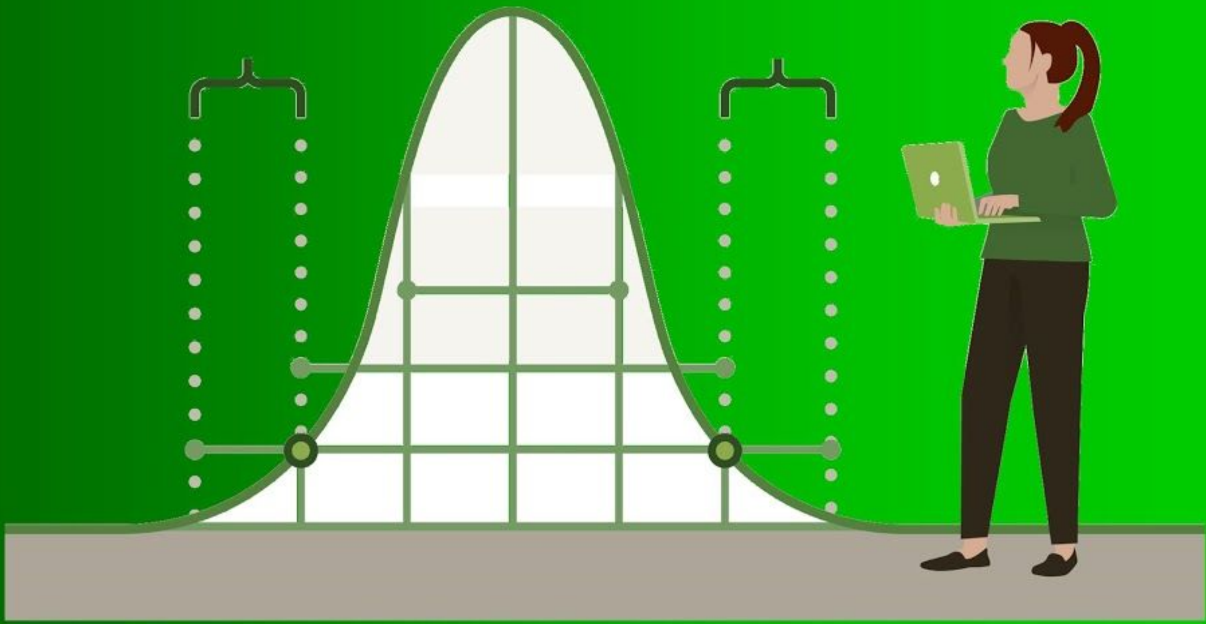
Animal Genetics & Breeding

BIOSTATISTICS AND COMPUTER APPLICATION

(UNIT - I)



Lecture Notes on

Introduction and Importance of Statistics and Biostatistics

First eprint

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ABOUT

These lecture notes on *"Introduction and Importance of Statistics and Biostatistics"* were prepared and delivered to my undergraduate students studying Animal Genetics & Breeding course. This course was offered in the second professional year of Bachelor of Veterinary Science & Animal Husbandry degree at College of Veterinary & Animal Sciences, S.V.P.U.A.T, Meerut, Uttar Pradesh, India. My wish to devote time in writing this lecture notes originated from the inquisitive faces of budding Veterinary doctors that why Biostatistics got a place in the Veterinary curriculum. I have tried to explain how application of statistics has leveraged various subjects in their present form. Use of diagrams, explanatory boxes, tables have deliberately been used throughout the notes to create an interest among the students. Once through with these lecture notes readers will be able to understand the basics and importance of this subject. I had tried my level best to simplify the concept in easy to understand language. Further constructive suggestions to improve this lecture notes are always welcome from readers on my email and whatsapp.

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Introduction and importance of Statistics and Biostatistics

1. Statistics

Statistics is a science that is applied to a set of data to obtain some meaningful numerical information through a set of procedures in relation to predetermined objectives. Set of data rather than a single datum is the essence of statistics. The ability of the human brain to draw some conclusions from numerical values goes on decreasing as we increase their number of occurrences of values in a data set. The beauty and application of statistics resides in its ability to obtain reduced numerical value(s) signifying characteristics of the original data set. These reduced numerical value(s) can easily be understood by the human brain. Owing to this ability, statistics is being applied in a number of subjects ranging from economics, sociology, engineering to biology. The term statistics was first introduced in 1791 by Sir John Sinclair in his work "Statistical accounts of Scotland". The etymology of word Statistics can be understood by deciphering meanings of its originating words in different languages.

