall under this category. A formal report takes the shape of book & is divided into many chapters & sections. The writing of the report requires a sound selection of facts & careful organization of subject matter.

### Articles

S&T writing often takes the shape of articles of varying length & specific format. Such articles convey communicated knowledge on particular subject for preservation & dissemination of ideas. These articles may be sub-divided into 3 categories, ~~technical~~

- Technical
- Sem-technical
- Popular

## Characteristics of good research design

- 1) A good design is often characterised by adjectives like flexible, appropriate, efficient, economical & so on.
- 2) Generally design which minimize bias & maximize the reliability of data collected & analysed is considered a good design.
- 3) The design which gives smallest experimental error is supposed to be best design in many investigation.
- 4) A design which yields maximal information & provides an opportunity for considering many different aspects of problem is considered most appropriate & efficient design in respect of many research problems.



## UNIT-3 Research Process

Research paper consists of series of action or steps

- 1) Formulation Research problem
- 2) Extensive literature survey
- 3) Developing Research design
- 4) Preparing " "
- 5) Determining " " "
- 6) Collecting " Data
- 7) Execution of project
- 8) Analysis of data
- 9) Hypothesis testing
- 10) Generalization & Interpretation
- 11) Preparing Report / part of result

### 1) Formulation Research problem

There are 2 types of research problems

- > These which are relate to state of nature
- > These " " " " " to relation b/n variable

Researcher must single out problem he want to study; i.e. he must decide general area of interest of subject-matter that he would like to enquire into. Initially the problem may be stated in a broad general way.

#### 4) Preparing research design

<sup>concept</sup> The researcher will be required to prepare research design, i.e. he will have to state conceptual structure which research would be conducted. The preparation of such design facilitates research to be as efficient as possible yielding maximal information. In other words function of research design is to provide for collection of relevant evidence with minimal expenditure effort, time & money.

The preparation of research design, appropriate for particular research problem

- > The means of obtaining the information
- > The availability & skills of researcher & his staff

> Explanation of way in which selected means of obtaining information will be organized & reasoning leading to selection.

- > Time available for research
- > Cost factor relating to research i.e. finance available for purpose

### 5) Determination sample design

The research must decide way of selecting a sample or what is popularly known as sample design. Sample design is definite plan determined before any data is actually collected for obtaining sample from given population.

Sample can be either probability sample or non-probability sample, with ps each element has known probability of being included in the sample but nps do not allow the researcher to determine this probability. PS are those based on simple random sampling, systematic, stratified, cluster/are " where as NPS based on convenience sampling, judgement sampling, & quota sampling technique.

The sample design to be used must be decided by researcher taking into consideration nature of enquiry & other related factors.

### 6) Collecting data

There are several ways of collecting the appropriate data which differ considerably in context, money cost, time & other resources at disposal of researcher.

Primary data can be collected either through experiment or through survey. In case of survey, data can be collected by any 1 or more of following ways

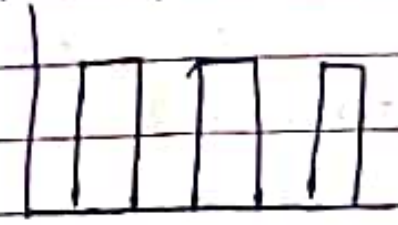
- By observing
  - > Through personal interview
  - > Through telephonic
  - > By mailed of questionnaires
  - > Through schedules

The researcher should select one of these method of collecting data taking into consideration the nature of investigation, objective & scope of inquiry, financial resources, available time & desired degree of accuracy

② Diagrammatic Tabular presentation! — Appearing to see & create a impression in mind it reveals hidden fact of data usually picture presentation of data makes impression that an other diagr

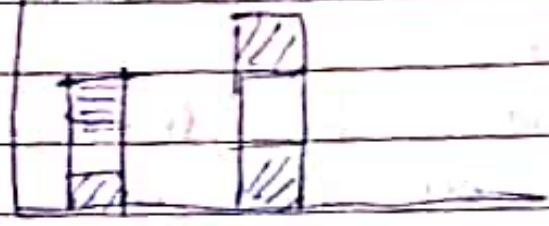
Types of diagrams

- 1) 1 dimension diagr. — Bar diagrams are called " " bar ht of bars is of real significance & not width of bar
- a) Simple bar diagram - It is used represent only 1 character one bar represent only 1 variable

