

Landscaping Biostatistics Education in India

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Summary

Biostatistics plays an important role in measuring, understanding, and describing the overall health and well-being of a population. Biostatistics as a subject evolved from the application of statistics in various research aspects of biology, biomedical care, and public health. However, with a recent increase in number of health and pharmacy related research, the demand for trained biostatisticians is also increasing. The present paper is an attempt to undertake a situational analysis of biostatistics education in India. A systematic, predefined approach, with three parallel strategies was used to collect and assemble the data regarding training in biostatistics in India. Our study results show that there is paucity of programs providing specialized training in biostatistics in India. Only about 19 institutions in India are offering various courses in biostatistics/medical statistics/health statistics/biometry. It is important to look into the current capacity building initiatives in this domain. Some other means for giving importance to biostatistics could be by making it a separate branch/specialization in a majority of the institutions, particularly in medical colleges.

Key words: Biostatistics, Capacity building, Human resources, Public health education

Introduction

In the context of public health education, subjects, like biostatistics, which have an interdisciplinary nature, play an important role in measuring, understanding and describing the overall health and well-being of a population. Biostatistics is a subject evolved from the application of statistics; therefore, majority of the institutions, where existing courses in statistics are offered, teach biostatistics along with statistics, mostly constituting a relatively small portion of the course content. However,

with a recent increase in number of health and pharmacy related research, the demand for trained biostatisticians is also increasing. Hence, there is a need to give proper and practically oriented training in biostatistics to people with relevant background. Against this background, this manuscript is an attempt to list various institutions in India that offer courses in biostatistics/medical statistics/health statistics or biometry to provide an idea about the number of people trained every year in biostatistics in India. This will in turn reveal whether these numbers are compatible with the requirements. Before analysing the current situation in India, this paper also tries to give a brief history of statistics in India and the evolution of biostatistics as a subject from statistics.

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History of Statistics in India

India has a long history of applying statistical concepts in terms of data collection and its simple analysis, which got strengthened during the British period. The origin of statistics in India dates back to the Mauryan period (321 – 296 B.C.) in the Arthashastra by Kautilya, which explained the data collection system in agriculture, population, and economic censuses in villages and towns.¹This practice related to the original field of statistics, the measurement

of characteristics of towns or states. The practice of collecting and compiling data continued during 1590 A.D., in the period of Emperor Akbar, and during 1596-1597 A.D. in the *Ain-i-Akbari* written by Abul Fazal.¹ Apart from the population data, this document had the best compilation of data during that period with details of systems of legalized measurements, land classification, crop yields, and other information. This traditional system of data collection continues, depending on the kind of requirement; however, it gained momentum and got expanded during the British period.

The East India Company needed acquisition of counts and detailed information of their occupied territories, including area topography information, characteristics and conditions of inhabitants (including religion and customs), and assessment of natural products of the countries like fisheries, mines, agricultural yields and many more - mainly for the purpose of taxation and revenue generation. This compilation of information started in 1807 in India, covering a small portion of India only. The first systematic attempt to collect the information on the whole country was made during 1867 – 1872, which was incomplete. The first complete decennial census of India started in 1881 and since then, it is continuing with minor changes. Later, the need was felt by the Indian Famine Commission and agricultural departments to collect timely and accurate data related to agriculture. In lieu of this, a Statistical Bureau was formed at the centre (New Delhi) in 1895 and a Director General of Statistics was appointed.

Throughout the British period, the development in statistics was mainly geared towards administration, trade, commerce, and other such activities. However, an urgent need for appropriate statistical framework was felt immediately after independence in 1947 for the economic and social development of the country. Hence, Prof. P. C. Mahalanobis, an architect of modern statistical methods in the Indian subcontinent, was appointed as Honorary Statistical Advisor to the Indian Cabinet and a Central Statistical Unit was set up in 1949 under his leadership. Apart from this, some other organizations like the Central Statistical Organization (CSO) and the National Sample Survey (NSS) were also created to synchronize various statistical activities throughout India.

Although Prof. P. C. Mahalanobis, a physicist by training, is considered as the architect of modern statistics in India, the first Indian person with the formal degree in

statistics was Prof. P. V. Sukhatme, who completed his Ph.D. in statistics from the University of London in 1936. Dr. Sukhatme, who wrote a book on sampling, devoted a good deal of his time and energy in popularizing statistical methods among the practitioners of agriculture, veterinary medicine, nutrition, and related sciences. He had also set up a research institute – the Maharashtra Association for Cultivation of Sciences (MACS), and started the Department of Biometry and Nutrition in collaboration with Pune University.