1.1. Etymology of Statistics

The origin of word statistics spreads to various languages as depicted in table 1. The first two words converge towards the political matters of state. However, the word "*statistik*" has principle meaning towards data used by administrative public bodies. It is quite obvious that during earlier times the subject of statistics finds more of its application in state matters rather than routine activities of a common man. Therefore, statistics in earlier times was called "Science of states" or the "Science of kings" as it was most often used by states or kings.

Table 1 Originating words of Statistics and their meanings

S.No.	Originating word	Language	Meaning
1.	*Statisticum collegium*	New Latin	Council of State
2.	*Statista*	Italian	Statesman or Politician
3.	*Statistik*	German	Analysis of data about the state

1.2 Perception of word Statistics

The statistics over the time had been perceived in two different senses. One is plural sense and other is singular.

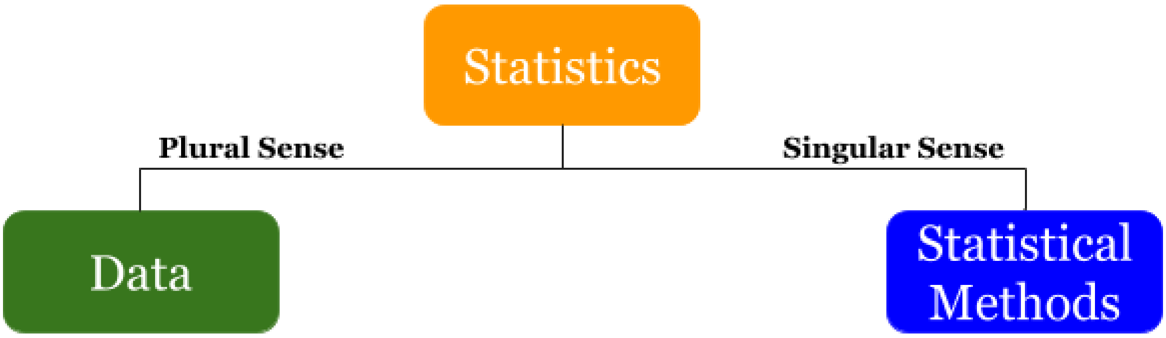

Fig 1 Perception of word Statistics

1.2.1 Statistics in plural sense

The statistics in its plural sense signifies usable information and facts in the form of data. The definition of statistics in its plural sense can be obtained from different sources as depicted in Box 1.

Box 1 Definitions of statistics in plural sense

Statistics are numerical statements of facts in any department of enquiry placed in relation to each other.

A.L. Bowley

The classified facts respecting the condition of the people in a state, especially those facts which can be stated in numbers or in tables of numbers or in any tabular or classified arrangement.

Webster Dictionary

By statistics we mean quantitative data affected to a marked extent by multiplicity of causes.

Yule and Kendall

"Statistics is the aggregate of facts affected to mark extent by the multiplicity of causes, numerically expressed, enumerated or estimated according to a reasonable standard of accuracy, collected in a systematic manner for the predetermined purpose and placed in relation to each other"

Horace Secrist

However difficult to memorize but the definition of Statistics in its plural sense given by *Prof. Horace Secrist* is most comprehensive and meaningful. This definition can be partitioned into different excerpts to understand underlying meaning as given in Table 2.

Table 2: Different excerpts from definition of statistics given by *Prof. Horace Secrist* in plural sense and their meaning

S.No.	Excerpt	Meaning
1.	*Aggregate of facts*	Statistics composed of assorted related data. Single values or unrelated aggregated data does not constitute statistics.
2.	*Affected to mark extent by the multiplicity of causes*	The assorted data in statistics are generally influenced by number of factors working conjointly or solitarily
3.	*Numerically expressed*	The data in statistics need to expressed with some measurable numerical quantity
4.	*Enumerated or estimated according to a reasonable standard of accuracy*	Since related data are either repeatedly collected or estimated from different sources good accuracy needs to be maintained in collection or estimation of facts
5.	*Collected in a systematic manner for the predetermined purpose*	The purpose of collecting the data needs to be available beforehand and accordingly a systematic manner for collection of data needs to be implemented
6.	*Placed in relation to each other*	The data should be arranged in relation to different factors (like age, sex, place etc.) so that a purposeful logical comparision can be carried out.

