

BIostatistics EDUCATION FOR UNDERGRADUATE MEDICAL STUDENTS

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Biostatistics is relevant to students and practitioners in medicine and health sciences and is taught as a part of the medical curriculum. The Biostatistical literacy of medical students is a problem all over the world including Pakistan which is actively discussed in different publications. Biostatistics is the subject in the medical curriculum that is not popular among the undergraduate students. The negativity of the medical students towards biostatistics is real and their perception can easily be changed through interactive teaching techniques by trained faculty. This paper describes the problems and challenges confront in teaching biostatistics to medical students. Some suggestions and guidelines are presented which may help to surmount these problems and enhance the teaching of biostatistics in health sciences.

Keywords: *Biostatistics, Medical Students, Curriculum, Computer – Based Learning.*

BACKGROUND

Prior to the twentieth century, medical research was primarily based on trial and empirical evidence. Diseases and the risk factors associated with a disease were not well understood. Drugs and treatments for diseases were generally untested. As medicine has moved to become more evidence based, biostatistics has become ever more important and relevant to the practice of medicine and the education of tomorrow's doctors. It has also become increasingly evident that the interpretation of much of the research in health sciences depends to a large extent on biostatistical methods. The applications of biostatistics was started in the 17th century on causes of death, births, marriages, construction of life tables and estimating population sizes, that is now known as "Vital Statistics". The field of genetics was the second epoch which was most benefited by biostatistical ideas emerging in the works of Mendel, Bateson, Darwin, Pearson and Fisher.²

INTRODUCTION

Biostatistics is a branch of applied statistics that is concerned with the application of statistical methods to medicine, clinical trials, demography, population estimation, modelling, community diagnosis and surveys. In general, the purpose of using biostatistics is to gather data that can be used to provide honest information about unanswered biomedical questions. Biostatistics is now considered as an essential tool in planning and delivery of health care systems. The knowledge and ability to use biostatistical

techniques have also become increasingly important in health sciences.

The medical practitioner in the 21st century will need a far greater ability to evaluate new information than in the past. A good understanding of biostatistics can improve clinical thinking, decision making, evaluations and medical research.

Undoubtedly, medical professionals are becoming aware of the importance of leaning and applying biostatistical methods in their research. This wish is not constrained to medical researcher but medical practitioners who read medical literature to keep them abreast also wish to gain a minimum knowledge in biostatistics. The role of biostatistics in medical education is now well recognised and the curricula in almost all the medical institutions and universities across globe has provision of teaching biostatistics to undergraduate and postgraduate medical students / professionals.

In Pakistan, medical statistics is non-existent although medical research in Pakistan has gained momentum over the past several years. However, the logical conclusions based on information and data are rarely witnessed. This problem is due to the non-availability of Biostatistics faculty and practically medical students, researchers and doctors are also unaware of its logic, uses and inferences to be obtained.

Teaching Biostatistics to Medical Students

The role of biostatistics in medicine and health care is sometimes only fully understood and appreciated once the end – users are fully qualified in it. As alre-

ady stated, almost all health sciences disciplines have the provision of teaching biostatistics. For a number of reasons biostatistics is one of those subjects in the medical curriculum that is possibly unpopular among the medical students.

At undergraduate level there is a great difference in terms of organization of teaching and time allotted for biostatistics instruction in medical schools / colleges globally. In United States, Canada, Australia and United Kingdom biostatistics is being taught in 1st and 2nd year of study with a very small percentage of schools spreading this instruction over more than one term. *While in Pakistan it is taught in 4th year of education as a component of Community Medicine subject and the contents are covered in just 3 – 5 lectures.* Besides, for admission in the medical schools of Saudi Arabia, apart from passing the entrance test the students must have also completed a pre-medical course in biostatistics.

In Pakistan at undergraduate stage, biostatistics courses are taught in a manner that are generally short and covers only introducing the concepts of Descriptive Statistics and a very little part of Inferential Statistics which does not help a medical student to groom himself for decision making.

Globally the Biostatistics curriculum varies

from school to school reflecting the degree of faculty sophistication. In 1975, the American Statistical Association in their meeting proposed the core curriculum for Medical Statistics to be taught at undergraduate level which is being updated in light of the usage of contemporary techniques.