Another landmark in the development of statistics as a discipline in India is the establishment of the Indian Statistical Institute (ISI) in Kolkata, West Bengal, set up by Prof. P. C. Mahalanobis in the year 1932. The institute first started short training courses in statistics, which were attended mainly by the officers on study leave in government and other organizations from all over India. Later on, when this institute was declared as an “Institute of National Importance” in 1960, other courses like Bachelor of Statistics (B. Stat.), Master of Statistics (M. Stat.), and Ph.D. in Statistics were introduced. One of the main reasons for the rapid development of statistics in India was the close interaction between ISI and various technical wings of the Government of India.¹ In the mean time, the first post-graduate course in statistics as a separate and full-fledged discipline, and not as a part of mathematics or economics, started in 1941 in Calcutta University. Slowly and slowly, courses in statistics as a subject have been introduced in a number of universities and institutions, and today quite a large number of educational institutions all over India are offering various bachelors, master, and Ph.D. level courses in statistics.

Evolution of Biostatistics

Biostatistics as a discipline evolved from the application of the discipline of statistics to the biological and biomedical areas. It is a branch of applied statistics, which in early part of the 20th century was primarily in agriculture and other areas of biological sciences. Biostatistics provides tools for the summarization and understanding of numerical laboratory and clinical data, including critical reading and understanding of the biomedical literature. It gained momentum in the twentieth century with the rapid advancement of medicine. Before the middle of the twentieth century, conclusions about human illness occurred mainly through the study of anatomy and physiology. Case studies or case series were common ways to ‘prove’ that a particular treatment was beneficial

or that certain aetiology was the cause of an illness. Use of statistical reasoning for the above purpose took a while to develop, mainly because of differences in opinion among the physicians regarding the two approaches. However, with the emergence of evidence-based approaches, the need for biostatistical concepts was felt, which in turn resulted in greater use of statistical concepts in health-related fields. Globally, the contributions by Sir Ronald Fisher, Austin Bradford Hill, and Archie Cochrane for the development of evidence-based medicine were commendable.² With the development of epidemiology and information technology in the last few decades, not only the awareness and use of biostatistical methods in medical, clinical, and public health research have increased many folds, but the computational skills have also been enhanced remarkably. The INCLIN (International Clinical Epidemiological Network) consortium, in collaboration with the Rockefeller Foundation and USAID (United States Agency for International Development), has contributed substantially to the capacity building of biostatisticians working in medical institutions in selected developed and developing nations, including India.

Teaching, Training, Research and Consultancy

As far as statistics is concerned, the number of institutions offering courses in statistics is of substantial number and is increasing, but biostatistics has not been given the importance which it needs. All medical colleges in India do not have separate departments of biostatistics. At the academic level, in the majority of medical colleges, biostatistics is not being taught as a separate discipline even today. This constitutes a very small portion in the curriculum and many a times taught by instructors who are not trained biostatisticians.³ During their study at the medical school, the majority of students does not give importance to biostatistics and only appreciate and completely understand the concepts when they complete their studies and start clinical practice.⁴ Hence, to generate interest among medical students for biostatistics, it is very important to have effective teaching methodologies. Over the years, there are changes and modifications in the ways biostatistics has been taught, but still lot more is required to make the subject more interesting and applicable. It has moved from the conventional theory-based mode to more practical-based. However, there is still scope to include more practical exercise in the teaching of biostatistics.

Biostatisticians develop and apply statistical methods to scientific research in health-related fields, including medicine, epidemiology, and public health. They work closely with other public health disciplines to develop outcome measures to ascertain the effectiveness of programmatic activities and to develop the means to collect such measures, which may include surveys, lab reports, hospital discharge data, etc. Biostatisticians help formulate the scientific questions to be answered, determine appropriate sampling techniques and sample size, coordinate data collection and management procedures, and conduct statistical analyses and its interpretation to answer those scientific questions. They also play a very important role in the preparation of research material for publication.

Biostatistician's functions are increasingly becoming vital in the public policy arena as well. For instance, biostatisticians play a large role in informing policy makers about issues such as risk and protective factors affecting heart and lung disease, formulating new drug policy to combat infectious diseases, etc. By the next generation, biostatisticians are expected to be trained professionals fully equipped with the necessary skills for jobs in academics, government, and industry. In all these settings, biostatisticians are considered consultants to other researchers.^{5,6} Teaching consultation skills needs to be an integral part of any applied biostatistical training program. Success of such training might be seen in terms of subsequent statistical consultations offered to the clients in worldwide settings.⁷

In the field of applied health research, many a times it does happen that a group of researchers start a study without including a biostatistician on board and involve them only at a later stage, whenever desired. If any problem at that stage is identified, which cannot be rectified because the major portion of the study has been already completed, then it becomes very difficult for the biostatistician to work out a reasonable solution.