One of the very pertinent examples of statistics in plural sense is livestock census data. The livestock census data can easily be retrieved from the Animal Husbandry Statistics page of the Department of Animal Husbandry and Dairying (DAHD) website.

1.2.2 Statistics in singular sense

The statistics in its singular sense means statistical methods. It deals with the basic methodology adopted from collection of data to till an inference is made out. Various scientists defined statistics in its singular sense owing to its application and scope as presented in box 2.

Box 2 Definitions of statistics in singular sense

Statistics is the science of estimates and probabilities.

Prof. Boddington

Statistics may be called the science of counting and may be called the science of averages.

A.L. Bowley

> *"Statistics is the method of judging collective, natural or social, phenomenon from the results obtained from the analysis or enumeration or collection of estimates"*
>
> *King*
>
> *"Statistics is a science which deals with the method of collecting, classifying, presenting, comparing and interpreting the numerical data to throw light on inquiry"*
>
> *Seligman*
>
> *"Statistics is the science of collection, presentation, analysis, and interpretation of numerical data from logical analysis"*
>
> *Croxton and Cowden*

The definitions given by *Croxton and Cowden* seem to be most appropriate out of the above given definitions. It encompasses almost all the methodologies we cover in statistics. The brief meaning from excerpts of this definition has been explained to understand our further exploration into the subject. These meanings of these excerpts can easily be understood and equated with various forthcoming statistical methodology we are going to cover in syllabus as given in Table 3.

Table 3: Meaning of different excerpts from definition of statistics given by *Croxton and Cowden* in singular sense equated with different statistical methodology

S.No.	Excerpt	Meaning	Statistical Methodology
1.	*Collection*	Data is collected as per the requirements and objectives of study either from a primary / secondary source	1. Collection, Classification and tabulation of data 2. Sampling methods
2.	*Presentation*	Process of representing classified and tabulated data in the form of diagrams and graphs to carry out comparison or deducing trend in data	1. Graphical and diagrammatic representation of data
3.	*Analysis*	It basically involves various statistical methods to describe, correlate or make inferences from the data. Ultimately some decision is made on the basis of collected data.	1. Measures of Central tendency. 2. Measures of Dispersion. 3. Probability and probability distributions. 4. Moments, Skewness and Kurtosis. 5. Correlation and Regression. 6. Tests of hypothesis- t and Z-tests. Chi-square test.

			7. Analysis of variance and F-test of significance.
4.	*Interpretation*	The results of analysis are interpreted by experts based on their domain knowledge and its application in real world problems.	1. Subject specific domain knowledge

Additionally statistics also involves designing of experiments by setting up a testable hypothesis within limited resources. Designing is done in a way to minimize the fixed and random errors in an experiment. It is a great way to carry out economical experiments on a relatively smaller sample size without much affecting precision and accuracy of the results. Inferences made out of experiments done on smaller samples after proper designing are much closer to the real results of the whole population.

1.3 Timeline of Statistics

The various statistical methods we study today one after the other were discovered and utilized by human kind at different points of time. The timeline of frequently used statistical parameters have been depicted in Fig 2. We will study these statistical parameters in detail in our forthcoming lecture notes.

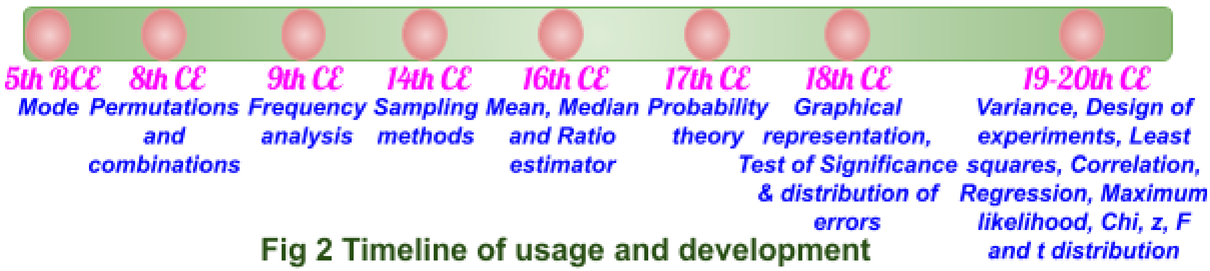

Fig 2 Timeline of usage and development of some statistical parameters

1.4 Types of Statistics

The subject of statistics can be classified on the basis of function or underlying distribution of the data. The organization of various types of statistics can be appraised from Figure 3.

