STA 2130: FUNDAMENTALS OF BIOSTATISTICS

PURPOSE:

The purpose of this course is to provide the student with a solid introduction to epidemiology, statistics and public health upon which further units will build.

OBJECTIVES:

At the end of this course, the student should be able to:-
1. Define public health, epidemiology and screening
2. Identify the role of statistics in health
3. Describe different measures of disease frequency and risk

4. Identify different epidemiological study designs.

5. Read and understand medical literature
6. Identify preventive strategies in health.
7. Recognize the role of biostatistics to the real world.

COURSE DESCRIPTION:

Introduction to public health and screening, role of statistical methods in public health, describing data using various methods, various actors and disciplines involved. The epidemiological measures of disease frequency and risk, study design, interpretation of epidemiological studies, and preventive strategies. Reading and interpretation of statistical analyses from life science and medical literature. Extensive reading and class discussion of articles from the medical literature. Medical diagnosis, Receiver Operating Characteristic (ROC) curves. Classical examples of longitudinal studies. Role of Biostatistics in modern society.

COURSE TEXT BOOKS:

1. *Bernard R. Rosner (2003). Fundamentals of Biostatistics. Duxbury press. ISBN :534370683*
2. *Box,G.E.P.,Hunter,W.G.,andHunter,J.S.(1978),Statisticsfor Experimenters: An Introduction to Design, Data Analysis, and Model Building, John Wiley and Sons.*

COURSE JOURNALS:

1. InternationaljournalofBiostatistics.

2. Biostatistics ISSN.1465-4644; 1468-4357

FURTHER REFERENCE TEXT BOOKS AND JOURNALS:

1. *Chambers,John,WilliamCleveland,BeatKleiner,andPaulTukey, (1983), Graphical Methods for Data Analysis, Wadsworth , ISBN 0-8247- 4614-7.*
2. *Stroup, D.F., & Teutsch, S.M. (1998). Statistics in Public Health: Quantitative Approaches to Public Health Problems. NY: Oxford University Press.*
3. *Munro, B.H., & Page, E.B. (1993). Statistical Methods for Health Care Research. (2nd Edition). Philadelphia, PA: J.B. Lippincott Co.*
4. *Selvin, S. (1991). Statistical Analysis of Epidemiologic Data. NY: Oxford University Press.*
5. *American Statistician*
6. *Journal of the American Society*
7. *Biometrics*

TEACHING METHODS:

1. Lecture:oral presentation that will take place online via googlemeet,zoom or the Kenet platform.
2. Others include exercises, class questions and discussions, or student presentations.
3. Tutorial materials that will be provided on the e-learning system

INSTRUCTIONAL MATERIAL/EQUIPMENT: Include course notes, computers, online classes.

ASSESSMENT

1. Written end of semester Examination comprising 70% of the total marks

2. Continuous Assessment Tests within the semester comprising 30% of the

total marks (Tests 20% and Assignments 10%)

Fundamentals of Biostatistics lesson one

In this Lesson we introduce the course: At the end of the session you should be able to:

- Define biostatistics, epidemiology, public health and screening
- Differentiate the different components of biostatistics.
- Identify the roles of a biostatistician.

What is biostatistics?

Biostatistics is a portmanteau word made from biology and statistics

It is the application of statistical principles to questions and problems in medicine, public health or biology. For instance,

- it might be of interest to characterize a given population with respect to the proportion of subjects who are overweight or the proportion who have Malaria and
- it would also be important to estimate the magnitude of these problems over time or perhaps in different locations.
- In other circumstances it may be important to make comparisons among groups of subjects in order to determine whether certain behaviors (e.g., smoking, exercise, etc.) are associated with a greater risk of certain health outcomes.

It would, be impossible to answer all such questions by collecting information (data) from all subjects in the populations of interest. A more realistic approach is to study samples or subsets of a population. The discipline of biostatistics provides tools and techniques for collecting data and then summarizing, analyzing, and interpreting it. If the samples one takes are representative of the population of interest, they will provide good estimates regarding the population overall. Consequently, in biostatistics one analyzes samples in order to make inferences about the population.

What is Statistics?