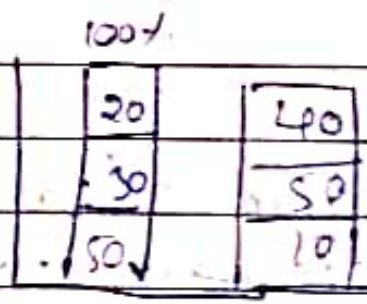


- b) Subdivided bar diagrams: [Compound  
 These " into certain part total height proportional to different sub division representing component part

3) Multiple bar diagram:- in compound bar chart when subdivisions are more than a type of data this type bar used when we have to make comparative study of different character



4) % bar diagram:- In compound bar chart when subdivisions are more than a subdivisions are converted into % of whole & ht of each bar as 100 unit



6) Cross sectional research :- involves studying a sample of population at single pt in time to gather data about specific issue.  
eg: conducting a survey to understand people's preferences for different types of entertainment.

- 7) On the basic method of research
- Philosophical research
  - Historical "
  - Survey "
  - Experiment
  - Case-study

### 9) Hypotheses testing

After analysing data as stated above, the researcher is in position to test his hypothesis, if any, he had formulated earlier. Do the facts support hypothesis or they happen to be contrary? This is usual question which should be answered while testing hypothesis. Various tests such as chi square test, t test, F-test have been developed by statisticians for the purpose. After testing with result is either accepting the hypothesis / or rejecting

### 10) Generalization & Interpretation

If a hypothesis is tested & upheld several times, it may be possible for research to arrive at generalization, i.e. to build theory. As matter of fact, real value of research lies in its ability to arrive at certain

generalization. If researcher had no hypothesis to start with, he might seek to explain his findings on the basis of some theory. It is known as interpretation.

The process of interpretation may quite often trigger off new questions which in turn may lead to further research.



## 1) Various forms of scientific writing

### Reports

A scientific & technical reports may follow a pattern according to its purpose & scope. The most imp type of S&T R are form reports, article reports & formal reports such as research papers, dissertations & theses.

Form reports are made as given prototype design especially by an organization according to its specific requirements.

The Report writer has to fill in the columns & give the required facts under different heads. It is a true statement of facts, figure or data, which form the basis for evaluation of work in an

institution or organization. Such reports are quite common in the fields of technical education, industry & scientific research.

Article reports take shape of technical articles. The use of heading, sub-headings, tables & figures, charts & graphs

is made effective communication fact & findings. Related information may also given

appendix. if it cannot be integrated into the

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 22 \quad 22 \\
 15 \quad 15 \\
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the ambiguities if any, related to the problem may ~~be set~~ resolved.

Then the feasibility (describing easy/difficult particular soln has to be considered before a working formulation of problem can be setup.

The formulation of general topic into specific research problem, then constitutes 1<sup>st</sup> step of scientific enquiry.

Essentially 2 steps are involved in FRP, understanding problem thoroughly, & rephrasing the same into meaningful terms from an analytical point of view.

The researcher must at same time examine all available literature to get himself introduction with selected problem.

He may review 2 type of literature

1. Conceptual literature concerning concept & theories, & empirical literature consisting studies made earlier which are similar to proposed.

After this researcher rephrases the problem into analytical / operational terms, to put problem in specific terms as possible. This task of formulation / defining, a research problem is step of great imp in entire process.

## 7) Execution of project.

It is very imp step of research process. If the execution of project proceeds on correct lines, data to be collected would be adequate & dependable. The researcher should see that project is executed in systematic manner & in time. A careful watch should be kept unanticipated facts in order to keep the survey as much realistic as possible.

## 8) Analysis of data

After data have been collected, researcher turn to task of analyzing them. The analysis of data requires a no. of closely related operation such as establishment of categories, applin. of these categories to raw data through coding, tabulating, drawing statistical inference. Tabulating is a part of technical procedure wherein classified data is put in form of table. Analysis work after tabulation is generally based on computation various  $\chi$ , coefficient  $k$  by applying various well defined statistical formulae.