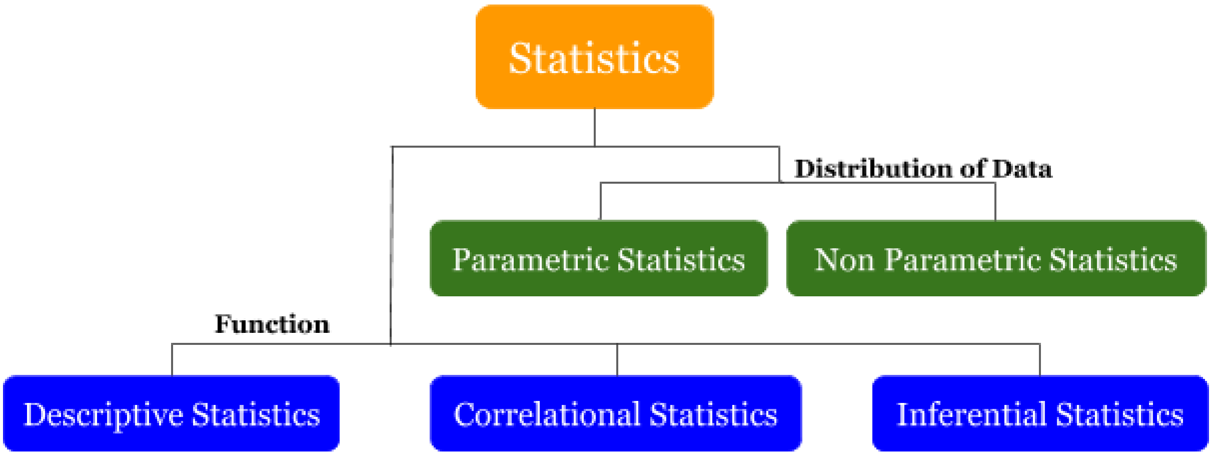

Fig 3 Types of Statistics

1.4.1 Distribution basis

Statistics can be classified on the basis of type of distribution in data which is subjected to analysis. It is broadly divided into Parametric and Non parametric statistics. These statistics are generally carried out on samples. It becomes imperative to understand what actually constitutes a sample? Data on articles or objects under study can have following general characteristics on which certain terminologies are being deduced and differentiated in statistics as described in table 4.

Table 4 Terminologies in statistics based on number and characteristic of article / object / item

S.No.	Terminology	Number of Articles / objects / items	Characteristic
1.	Population	Infinite	Unknowable
2.	Statistical Population	Finite	Unknowable
3.	Sample	Finite	Knowable

An unbiased sample randomly drawn from a statistical population generally possesses most properties and characteristics of that population. Sample is generally obtained through scientific sampling procedures with some predetermined objectives. Such samples are considered to be the best representative of the population.

1.4.1.1 Parametric Statistics

The parametric statistics is one which is applied on data that follows characteristics of normal distribution in a population. We will study normal distribution in detail in our forthcoming lectures.