Statistics is the science of data that involves:

- Collection of information
- Classification of information
- Summarization of information
- Organization of information
- Interpretation of information

If related to Biological or Medical sciences called **Biostatistics**

The Role of Biostatisticians

Biostatisticians are said to be the specialists of data evaluation, as it is their expertise that allows them to take complex, mathematical findings of clinical trials and research-related data and translate them into valuable information that is used to make public health decisions.

The work of biostatisticians is also required several organizations including but not limited to:- Research organizations, Universities, hospitals, government agencies and legislative offices, where research is often used to influence change at the policy-making level.

In short, these professionals use mathematics to enhance science and bridge the gap between theory and practice.

Biostatisticians are required to develop statistical methods in several types of study such as clinical trials, observational studies, longitudinal studies, and genomics:

- Clinical trials: Studying the evaluation of treatments, screening, and prevention methods in populations
- Epidemiological: Studying the causes and origins of disease in humans
- Human Genetics: Studying the genetic differences associated with diseases and disease states
- Genomics: Studying the biological activity of genes as they relate to diseases and treatments
- Spatial Studies: Studying the geographical distribution of disease/risk factors

A Biostatistician responsibilities include:

- Designing and conducting experiments related to health, emergency management, and safety
- Collecting and analyzing data to improve current public health programs and identify problems and solutions in the public health sector
- Interpreting the results of their findings

The validity of their research results depends on how well they can make meaningful generalizations and how well they can reproduce and apply experimental methods.

Why do we need to study Biostatistics course?

i. Statistics has widespread use in health sciences, so there is need for all health professionals to learn Bio-statistics particularly those who are involved in research.
ii. To learn how to deal with numbers, although computers makes these calculations easier, but so not replace the need to understand the methods.
iii. To assess evidence from different studies

iv. To understand published scientific papers
v. To do research and write papers in scientific journals.

This unit introduces fundamental concepts and definitions for biostatistics.

Areas that will be important as you take the course include:-

Public health

Epidemiology

Screening

Genetics/genomics

Here we describe these areas briefly but later in the course we discuss them in detail:

Public health

Public health is the science of protecting and improving the health of people and their communities. This work is achieved by promoting healthy lifestyles, researching disease and injury prevention, and detecting, preventing and responding to infectious diseases.

Overall, public health is concerned with protecting the health of entire populations. These populations can be as small as a local neighborhood, or as big as an entire country or region of the world.

Public health professionals try to prevent problems from happening or recurring through implementing educational programs, recommending policies, administering services and conducting research—in contrast to clinical professionals like doctors and nurses, who focus primarily on treating individuals after they become sick or injured. Public health also works to limit health disparities. A large part of public health is promoting healthcare equity, quality and accessibility.

Epidemiology

The word epidemiology comes from the Greek words

- *epi*, meaning on or upon,
- *demos*, meaning people, and

- *logos*, meaning the study of.

The word epidemiology has its roots in the study of what befalls a population. Many definitions have been proposed, but the following definition captures the underlying principles and public health spirit of epidemiology:

*Epidemiology is the **study** of the **distribution** and **determinants** of **health-related states or events** in **specified populations**, and the **application** of this study to the control of health problems*.

The key words in this definition are:

Study

Epidemiology is a scientific discipline with sound methods of scientific inquiry at its foundation. Epidemiology is data-driven and relies on a systematic and unbiased approach to the collection, analysis, and interpretation of data. Basic epidemiologic methods tend to rely on careful observation and use of valid comparison groups to assess whether what was observed, such as the number of cases of disease in a particular area during a particular time period or the frequency of an exposure among persons with disease, differs from what might be expected. However, epidemiology also draws on methods from other scientific fields, including biostatistics and informatics, with biologic, economic, social, and behavioral sciences.

In fact, epidemiology is often described as the basic science of public health, and for good reason. This is because:

- Epidemiology is a quantitative discipline that relies on a working knowledge of probability, statistics, and sound research methods.
- It is a method of causal reasoning based on developing and testing hypotheses grounded in such scientific fields as biology, behavioral sciences, physics, and ergonomics to explain health-related behaviors, states, and events.

However, epidemiology is not just a research activity but an integral component of public health, providing the foundation for directing practical and appropriate public health action based on this science and causal reasoning.

Distribution

Epidemiology is concerned with the **frequency** and **pattern** of health events in a population:

Frequency refers not only to the number of health events such as the number of cases of meningitis or diabetes in a population, but also to the relationship of that number to the size of the population.