3) On basis of utility of content  
3) Basic / Fundamental / Theoretical research :- This type of research is driven by curiosity & aim to expand gk without immediate practical appls. It explores theories & principles.

eg:- investigating fundamental properties of certain particle in physics.

4) Experimental or Applied research :- Applied research focuses on solving specific real-world problems. It involves using knowledge gained from basic research to address particular issue.

eg:- Developing a new drug based on insight from fundamental research on specific biological process.

c) On the basis of Approach of research

s) Longitudinal research :- Involving studies a subjective phenomenon over extended period to observe changes or development.

eg:- Tracking education & career paths of group of student over several years.

## Role of Biostatistics

1) Study design: — B.S contribute to planning & design of research studies, ensuring that appropriate statistical methods are used to address research questions effectively. They help determine the sample size, randomization & control measurement to maximize the study's validity & reliability.

2) Data collection & Management: — B.S develop protocols & tools for data coll., ensuring data are gathered in std & unbiased manner. They also improve integrity & quality of data by implementing data management procedures.

3) Data analysis: — B.S is core of data in life science. B.S apply various statistical techniques to analyze data, identify trends, draw meaningful inferences & determine significance of research findings.

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→ What are ethical issues of biomedical research

A predominant view within the current ethical discussion on human dealings with animals is that humans are vested with basic moral right to use animals for their own ends. This right, however, is subject to limits where animals are significantly harmed by human actions or are killed without sufficient reasons. In the established system of normative positions on animal ethics, this position is classified as "Pathocentric". This means that a living organism's ability to suffer entails an obligation to protect it. On the other hand, a position is defined as "Anthropocentric" if it categorically makes humans 'the measure of all things', including when it comes to treatment & protection of animals. A 3<sup>rd</sup> relevant position here is "biocentric" view which assigns ethical value to all living organisms including lower animals & plants. While the extreme version of these 3 positions are incompatible with one another, these more moderate forms are generally regarded as reconcilable.

## ② Definition, scope & role of biostatistics.

### Research

It is systematic & rigorous investigation aimed to acquiring new knowledge, understanding or solving problems through collection, analyses & interpretation of data & evidence.

### Scope of biostatistics

1) Study design :- Biostatistics are involved in planning & design of research studies. They help researchers select appropriate study design, sampling methods, & sample sizes to ensure study objectives are met & results are reliable.

2) Data collection :- Biostatistics are involved developing data collection protocols & instrument, such as surveys, questionnaires, & clinical trial protocols. Biostatistics ensure that data collection procedures are standard, unbiased & yield high quality data.

All these publications require skill & attention. Manual should be written with great care to have desired effect. The success of flow manual to great extent depends on effectiveness of information provided in the booklet. Many industrial establishments engage experts to do this job.

### Scientific correspondence

Communication may be in the form of correspondence b/w 2 different organizations or within same organization for vertical & horizontal flow of scientific & technical information. Both letters & memoranda are a useful tool for S&T comm. They help in recording technical information, making & seeking recommendations in S&T matters, providing clarification, co-ordinating projects, initiating action & meeting many other requirements of different institutions. All these forms of S&T comm are used by students, scientists, scholars, administrators & industrialists according to their specific needs.



## ii) Preparation of report / thesis

Finally, the researcher has to prepare of what has been done by him, writing of report must be done with great care.

layout of report should be

- 1) Preliminary pages
- 2) Main text
- 3) End matter

In It's preliminary pages of report should carry title & date followed by acknowledgements & foreword. Then there should be table of content followed by list of tables & list of graphs & charts, if any, given in report.

The main text of report should have

- 1) Introduction
- 2) Review of literature
- 3) Material & Methodology
- 4) Result & discussion
- 5) Summary & conclusion

At the end of report, appendices should be enlisted in report to all technical data. Bibliography i.e. list of books, journal, report etc. consulted should also be given end. Index should also be given specially in published research report.

Technical article contains highly specialized information & involve the use of technical vocabulary & scientific abbrev, which are understood by experts belongs to particular discipline. These are published in specialized journals.