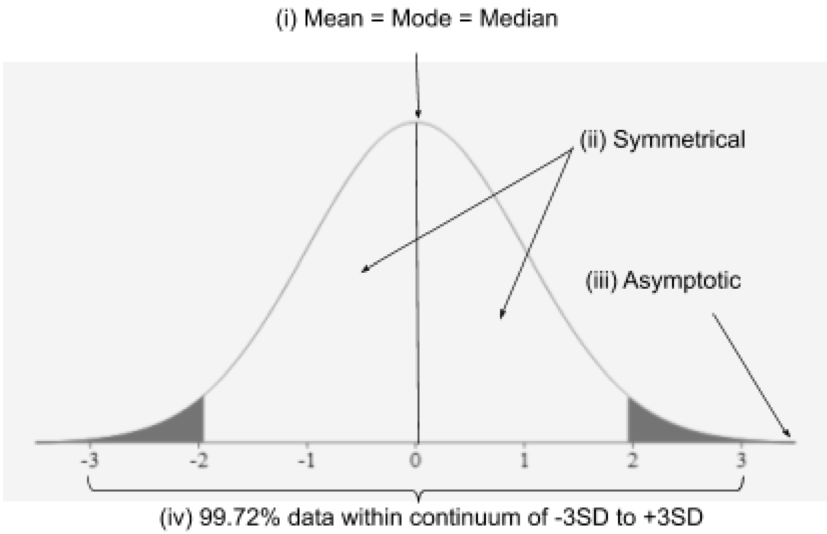

Fig 4 Properties of normal distribution

The normal distribution has equal measures of central tendency (Mean = Mode = Median) around which data is symmetrically distributed with 99.72% of cases within a spread of -3 standard deviation to +3 standard deviation. The normal curve and x -axis get closer to each other but do not intersect and hence are asymptotic to each other. Major examples of parametric statistics are z, t, F statistics and can only be applied on data that obeys normal distribution. One of the important features of data obeying normal distribution is that such data are measured on continuous interval scale. We will study how differently data can be measured in our forthcoming lectures.

1.4.1.2 Non Parametric Statistics

Non parametric statistics are not dependent on the assumptions of normal distribution in a population and hence also known as distribution free statistics. These can be applied on discontinuous data other than scale interval like nominal and ordinal data. Details of these data types will be undertaken in forthcoming lectures. Non parametric statistics can very well be applied to small sample sizes. Some of the notable examples of Non parametric statistics are chi-square, Spearman's rank difference method of correlation, Kendall's rank difference method, Mann-Whitney U test, etc.

1.4.2 Function basis

The statistics can also be divided on the basis of a set of procedures applied on data so as to serve a particular function. Whether you want to describe, find association or make out inferences from data set(s), all this can be done using statistics. Accordingly based on the function it serves, statistics can be divided into descriptive, correlational and inferential statistics.

1.4.2.1 Descriptive Statistics

The descriptive statistics is used to describe the tendencies in a given data set. To do so it takes help of graphical and tabular approaches to describe, summarize and analyze the data for measures of central tendencies and dispersion. The enumeration of hidden tendencies in data helps the investigator to describe the phenomenon.

1.4.2.2 Correlational Statistics

The correlational statistics tells about the interrelationships between data sets. It tells about the commonalities between data sets. This helps us in describing the degree and direction of correlation between data sets. Important statistical tools available are correlation and regression.

1.4.2.3 Inferential Statistics

The inferential statistics provides us the power to draw inferences about population based on statistics of sample. It is also used to make inferences about different samples drawn from population. Future predictions can also be made by making use of inferential statistics. It generally starts with setting up a null hypothesis and testing it for possible rejection. Statistical tests like t test, z test and F test are majorly used tests in Inferential statistics.

1.5 Importance and use of statistics

Statistics is applied in numerous fields owing to importance and applicable nature. Few have been described herein to get students acquaint with application of statistics in various fields.

1.5.1 Administration

Proper functioning of any organization, smaller or bigger, public or private depends upon its proper administration and correct policy making. The prior data is generally analyzed statistically before making any policy. Major fields like public administration, business administration relies on statistical methodologies to get insights from previous data for policy making and forecasting.

1.5.2 Social Science

Statistics have vast application in social science and behaviour of subjects. Various types of statistics already described play vital roles in understanding responses from the subject and making decisions accordingly as per the objectives of study in social science.

1.5.3 Mathematics & Engineering

Statistics itself is the branch of mathematics. Precise calculation of a measure in different conditions or at different occasions in mathematical and engineering problems can be done by making use of statistics. Mathematics models make integral connectivity of these pure sciences with statistics.

1.5.4 Commerce & Accounting

Project implementation to outcomes are majorly governed by commerce and accounting. Cost benefit ratio is one the majorly used tool for successfulness of any commerce and accounting matters assisted by statistical tools. Data on input and output of a project or study needs to be statistically analyzed for ascertaining its efficacy.

1.5.5 Research & Development

Research and development procedures cannot be imagined without proper experimental designing, analysis of generated data followed by interpretation of results as per the objectives of study. All this is possible and done by applying various statistical principles and tools.

1.5.6 Biology

Most biological phenomena are relative rather than absolute. They depend on a number of causal factors and interrelationship among them making it difficult to draw subjective inferences. Statistical methods are widely applied to the problems of biology including human biology, medicine, public health, agriculture, veterinary and genetics etc. This branch of statistics is also known as Biostatistics.

2. Biostatistics

Biostatistics is the science of applying statistical methods and principles to decipher meaningful and easy to understand information from the biological data set(s). The biological data set(s) herein entails human biology, medicine, public health, agriculture, veterinary and genetics etc. Sir, Francis Galton is considered to be the father of biostatistics. He pioneered the work on correlational statistics of the human population.

