

The Successful Teaching of Statistics to Every Medical Student

WHY this is needed

WHAT should be taught

HOW and by Whom

it should be taught



The Government of Pakistan



World Health Organisation,



International Epidemiological Association

FOREWORD

As part of its endeavour to raise the quality of health care delivery through more effective use of statistical material and methods, the World Health Organization has, since 1962, sponsored a number of programmes designed to improve the teaching of statistics to medical undergraduates and health service personnel. A recent activity in this field was the Interregional Conference on Teaching Statistics to Medical undergraduates, held in Karachi, Pakistan from 4-9 March 1978. The Conference was sponsored by the World Health Organization, the Government of Pakistan and the International Epidemiological Association.

The agreed aim of the Conference was "to ensure the successful learning of statistics by every medical student". To further that aim participants were asked first to consider and define why statistics need to be taught to all medical students, and then to recommend what should be taught and how, when and by whom this should be done? The report of the Conference follows these guidelines. It is based on discussions stimulated by a wide range of background papers, opinions expressed in working groups in response to questions put to them, panel discussions and discussions following demonstrations or teaching sessions in which medical students participated.

We believe that medical teachers, physicians and administrators who read the report will find in it much to interest them and some recommendations they will wish to put into practice, whatever their country, the nature of its health problems and the way in which its health services are organized.

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ACKNOWLEDGEMENT

The Conference was financially supported by the Government of Pakistan, the World Health Organization, the International Epidemiological Association, the National Centre for Health Statistics, USA and various national health agencies and teaching institutions.

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Conclusion and Recommendation

1. WHY STATISTICS SHOULD BE TAUGHT TO EVERY MEDICAL STUDENT ?
 - 1.1. A knowledge of statistics is required to understand the rationale on which diagnostic, prognostic and therapeutic decisions are based and to appreciate that medicine is largely a matter of probabilities.
 - 1.2. A doctor needs to interpret laboratory tests and bedside observations and measurements in the light of a knowledge of physiological, observer and instrumental variation.
 - 1.3. The practising physician must know and understand the statistical and epidemiological facts about the aetiology and prognosis of the diseases he treats in order to give the best advice to his patients about how to avoid or limit their effects.
 - 1.4. Medical practitioners are the primary generators of the data on which health statistics are based, they need to know how to use those data to the benefit of their own practices and how they are used in the organization and delivery of health care in their country.
 - 1.5. The practising physician needs to know how to interpret and draw inferences from the statistics that describe his country's health problems and the resources available to meet them.
 - 1.6. The study of statistics helps to foster in students critical and deductive faculties they will need to
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apply throughout their medical studies and, after graduation, their practice of medicine.

- 1.7. To appraise the validity and worth of articles in medical journals and the claims made in the literature distributed by drug manufacturing companies, the practising physician needs to understand and recognize fallacies in the statistics presented in them.
- 1.8. Statistics is an essential part of the scientific method. Reputable medical journals are unlikely to accept papers for publication unless they are statistically sound, and requests for research funds are unlikely to be successful unless supported by appropriate statistics.

2. WHAT STATISTICS SHOULD BE TAUGHT ?

Although the extent of the statistical knowledge and skills medical students need to acquire will vary from country to country, there is a core of knowledge which all students need to acquire irrespective of the country in which they are trained. A programme for presenting this core can be divided into four parts:

2.1. STATISTICAL PRINCIPLES AND METHODS.

- 2.1.1. Introduction to the role of statistics in human biology and medicine.
 - 2.1.2. Collection and organization of data and scales, of measurement.
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- 2.1.3. Presentation of data in tables, graphs and charts.
 - 2.1.4. The variability of biological, clinical laboratory, psychological, social and environmental data.
 - 2.1.5. Measures of central tendency and location: mean, median, mode, their uses and interpretation
 - 2.1.6. Measures of variation: range, percentiles, variance and standard deviation
 - 2.1.7. The concept of probability.
 - 2.1.8. Sampling: sampling methods, sampling errors randomisation, selection and bias.
 - 2.1.9. Statistical inference: tests of significance, their uses and interpretation.
 - 2.1.10. The concepts of association and causality: measures of regression and correlation and their interpretation.
 - 2.2. HEALTH STATISTICS INCLUDING DEMOGRAPHY AND STATISTICS.
 - 2.2.1. Introduction: the doctor's role as producer and user of statistics on mortality, morbidity, and use of health services.
 - 2.2.2. Population dynamics: size, structure, growth and movement of population and indices of fertility, survival and replacement.
 - 2.2.3. Censuses of population: characteristics, and registration of births and marriages.
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2.2.4. Mortality statistics: registration of deaths, International classification of diseases, crude age and sex specific, and standardized death rates; standardized mortality ratios.

2.2.5. Morbidity statistics: sources of information on diseases and disability, and measures of morbidity

2.2.6. Health services statistics: sources of data on availability and use of health services and their activities.

2.3. STATISTICS IN CLINICAL MEDICINE.

2.3.1. Variation in medicine: biological, pathological, observer and instrumental variation.

2.3.2. The statistical foundation of diagnosis, prognosis and treatment.

2.3.3. Diagnosis: the relation between clinical assessments and the distribution of symptoms, signs and laboratory-type measurements in the general population.