With the above backdrop, the involvement of biostatisticians in any research study from the beginning becomes very crucial. Hence, availability of sufficient people with expertise in biostatistics/medical statistics/health statistics/biometry is very much required. This in turn requires that an adequate number of people be trained in these areas. An extensive search strategy was used to find out existing courses in biostatistics and related fields in India, details of which are given in the following section.

Methodology

The information regarding the existing long term teaching and training programs in biostatistics and related fields like medical statistics, health statistics, and biometry in India was obtained by using systematic search strategies. The Google internet-based search engine was used to get the list of institutions offering courses in biostatistics and its related fields. First of all, key words for the search were identified. The various key words used were: Biostatistics, health statistics, medical statistics, and biometry. The search was limited to the courses that are offered in India only. In the process of the search, information was mainly obtained on name of the course, name of the organization offering the course, location, duration of the course, eligibility criteria for admission, mode of delivery of the course (regular fulltime or correspondence), and if possible, the number of seats available. From the search results, short-term teaching and training programs of duration less than six months were excluded.

Results

Overall, only about 19 institutions in India are offering various courses in biostatistics/medical statistics/health statistics/biometry [Table 1]. As far as the regional distribution of these institutions is concerned, a majority of them are in the southern region of India [Figure 1]. Except for a few institutions like Banaras Hindu University, Amrita School of Medicine, All India Institute of Hygiene and Public Health and West Bengal University of Health Sciences, the majority of the institutions have programmes titled as Biostatistics. There is wide variety of available courses, starting from certificate courses, diploma courses, post graduate diploma courses, master's level courses, and doctoral programmes. An extensive three years fellowship program in biostatistics is being offered by Sanjay Gandhi Post Graduate Institute of Medical Sciences, in Lucknow, which gives a rigorous training including both theory and practical, and also on handling a variety of statistical software.

With the exception of Manipal University, Sardar Patel University, and Global Institute of Medical Sciences, Baroda, which offer six months certificate courses, all other institutes are offering programmes of duration one year or more. All diploma, post-graduate diploma, and M.Phil. courses are of one year duration, master's level courses are of two years duration, and duration for

doctoral level programmes are three years and above. Out of all the available institutions, the majority of them run fulltime courses, which is very much required because a subject like biostatistics is better understood when taught face-to-face with lots of discussion and hands-on experience of data analysis by using some statistical software. Cliniminds, a clinical research training institute, runs various post-graduate and advanced post-graduate diploma programs in biostatistics and its related field. These programs are mainly run either as regular weekends or in a distance learning mode, considering the target audience is working individuals. There are institutes in India like Christian Medical College, Vellore, which offers regular training programs of short duration (from three days to one week) in various topics in biostatistics. Short-term training workshops are also organized for building capacity in analysis skills by using some statistical software like STATA, SAS or SPSS.

The eligibility criterion for admission to post-graduate courses varies according to the type of program and also, to a certain extent, from one institution to another. It ranges from a minimum of recognized bachelor's degree with medical subject or any other subject with mathematics or statistics as one of the subjects, to a maximum of master's degree in the field of statistics, depending on the type of course. Doctoral programs have the requirement that students who apply for the course should have a post-graduate degree in statistics or its related branches like biostatistics, medical statistics, health statistics, biometry, etc. For the majority of the master's level programs, a candidate should have a bachelor's degree with mathematics or statistics as the main subjects. However, the M.Sc. course of SRM University, Tamil Nadu, requires a graduate in medicine, AYUSH (Ayurveda, Yoga, Naturopathy, Unani, Siddha, and Homeopathy), engineering, pharmacy, physiotherapy, occupational therapy, dentistry, and arts and science with mathematics at higher secondary level, for admission in the program. The post-graduate diploma course of the Indian Institute of Public Health, Hyderabad has a requirement of a bachelor's degree in any discipline. However, Madurai Kamraj University, Tamil Nadu, requires a candidate with degree in science having mathematics as one of the subjects in 12th grade. Diploma in health statistics courses in various institutions have the criteria of selecting individuals with bachelor's degree (either medical or B.A./B.Sc. with mathematics or statistics as one of the subjects).