2.1 Etymology and definition of Biostatistics

The word 'Biostatistics" is made by fusing the words bio & statistics. Where the word "bio" has its origin from greek word "bios" that means one's life, course or way of living, lifetime". In modern context the word biostatistics is often being synonymised as biometry, biometrics, biological statistics, medical statistics , clinical statistics biostatistical science, biomedical statistics, medical biostatistics, environmental statistics, pharmaceutical statistics, biopharmaceutical statistics and public health statistics. Various definitions of biostatistics and its commonly used synonym Biometry have been presented in Box 3.

Box 3 Definitions of Biostatistics and Biometry

Biostatistics is defined as "statistical method(s) in medicine and the health sciences.

Greenberg

Biometrics is a delineation of living things.

Snedecor and Cochran

Biometry is the study, development and application of procedures and techniques in computer science, mathematics, operations research, probability, statistical systems analysis for biological investigations and phenomena.

Federer

2.2 History of Biostatistics

People throughout history had made efforts to find logical answers to the biological problem by using biostatistics in one or the other form. Some of the excerpts about historical background on usage of biostatistics in medicine and its timeline are explained hereinafter.

Table 5 Timeline and history of biostatistics

S.No.	Timeline	Resource	Biostatistics Analogy
1.	c. 400	The treatise	Explained imbalance in bodily fluids called

	BCE	On Airs, Waters, and Places *by Hippocrates*	humour an underlying cause of disease. Which in turn is affected by the environment and geography.
2.	c. 200 BCE	Bible's Book of Daniel	Illustrated comparative study on diet intervention on subjects (Meat and wine versus legumes and water)
3.	1662	Natural and Political Observations Made Upon the Bills of Mortality by *John Graunt*	Summarized the analyses of 50 years of data extracted from the Bills of Mortality, London. He observed the regularity of mortality from causes other than plague.
4.	1693	Life table for city of Breslau by *Halley*	He produced a life table showing the number of people surviving to any age from a cohort born the same year. He also used his table to compute the price of life annuities.
5.	1722	Pamphlet *by John Arburthnot*	He asserted (without evidence) that the chance of dying from inoculation-induced smallpox was 1:100 compared to 1:10 from naturally-occurring smallpox. Therefore it is better to go for smallpox inoculation.
6.	1757	Controlled clinical trial on Scurvy by *Lind*	Twelve sailors, two in each group were given the same diet except few ingredients under study. Better results were obtained in groups that received lime and oranges. Lind is credited to be father of controlled clinical trials owing to this pioneer study.
7.	1835	Treatise "Recherches sur les effets de la saignée" by *Pierre-Charles Alexandre Louis*	Louis calculated a ratio of deaths to be 3:7 in patients undergoing bloodletting compared to a lower mortality rate of approximately 1:4 in patients with no blood letting*. Where bloodletting is the withdrawal of blood from a patient to prevent or cure illness and disease practiced until the late 19th century.
8	1840	Treatise "Principes généraux de statistique médicale" by *Jules Gavarret*	Louis in his work reported 52 deaths and 88 recoveries in the typhoid patients accounting 37% mortality. Gavarret pointed out that this mortality may vary

			from 26 to 49% if 140 cases are observed randomly from the population. A confidence interval in Louis findings had been introduced by Gavarret.
9	1893	Establishment of Biometric school at University College of London headed by *Karl Pearson*	Karl Pearson developed many indispensable statistical tools like curve fitting, test of goodness of fit and correlation as applied on biological data.
10	1927	*Greenwood* student of *Pearson* and first professor of epidemiology and vital statistics at the London School of Hygiene and Tropical Medicine	Greenwood laid the foundation and usage of mathematics for better understanding of epidemiology. Where epidemiology is the "study and analysis of the distribution (who, when, and where), patterns and determinants of health and disease conditions in defined populations".
11	1946	Famous clinical trial "Efficacy of streptomycin in treating tuberculosis" by *Bradford Hill*	This trial is often characterised as the first clinical trial to use a randomisation scheme effectively.
12	1984	Poll on most important scientific, technological and medical discoveries since 1900 by *American Association for the Advancement of Science*	Statistics (chi square test) which is having wider application in Biostatistics was adjudged to be the most significant contribution to our life in the 20th century.
13	2000	New England Journal of Medicine (NEJM)	Application of statistics to medicine was adjudged as one of the eleven most important medical developments during the 20th century in the list containing names like anesthesia and antibiotic.