The scope of semi-technical articles is much broader as they can also be understood & used by people working in similar disciplines. The use of technical vocabulary & abbrev is reduced to mini. These articles are also published in scientific journals but they have wider readership.

Popular articles on scientific & technical subject are meant for educated people who are not specialists. The use of technical vocabulary & abbrev is avoided. The emphasis is on easy & interesting communication of information & not on complicated details. These articles are published in periodicals & journals of common interest & are widely read.

4) Interpretation of results — B.S play a role in the interpretation of results. They help to assist researchers & stakeholders to understand the implications & limitations of study. It also guides them in making informed decisions.

5) Clinical trials — In medical research, B.S is essential for design & analysis of clinical trials. B.S ensure that clinical trial results are valid, reliable & compliant with regulatory standards.

6) Epidemiological studies — B.S is integral to epidemiological studies that investigate disease patterns, risk factors & public health interventions. B.S analyze epidemiological data to identify trends, assess disease burden, & develop preventive strategies.

7) Public health policy — B.S provide evidence for policy making & decision making. It helps to understand the impact of health interventions, assess health disparities & allocate resources effectively.

Notation used to represent population parameter & sample statistics are different

∴ Population size : N

Sample size : n

### Mean

∴  $\bar{x}$  for sample mean & for population mean

$$\bar{x} = \frac{\sum x_i}{n}$$

$\sum x$  - sum of all individual scores,

n - no. of scores

### Median

~~If data is 2, 3, 4, 5, 7, 10, 10 then 56000~~

Median is middle value in a distribution of data listed in numeric order

$$= \frac{n+1}{2}$$

Odd no. =  $\frac{n+1}{2}$

### Mode

The value in data set, that occurs most frequently

- A thesis is also based on research work of student or a scholar. It often refers to outstanding research work by done scientists in various disciplines. While the term "dissertation" is modest in connotation, the term "thesis" is high sounding. The former should therefore, be preferred while referring the research work done by a student at master's or doctoral level.

## Manuals

It is functional form of S&T writing which aims at attracting the user's attention & providing him with easy & accurate information & guidance about methodology, experiments, machine & product. Information brochures, instruction books, guidance manual & style manuals contain useful information for the users.

## The 3 R principle

Although animal experimentation cannot be completely avoided in research, there is general consensus that it must be restricted to necessary minimum.

The 3 R principle devised by W Russell & R Burch in 1959. The 3 R's stand for

✓ Refinement

✓ Reduction

✓ Replacement

### Refinement:

The aim of principle is to avoid animal experiments where possible, to reduce their nos & to limit harm caused to animal during experiments to necessary to minimum.

The consistent & responsible implementation of the 3R principle accommodates ethical concerns against the use of animal & also improve the quality of the test result.

The refinement of animal experiments has the objective of minimizing the adverse effects of research procedure on animals.

6) Public Health Research — B.S. is indispensable in public health research where it acts as an underlying disease prevention identifying health threats, evaluating the impact of public health interventions.

7) Genomics & Genetics — In Genomic & Genetic research, B.S. analyses large-scale genetic data to study genetic variation, heritability of disease & gene-environment interactions.

8) Bioinformatics — B.S. closely related to bioinformatics which involves analyzing & interpreting data using computational techniques. B.S. contribute to analysis of genomic & proteomic data.

9) Health Policy & Decision maker — B.S. and provide evidence for health policy formulation & decision making. It helps policy maker understand health trends, assess health outcomes, & allocate resources effectively.

6) Public Health Research — B.S is indispensable in public health research, where it aids in understanding disease prevalence, identifying health disparities & evaluating the impact of public health interventions.

7) Genomics & Genetics — In Genomic & Genetic research, B.S analyse large-scale genetic data to study genetic variation, heritability of disease & gene-environment interactions.

8) Bioinformatics — B.S closely related to " ", which involves analyzing & interpreting data using computational techniques. B.S contribute to analysis of genomic & proteomic data.

9) Health Policy & Decision making — B.S and provide evidence for health policy formulation & decision making. It helps to policymakers understand health trends, assess health <sup>care</sup> outcomes, & allocate resources effectively.



## Dispersion (Variability)

A measure of spread of scores in a distrib.