Table 1: Matrix of existing courses in Biostatistics and its related field in India

S. No	Name of the Institute/University	Title of the Program	Nature of Program	Duration	Eligibility	Mode of Learning	No. of seats
1	National Institute of Mental Health and Neuro Science, Bangalore, Karnataka ⁸	Doctor of Philosophy in Biostatistics	PhD	3-5 years	M.Stat (ISI)/MSc in Statistics/ Biostatistics /Medical Statistics/Health Statistics /Agricultural Statistics	Regular	
2	All India Institute of Medical Science, New Delhi ⁹	Doctor of Philosophy in Biostatistics	PhD	3 years	Masters degree with minimum merit	Regular	
3	Sanjay Gandhi Post Graduate Institute of Medical Science, Lucknow, Uttar Pradesh ¹⁰	Fellowship in Biostatistics	Fellowship	3 years	Masters degree with merit	Regular	2
4	St. Thomas College, Kottayam, Kerala ¹¹	M Sc in Biostatistics	Masters	2 years	Bachelor Degree with merit	Regular	20
5	Smt. Devkunvar Nanalal Bhatt Vaishnav College for Women, Chennai, Tamil Nadu ¹²	M Sc in Biostatistics	Masters	2 years	Bachelor Degree with merit	Regular	
6	Christian Medical College, Vellore, Tamil Nadu ¹³	M Sc in Biostatistics	Masters	2 years	Bachelors degree with statistics	Regular	
7	Manipal University, Manipal, Karnataka ^{14,15}	M Sc in Biostatistics Certificate course in Biostatistics, epidemiology and research methodology	Masters Certificate	2 years 6 months	BSc Statistics/BSc Mathematics with Statistics as a subsidiary subject with a minimum of 50% marks in aggregate.	Regular	
8	University of Lucknow, Lucknow, Uttar Pradesh ¹⁶	M Sc in Biostatistics	Master	Two years	Graduate with a 50% min marks and Mathematics as one of the subjects at the Intermediate/Higher Secondary (10+2) level	Regular	20
9	SRM University, Chennai, Tamil Nadu ¹⁷	M A in Biostatistics M Sc in Biostatistics and Epidemiology	Master	Two years	Graduate in Medicine, Ayush, Engineering, Pharmacy, Physiotherapy, Occupational Therapy, Dentistry, and Arts and Science. Maths at Higher Secondary Level.	Regular	10
10	Amrita School of Medicine, Kochi, Kerala ¹⁸	M Sc in Medical Statistics	Master	Two years			
11	Banaras Hindu University, Varanasi, Uttar Pradesh ¹⁹	MSc in Health Statistics	Masters	Two years	B. Sc. (Hons.)/B.Sc. under at least 10+2+3 pattern securing a minimum of 50% marks in the aggregate in Science subjects (considering all the three years of B. Sc. Course). Statistics must be a Hons. subject at B. Sc. (Hons.) level/ Studied in all the three parts at Graduation level	Regular	12
12	Berhampur University, Berhampur, Orissa ²⁰	M Sc in Ecology Biostatistics and Taxonomy	Masters	2 years	Bachelor Degree with merit	Regular	
13	Indian Institute of Public Health, Hyderabad, Andhra Pradesh ²¹	Post Graduate Diploma in Biostatistics and Data Management	PG Diploma	1 year	Bachelors degree in any discipline	Regular	
14	Cliniminds, Academy for Clinical Research and Training Management, Noida, Uttar Pradesh ²²	Advanced PG Diploma in Biostatistics and SAS Advanced PG Diploma in Clinical Data Management PG Dip in Clinical Data Management and SAS Advanced PG Diploma in Clinical Data Management, Biostatistics and SAS	PG Diploma	Six months Six months Six months One year	MD, MS, MBBS, BDS, BHMS, BAMS, BUMS, BPT, B.Pharma, Graduate/Post Graduate Degree in Life Sciences, Mathematics, Pharmacology, Pharmacy, Medical Laboratory, Nursing, Biochemistry, Microbiology, Biotechnology and all professionals working with Pharmaceutical companies, CROs and hospitals	Regular Weekend program/ Distance Learning	

Table 1: (Cont.)