2.4 Importance and uses of Biostatistics

The field of Biostatistics is majorly being employed in various fields of biology. Some of the major fields which mainly employ biostatistics are described herein under.

2.4.1 Genetics and Breeding

Historically, Biostatistics and Genetics remained fostering fields for one another. Scientists from both the fields had carried forward both these sciences through usage of the then available bio-statistical tools and discovery of newer ones to explain complex problems of genetics. The timeline, scientist involved and concept of genetics fostered using biostatistics have been discussed in Table 6.

Table 6 Timeline of various genetics concepts fostered by biostatistics

S.No.	**Timeline**	**Scientist**	**Use of Biostatistics**
1.	1853	*Adolphe Quetelet*	He presented the theory of "human variance around the average". According to him most human traits being normally distributed in a population, produce sufficient variation for artificial or natural selection to operate.
2.	1856 - 1863	*Gregor John Mendel*	Used biostatistics to explain the collected data on 28000 pea plants to explain genetics of segregation patterns of factors (alleles)
3.	1869 - 1883	*Francis Galton*	He proposed a theory "Law of Ancestral Heredity" where fractions of the heredity coming from each ancestral composing an infinite series as against the Mendel's conclusions, that genetic inheritance were exclusively from the parents, half from each of them. He Published pioneering work in his book "Hereditary genius" in 1869 invented the method of historiometry to explain inheritance of abilities. He further strengthened his work through his work described in his paper "History of twins" in 1875 to fraction genetic and environmental effects. He invented the term Eugenics in 1883, where the term means a set of beliefs and practices that aim to improve the genetic quality of a human population. All his works were carried out using various tools and principles of biostatistics.
4.	1915 onwards	*Sewell Wright*	He along with R A Fischer and J B S Haldane are considered to be founders of Population genetics. The population genetics make extensive use of biostatistics. He is credited with the discovery of F statistics. He discovered the inbreeding coefficient and methods of computing it in pedigree animals using path analysis. He

			pioneered methods for computing the distribution of gene frequencies among populations as a result of the interaction of natural selection, mutation, migration and genetic drift along with Fischer.
5.	1930	*Ronald A Fischer*	He gave many contributions to genetics and statistics. Some of his notable contributions include the ANOVA, p-value concepts, Fisher's exact test and Fisher's equation for population dynamics. He combined Mendelian genetics with Charles Darwin "Theory of natural selection".
6.	1932	*J B S Haldane*	He authored "Causes of Evolution", in which he reestablished natural selection as the premier mechanism of evolution by explaining it in terms of the mathematical consequences of Mendelian genetics.

2.4.2 Public health

Public health has been defined as "the science and art of preventing disease", prolonging life and improving quality of life through organized efforts and informed choices of society, organizations (public and private), communities and individuals. Furthermore a related field, Environmental health is the branch of public health concerned with all aspects of the natural and built environment affecting human health. The prevention of disease is the central idea of this subject. It is always said that prevention is better than cure. We all know from our wealth of knowledge gained over a period of time that for occurrence of a disease there exists a number of predisposing factors. Scientific analysis of these predisposing factors using biostatistics helped us in preventing so many diseases.

2.4.3 Epidemiology

Epidemiology is the study and analysis of the distribution (who, when, and where), patterns and determinants of health and disease conditions in defined populations. The three W's of epidemiology differ from one disease to other due to host, pathogen and environment interactions. The underlying exploration of these factors needs application of biostatistics for better understanding of these diseases. Various studies in this subject like case series, case control studies, cohort studies, causal inference and population based health management requires sound knowledge of biostatistics.

2.4.4 Nutrition

Nutrition is the science that interprets the nutrients and other substances in food in relation to maintenance, growth, reproduction, health and disease of an organism.

Thus it becomes imperative to explore causal relationships among various factors involved in nutrition using biostatistics to achieve better efficiency.

2.5.5 Clinical trials

Clinical trials are experiments or observations done in clinical research. Such prospective biomedical research studies on veterinary patients are designed to answer specific questions about biomedical or behavioral interventions, including new treatments (such as novel vaccines, drugs, dietary choices, dietary supplements, and biomedical devices) and known interventions that warrant further study and comparison.