The resulting rate allows epidemiologists to compare disease occurrence across different populations.

Pattern refers to the occurrence of health-related events by time, place, and person. Time patterns may be annual, seasonal, weekly, daily, hourly, weekday versus weekend, or any other breakdown of time that may influence disease or injury occurrence. Place patterns include geographic variation, urban/rural differences, and location of work sites or schools. Personal characteristics include demographic factors which may be related to risk of illness, injury, or disability such as age, sex, marital status, and socioeconomic status, as well as behaviors and environmental exposures.

Characterizing health events by time, place, and person are activities of **descriptive epidemiology.**

Determinants

Determinant: any factor, whether event, characteristic, or other definable entity, that brings about a change in a health condition or other defined characteristic.
Epidemiology is also used to search for **determinants**, which are the causes and other factors that influence the occurrence of disease and other health-related events. Epidemiologists assume that illness does not occur randomly in a population, but happens only when the right accumulation of risk factors or determinants exists in an individual. To search for these determinants, epidemiologists use analytic epidemiology or epidemiologic studies to provide the "Why" and "How" of such events. They assess whether groups with different rates of disease differ in their demographic characteristics, genetic or immunologic make-up, behaviors, environmental exposures, or other so-called potential risk factors. Ideally, the findings provide sufficient evidence to direct prompt and effective public health control and prevention measures.

Health-related states or events

Epidemiology was originally focused exclusively on epidemics of communicable diseases but was subsequently expanded to address endemic communicable diseases and non-communicable infectious diseases. Let's understand the difference between epidemic, endemic and pandemic terms used in disease/health related states.

An **epidemic** is a temporary prevalence of a disease, it occurs within a short time and affects many people.

Endemic *is* used to describe a disease that is prevalent in or restricted to a particular location, region, or population.

Pandemic can be used for a disease that has spread across an entire country or other large landmass, the word is generally reserved for diseases that have spread across continents or the entire world. It is an epidemic that has affected many countries

By the middle of the 20th Century, additional epidemiologic methods had been developed and applied to chronic diseases, injuries, birth defects, maternal-child health, occupational health, and environmental health. Then epidemiologists began to look at behaviors related to health and well-being, such as amount of exercise and seat belt use. Now, with the recent explosion in molecular methods, epidemiologists can make important strides in examining genetic markers of disease risk. Indeed, the term health-related states or events may be seen as anything that affects the well-being of a population. Nonetheless, many epidemiologists still use the term "disease" as shorthand for the wide range of health-related states and events that are studied.

Specified populations

Although epidemiologists and direct health-care providers (clinicians) are both concerned with occurrence and control of disease, they differ greatly in how they view "the patient." The clinician is concerned about the health of an individual; the epidemiologist is concerned about the collective health of the people in a community or population. In other words, the clinician's "patient" is the individual; the epidemiologist's "patient" is the community. Therefore, the clinician and the epidemiologist have different responsibilities when faced with a person with illness. For example, when a patient with diarrheal disease presents, both are interested in establishing the correct diagnosis. However, while the clinician usually focuses on treating and caring for the individual, the epidemiologist focuses on identifying the exposure or source that caused the illness; the number of other persons who may have been similarly exposed; the potential for further spread in the community; and interventions to prevent additional cases or recurrences.

Screening

"Screening is the process of identifying healthy people who may be at increased risk of disease or condition. The screening provider then offers information, further tests and treatment. This is to reduce associated risks or complications" (UK National Screening Committee https://www.gov.uk/guidance/nhs-population-screening-explained).

Or

Screening refers to the use of simple tests across an apparently healthy population in order to identify individuals who have risk factors or early stages of disease, but do not yet have symptoms (WHO).

The underlying concept of screening is that early detection of risk factors or early disease is beneficial for the clinical or public health outcome.

In summary:

- **Biostatistics** is the application of statistical principles to questions and problems in medicine, public health or biology.
- **Statistics** involves collection, classification, summarization, organization and interpretation of data.
- Persons who carry out biostatistics are called **biostatisticians**
- **Public health** is the science of protecting and improving the health of people and their communities. This work is achieved by promoting healthy lifestyles, researching disease and injury prevention, and detecting, preventing and responding to infectious diseases.
- **Epidemiology** is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems.
- **Screening** is the process of identifying healthy people who may be at increased risk of disease or condition