15	Madurai Kamaraj University, Tamil Nadu ²³	Post Graduate Diploma in Biostatistics	DHeS	1 year	A Degree in Science with Mathematics as one of the subject in +2 (XII Std.)	Distance learning
16	West Bengal University of Health Sciences, Kolkata, West Bengal ²⁴			1 year	Registered Medical Graduates (MBBS / BHMS / BAMS) or candidates, who have passed the B.A or B.Sc. or B. Com. Examination with Mathematics or Statistics as one of the subjects from a recognized University	
17	All India Institute of hygiene and public Health, Kolkata, West Bengal ²⁵	Post Graduate Diploma in Health Statistics		1 year	Medical graduates or BA/BSc with mathematics or statistics as one of the subjects	In-house
18	Global Institute of Medical Sciences, Baroda, Gujarat ²⁶	Diploma in Biostatistics and Research Methodology	Certificate in Biostatistics and Research Methodology	1 year	Graduate (Any), MBBS; BPT, BOT	Correspondence
19	Sardar Patel University, Vallabh Vidyanagar, Gujarat ²⁷	Certificate course in Biostatistics		6 months	Bachelor's degree from any faculty of this University under 10 + 2 + 3 or an examination recognized as equivalent thereto with at least 40 percent of marks. In addition, Biology at XII Std or at later stage of study and a four credit course in statistics / mathematics is required	

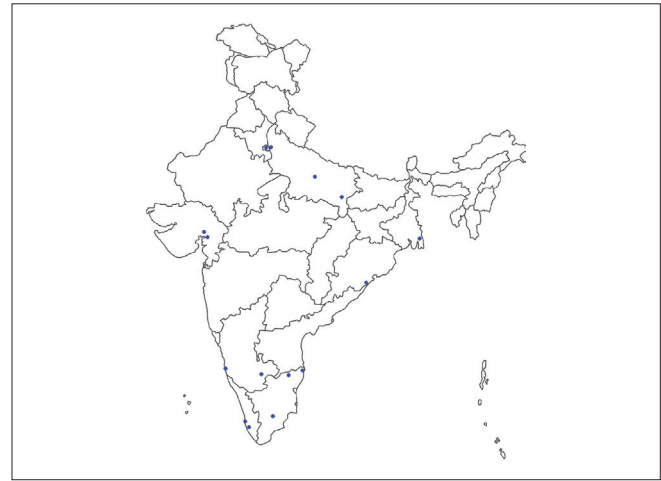


Figure 1: Regional distribution of various institutions offering courses in biostatistics and its related fields in India

Discussion

Biostatistics, being an interdisciplinary subject, is of immense importance in the vast majority of the researches that are being undertaken in the field of health sciences. This manuscript listed the existing institutes and organizations in India, which offers courses in biostatistics and its related field. It cannot be denied that researchers and medical students do need training in biostatistics for better, critical understanding of the biomedical literature and for conducting any research study. With the rising number of researches in the field of health sciences, there is an increase in demand of researchers with biostatistics training. There is also a great need for formally training statisticians in biostatistics applied methodology. Considering the growing need of biostatisticians in health sciences, the University of Poona took the initiative in the 1970s by starting a full-time four-semester interdisciplinary course in mathematics, statistics, and biology i.e. M.Sc. Biometry. In view of this, when we look on the existing courses and training in biostatistics and its related field, the numbers are not satisfactory, and it emerges that still there is a need to increase specialized courses in biostatistics, especially in the northern region. In the majority of the medical colleges, it is taught as a part of preventive and social medicine course rather than as a separate discipline. It has been found that among the medical colleges, biostatistics is considered to be one of those subjects which students dislike the most.² It is important to look for the reasons as why the motivation behind learning biostatistics is very low.

With the emergence of evidence based medicine, the demand for application of biostatistics is increasing in India, but this is not in tune with the number of biostatisticians produced. With the personal experience of the first author, it seems that vacancies for a biostatistician in general are not filled very easily. Most of the time, only a few candidates appear for the interviews. The possible reasons for this can be the availability of small numbers of trained persons in the area. Over time, the number of institutions offering courses in medical statistics is increasing gradually; however, the number of teachers is very few. In the majority of medical colleges, biostatistics is been taught by faculty who are not trained biostatisticians. Although the system of teaching is gradually changing from a purely theoretical approach to a more practical approach, there still is a need to be more innovative in teaching biostatistics by taking real life examples to attract students.

Teaching future applied biostatisticians requires teaching consultation skills. Teaching statistical consultancy not only involves statistical methodological training but should also focus on improving interpersonal communication and negotiation skills.⁷ Hence, the job of biostatistics faculties becomes more crucial to generate interest and motivate researchers and students to understand the need for the study of biostatistics and its appropriate use. The other means for giving importance to biostatistics is by making it a separate branch/specialization in a majority of the institutions, particularly in medical colleges.

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