2.5.6 Pharmacology

Biostatistics has an important role in both designing a pharmaceutical experiment and evaluating its result. Biostatistics have enriched our knowledge which in turn helped pharmacologists to come out with safer, effective and high therapeutic index drugs.

The list is long. One can understand that any subject dealing with biological data cannot progress without using biostatistics. This subject is the backbone of all experiments conducted in these subjects. Additionally various models can be developed to quickly answer various problems encountered in subjects of biology.

3. Limitations

The major limitation of statistics resides in its prerequisite of a data set instead of a datum. Therefore statistics can only make inferences on samples or a population rather than an individual. However, the majority of day to day questions of a common man are individual based rather than population based. Statistics being a baby of mathematics deals with numerals rather than words. Therefore, there is limited and narrowed application of statistics on processes that cannot be measured numerically. When a phenomena happens, it occurs due to many causes, but all these causes can not be expressed in terms of data. So, we most of the time analyze available numerical data therefore leaving many causal factors ignored. Statistics in the hand of a dishonest or biased person becomes a puppet producing results as per their wish. Statistical inferences are based on probability and thus revolves around a confidence interval rather than absolute values. Although we use many laws and formulae in statistics but still the results achieved are not final and conclusive. As they are unable to give a complete solution to a problem, the result must be taken and used with much wisdom.

4. Summary

We understood from this lecture that statistics had been used in various subjects since ages. This subject bears the capability of deducing meaningful information from the data. This meaningful information can be numerically defined and represents the characteristics of the original data. We have studied that various people have defined statistics in singular and plural form. The singular form of statistics represents data, whereas plural form represents statistical procedures. The definitions given by *Horace Secrist* in singular and by *Croxton and Cowdene* in plural form gives a better idea about the meaning of statistics. Statistics have traversed a long timeline starting 5 BCE with the discovery of mode to discoveries of variance, experimental designing etc. in 19-20 CE. Statistics can be divided into Parametric and Nonparametric types based on distribution of data. Whereas it is divided into Descriptive, Correlational and Inferential statistics based on the function. Statistics have found its importance and use in various subjects like Administration, Social Science, Mathematics, Engineering, Commerce, Accounting, Research and Biology etc. We have studied how the subject of Biostatistics emerged when Statistics had been applied on biological data since ages. The biostatistics over the time has developed its symbiont space with subjects like Genetics, Breeding, Public Health, Epidemiology, Nutrition, Clinical Trials and Pharmacology etc. Finally under limitations of statistics, we have studied that statistics is not a solution for all the problems rather it provides a pragmatic approach to solve a problem. One has to finally apply his own wisdom of knowledge to come to a conclusion.

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ABOUT THE AUTHOR

Dr. Kuldeep Kumar Tyagi had completed his B.V.Sc & A.H. in the year 2006 from Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab India. He got admission in a master program in the subject of Animal Genetics and Breeding at Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India after securing 6th rank in All India ICAR-JRF examination. He had completed his Masters in the year 2008 and carried out research on competent fibroblast cells used in somatic cell nuclear transfer. He qualified CSIR Net in his first attempt during the final semester of masters program itself. He got selected as Assistant Professor in the year 2009 at College of Veterinary Science & A.H. at Navsari Agricultural University, Navsari, Gujarat, India. He enriched his practical knowledge and expertise in the subject of Animal Breeding while disbursing his duties as Scheme Incharge at Livestock Research Station of the same university for 9 years. During the same tenure he also accumulated practical expertise on various aspects of field level breeding programs while heading "All India Coordinated Research Project on Goat Improvement - Surti Field Unit" as Principal Investigator. He completed his Ph.D. in the year 2016 from the same university as an inservice candidate. He had worked on gene expression studies on mammary epithelial cells of buffaloes during his Ph.D. degree program. He had been selected as Associate Professor in the department of Animal Genetics & Breeding, College of Veterinary and Animal Science, Sardar Vallbhbhai, Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India in the year 2018. Since then he has been heading the same department as Officer-Incharge. He had handled 5 externally funded and 27 institutionally funded research projects. He had coguided two masters students. He has in his credit 60 research papers, 14 research recommendations and 4 success stories. He is a member of 4 professional societies and attended 21 conferences/ symposiums/ workshops. He has remained on a panel of experts for framing question papers for various Universities and National level examination bodies. He is hosting a google site for online teaching https://sites.google.com/view/learnagb and can be reached at drtyagivet@gmail.com for initiating a conversation.

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