For teaching Biostatistics to medical students the best time to start teaching is in 1st year of education. A course in Biostatistics can only be helpful and valuable for the student if Biostatistical concepts and applications are reinforced throughout his / her 5 years of education.

There are numerous Biostatistical procedures and techniques which have proven useful, they are widely used in biomedical sciences and majority of these techniques are not a part of the Biostatistics curriculum in Pakistan.

In May 2002 the National Curriculum Revision Committee on MBBS in its meeting held at Univer-sity Grant Commission, Islamabad revised the cur-riculum after due consideration of the comments and suggestions from Universities and Colleges across Pakistan. A comparison of Biostatistics cur-riculum is given below:

Table 1: Curriculum of Biostatistics at Undergraduate level.

Curriculum of foreign medical schools	Curriculum in Pakistan	Innovations in Pakistan's curriculum
Definitions and Terms	Concepts and Usage	Experimental Design (ANOVA – one and two way) Regression Analysis Correlation Analysis Logistic Regression Analysis Probability (Bayesian Statistics) Relevant Non-parametric tests Diagnostic Statistics (Sensitivity, Specificity, PPV, NPV, ROC Curve etc) Introduction to Survival Analysis
Ways of Data collection	Data and its types	
Descriptive Statistics	Descriptive Statistics	
<ul style="list-style-type: none"> Central Tendency (Mean, Median, Mode) Measures of Dispersion Graphical Presentation 	<ul style="list-style-type: none"> Central Tendency (Mean, Median, Mode) Measures of Dispersion Graphical Presentation 	
Inferential Statistics <ul style="list-style-type: none"> Z – tests t – tests Anova Techniques Multiple comparison tests Chi – Square 	Inferential Statistics t – tests Chi – Square (Introduction)	
<i>Discrete and Continuous Distributions</i>		
<i>Probability</i>		
<i>Non-parametric tests</i>		
<i>Correlation</i>		
<i>Regression</i>		

<i>Logistic Regression Analysis</i>		Introduction to Statistical
Sampling Survey	Introduction to Sampling Survey	
Vital Statistics	Vital Statistics	

Packages

Problems in Teaching Biostatistics

The worldwide picture of biostatistical education in medical schools is far better than that of what is being taught in Pakistan's medical colleges. Now-a-days medical students should be able to understand and interpret biostatistics so that they can use these techniques both during training and most importantly at postgraduate stage when they will be treating patients. Some of the problems encountered in teaching biostatistics to medical students are listed below:

- In Pakistan, a student is enrolled in a medical college after completing 12 years of education. At the pre-medical stage the curriculum has no provision of teaching statistical courses. When the students enter into medical colleges they are introduced to the general concepts of medical statistics and even the introductory concepts fail to be understood because lack of prior knowledge of statistics. This impacts negativity on the importance of biostatistics.
- Medical students are generally focused towards the study of medicine and towards basic sciences and have a very little desire of learning biostatistics.
- The time allotted for Biostatistical teaching is not enough and thus prohibits the explanation of most of the important techniques like Logistic regression analysis, Diagnostic Statistics and Survival Analysis etc.
- Instructors of biostatistics have varied background and thus presenting the subject in their own understanding makes it difficult for the student to squeeze out the interpretation from the results. In Pakistan, main problem in teaching biostatistics is the unavailability of trained biostatistics Faculty. Even with the promoting research culture, the data generated is in a paralysed state with no one to analyse it.
- The formal teaching in biostatistics neither engages the students nor meets their needs. A survey conducted on biostatistics teaching²⁰ showed that the students disliked the subject because it was taught in a formal way (formulas and calculation). Lot of contents were unimportant. The lectures were poorly presented and it was difficult for them to know what they needed to know.

A Pragmatic Approach for Teaching Biostatistics

In this section, some guidelines and tips are given for biostatistics teaching which may help to overcome some of the problems encountered and enhance the learning in this subject.