- Range
- Variance
- Standard deviation (SD)

### Range

It is difference b/n largest value of smallest value. It is informative for data without outliers.

### Variance

It measures the avg squared distance that scores deviate from their mean.

Sample variance -  $s^2$

population " -  $\sigma^2$

$$s^2 = \frac{\sum (x - \bar{x})^2}{n-1} \text{ or } \frac{SS}{n-1}$$

SS - sum of squares

$n-1$  - degree of freedom

SD :- It is square root of variance. It is avg distance that scores deviate from their mean.

$$s = \sqrt{\frac{SS}{n-1}}$$

## Scientific research paper

" " " are written & published reports describing original research results. A scientific experiment, no matter how spectacular the result, is not complete until the results are published. In fact, the cornerstone of philosophy of science is based on this assumption that original research must be published only this way, new scientific knowledge authenticated & then added to existing data base that we call science. Research papers are instrumental in cross-fertilization of ideas in the field of science, agriculture, & technology. These papers are published separately or included in journals of research brought out by universities & other educational institutions. The technical & scientific & technical writings are observed in research paper.

A scientific paper is primarily an exercise in organization. A scientific paper should be highly stylized, with distinctive & clearly evident components. Each scientific paper should have in proper order its introduction, Material & Methods, Result & discussion.

Good organization is key to good writing. However, there have been several somewhat different statements of organization that have been followed by some journals & some editors. The tendency towards uniformity is increasing & nowadays the same order is being followed.

### Dissertation & Theses

" are like research papers but they are wider in scope & longer in size. A dissertation is based on student research on particular subject. Like research paper it must conform to specific format requirement & should strictly follow the rules of scientific & technical writing.

5) Genomic & Genetic studies — B.S. analysis large-scale genomic & genetic studies to identify genetic factors associated with disease, assess heritability, & identify potential therapeutic targets.

6) Quality improvement in health care — B.S. methods are used to evaluate health care processes & outcomes, leading to continuous quality improvement in patient care.

7) Risk Assessment — B.S. aids in risk assessment to exposure to environmental hazards, occupational health risks, & infectious diseases.

8) Health informatics & Big data — B.S. & contribute to analysis of health-related big data, such as electronic health records, wearable devices, & health sensors, to derive meaningful insights & patterns.

## Two types of statistics

- 1) Descriptive statistics
- 2) Inferential "

Descriptive " :- They are procedures used to summarize, organize & make sense of set of scores or observations.

Inferential statistics :- They are procedures that allow researchers to infer or generalize observation made with samples to large population from which they were selected.

### Descriptive statistics

#### Type

- Central tendency descriptive statistics
- Dispersion Descriptive "

### Measures of central tendency

We use statistical measures to locate a single score, that is most representative of all scores in a distribution  
(Mean, median, mode)

1) Data analysis - One of the central aspects of biostatistics is analysis. Biostatistics use various statistical methods such as regression analysis, survival analysis, hypothesis testing to analyze data & draw meaningful conclusions.

2) Clinical Trials - Biostatistics plays a vital role in clinical trial which is essential for evaluating the safety & efficacy of new drugs, treatments & medical interventions. Biostatistics clinical trial protocol, analyze trial data & interpret result to determine treatment effectiveness.

3) Epidemiology - Biostatistics is closely linked to epidemiology, the study of disease patterns, factors influencing health outcomes in population. Biostatistics help to analyze epidemiologic data to identify risk factors, trends & patterns of disease occurrence.

An animal's capacity for suffering is central to this assessment. The human obligation to minimize stressful animal experiment must be weighed by extent to which animal are capable of suffering based on their respective level of neuronal development. Particularly inpt. to gradation of ethically grounded animal protection is animals capacity for self-perception. The strong protection should be given to animals presumed to have greatest capacity for experience due to their advanced level of development, such as primates. However, it must also be considered that less development animals occasionally react to an experimental setup with greater stress than those able to adapt to stress through training.

By carefully selecting the animal model, alleviating pain using analgesics & anesthetics, improving the technology used in non-invasive procedures & developing non-invasive research methods, it has developed possible to make great progress in the refinement of animal experiment.