2.3.4. Prognosis: the analysis of follow-up studies of morbidity and mortality and their interpretation.

2.3.5. Treatment: critical evaluation of the design and interpretation of prophylactic and therapeutic trials.

2.3.6. The ethics of statistical and epidemiological investigations in medicine.

2.4. THE LEVEL AT WHICH TO TEACH.

- 2.4.1. Discuss with the appropriate teachers what statistical knowledge and skills the students need in order to learn adequately other subjects in the medical curriculum.
- 2.4.2. Put questionnaires to and interview practising doctors to discover the statistical knowledge and skills they use in the work and to decide whether there is any additional knowledge which, if they possessed it, would enhance their effectiveness.
- 2.4.3. Decide from a review of a suitable sample of published papers what knowledge of statistics is needed to understand and appraise critically articles in medical journals and the claims made by drug companies.
- 2.4.4. Determine from discussion with appropriate specialists what statistical knowledge a practising doctor needs to take a sound view of local and National health care problems and to perform his role as a member of the social, economic and health information system to which he belongs.
- 2.4.5. Decide what knowledge and skills physicians of the future will need in view of changes in health care problems and services (e.g. increasing use of computer analysis and emphasis on non-hospital care).

3. HOW TO TEACH STATISTICS ?

3.1. MOTIVATE THE STUDENT TO LEARN.

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- 3.1.1. Always relate the teaching of statistical principles and methods to the solution of medical problems.
 - 3.1.2. Emphasise the relevance of statistics to diagnosis, treatment and prognosis.
 - 3.1.3. Use local or National data in problem solving exercises designed to illustrate statistical principles and methods.
 - 3.1.4. Point out the need to be able to interpret the validity and worth of the statistics used in articles in medical journals and in the literature distributed by drug manufacturers.
 - 3.1.5. Persuade clinical teachers to use statistical data and evidence in the course of their teaching, whenever appropriate.
 - 3.2. MAKE LEARNING AS EASY AS POSSIBLE.
 - 3.2.1. Tell the students at the beginning of the course that the aim of the statistics programme is to teach them only the essential statistical knowledge and skill they will need to practise medicine effectively in their day-to-day work after graduation.
 - 3.2.2. Allay any anxiety students may have that the ability to learn statistics requires a high level of mathematical ability by making it clear at the outset that only basic mathematical ability will be needed.
 - 3.2.3. Design the course content to give it a logical structure leading from the simple to the more complex; arrange presentation of the subject matter in steps
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graded to match the abilities of the least able students; and write the syllabus in behavioural objective terms defining precisely what the students should be able to do.

- 3.2.4. Produce a handout for each unit of instruction so that students need not take notes unless they wish to do so.
 - 3.2.5. Make the detailed course syllabus available to the students at the beginning of the course so that they are fully informed about what they have to learn.
 - 3.2.6. Teach at a rate which will ensure that the least able students achieve each course objective before proceeding to the next.
 - 3.2.7. Provide as many opportunities as possible for students to put into practice the statistical methods they are taught by applying them to data collected during their own laboratory work, surveys and projects.
 - 3.2.8. Teach as far as possible by means of lessons rather than by formal lectures (i.e., use teaching methods which enable the success of the teaching to be monitored by questioning the students throughout the progress of the lesson and the rate of teaching to be adjusted in accordance with the results).
 - 3.2.9. When class sizes are too large for lessons, say over forty, consider the provision of self-learning facilities, such as programmed texts, which permit students to learn for themselves at their own rate, with lessons
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or tutorials for the smaller number of students who require additional instructions.

3.3. USE A SYSTEMATIC APPROACH.

- 3.3.1. Determine the precise aims of the course.
- 3.3.2. Write the course syllabus as a series of precise objectives.
- 3.3.3. Translate the course syllabus into teaching/learning units in a logical teaching order with objectives and enabling objectives for each.
- 3.3.4. Decide upon and use the most suitable teaching method for each unit.
- 3.3.5. Use the most suitable methods of assessment to evaluate student learning, teaching effectiveness and course design.
- 3.3.6. If necessary, modify the teaching and the design of the course of study to improve future students' learning.

3.4. EVALUATE THE TEACHING.

- 3.4.1. Decide the purpose of assessment, e.g., student selection, student learning, teaching effectiveness.
 - 3.4.2. Decide at what points in the course of study assessments should be made.
 - 3.4.3. Decide the knowledge, skills and attitudes to be measured by each assessment.
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- 3.4.4. Define, in measurable terms, each element to be tested, e g., recall, interpretation, solution of problems.
 - 3.4.5. Choose the most suitable method or methods of assessment, bearing in mind the objectivity, validity, reliability, and discrimination characteristics of each method.
 - 3.4.6. Design the test to measure accurately the acquisition of the required knowledge, skill and attitudes.
 - 3.4.7. Check the worth of the course of study by finding out from graduates whether what they learned is of value to them in their practice of medicine or whether they would have liked to have been taught more or less, or differently.

4. WHO SHOULD TEACH STATISTICS?

- 4.1. Statistics should be taught to medical undergraduates either by a physician possessing sufficient knowledge of statistics to be able to teach to the required depth, or by an applied statistician who has acquired by formal or informal training an orientation to medicine and health care problems, has sufficient experience of medical data handling and research to be able to persuade students of the need to learn the subject and can use with conviction physiological and clinical examples during his teaching.
 - 4.2. To enable physicians to acquire the knowledge to teach statistics to medical students special courses in statistics should be provided, and to enable statisticians to acquire medical knowledge they
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