- The teacher must convince the medical students about the importance of learning the subject of biostatistics. The course should be aimed and taught in such a way that it increases student's motivation towards it. One of the best ways of motivating the students is to expose them to medical literature with the examples of uses and abuses of biostatistics. This could be accomplished most readily by preparing some interesting classroom sessions to provide students an opportunity to critique the reporting of biostatistical procedures reported in the journals.
- The instruction method should be problem – oriented instead of technique – oriented. The technique – oriented method is now an old style which contains hand calculations, formulas, drawing critical regions, traditional handouts and formal presentations which make the subject learning boring for the students. They just take the subject as they have to sit for 40 minutes with eyes open in the class and mind resting.
- Besides, problem – based approach should be introduced as this is a way of constructing and teaching using problems as the stimulus and focus on student's activity instead of presenting the material through a traditional lecture format. Problem based learning requires that students take an active part in their own learning, it is also best suited for motivated students who have the desire for own learning. In addition the students can emphasize their learning on the concepts and interpretations rather than the mathematical details according to their personal strength.
- Biostatistics is a branch of applied statistics and it must be taught in terms of application in biomedical research. The students should be exposed to real – life data instead of using the textbook examples which generally start from the statement “**suppose**”.
- Medical Students come from different educational backgrounds; some have interest in numerology which most of them dislike the biostatistics as a subject. Thus any emphasis on the statistical proofs and probabilistic reasoning should be discouraged. On the other hand if the instructor has no knowledge of teaching applied statistics then the whole course will be a roller-coaster ride for the students.
- Hand calculations should be avoided and for making the teaching interactive Computer – based approach should be introduced. Nowadays a variety of Biostatistical software's (SPSS, STATA, STATISTICA, NCSS and OPEN – EPI)

are available. Introducing CBL will also enhance the student's motivation for learning. Use of computers should be encouraged in teaching to allow the student to concentrate on the interpretation of the analysis rather than on hand calculations. On the other hand most major research projects involve a tremendous investment in time and money. This results in a large data that needs to be analysed and the tasks can be easily achieved by using computers.

- For designing of research reading medical literature is a pre-requisite. A student cannot read and understand medical literature without having knowledge of biostatistics and research methodology. A study performed by Altman (2000) reports that "statistical errors are so common that 50% of the medical literature have statistical flaws. Another study carried out (McGuigan SM, 1995) reported that 'serious statistical errors were found in 40% of 164 articles published in a psychiatry journal and in 19% of 145 articles published in an obstetrics and gynecology journal.
- The instructor should educate the students about the methodology in designing the research (research design, sampling technique / data collection and sample size etc) including the reporting and reading of biostatistical language in a research paper because nowadays, without proper reporting of biostatistics, the research article is rejected at the initial review. Furthermore, the teaching of biostatistics should not be limited to the use of data analysis techniques only. It is important that the students should be educated about the data collection techniques because all the biostatistical techniques are applied on the data collected.
- The important steps in teaching biostatistics are analysis and interpretation of data. It is the primary responsibility of the instructor to make the students understand about using accurate data analysing technique(s) under given condition(s). The inappropriate use of biostatistical methods and techniques may mislead the students understanding at a stage when their minds are fresh to gather knowledge. The instructor should address the questions of Why, Where and How while teaching the techniques. Inappropriate use of biostatistical techniques can be found in every stage of medical research related to data analysis, design of the research, data collection and compilation, analysis, implementation and interpretation.
- The second area at which the instructor should focus on is the interpretation of the data which

is heavily dependent on the usage of accurate technique(s), for example comparing means always address the differences, Chi-square tests addresses the associations. This core understanding is essential to be passed on to the students.

- The students should also be made aware of using common words mistakes like association, correlation and differences; all are statistical terms and should not be combined with english language meanings. Moreover, the instructor teaching biostatistics should strive to present a well-balanced combination of lectures, tutorials and practicals.

In **conclusion**, there is a substantial disagreement in the course contents of the biostatistical topics being offered in the medical curricula of Pakistan as compared to other countries. The teaching sessions should be enhanced to cover the major topics. The curriculum contents should also be updated after every 3 years in the light of latest advancements both in the subject of biostatistics and Health Sciences. biostatistics and research methodology should be taught as a continuum, with its relevance to thinking about health and disease. In all medical colleges, there should be a separate dedicated Department of Biostatistics that can teach and guide the students in all phases of conducting research. Students should be taught from a common, same standard, up to date, and self explanatory textbook in order to ensure consistency and avoid conflicting terminology. The negativity of our medical students towards biostatistics is real and their perception can easily be changed through interactive teaching techniques by trained faculty. One should remember that they want to become doctors and not biostatisticians. It should be the primary goal of the biostatistics teacher to offset the fear of biostatistics among medical students.

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