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Health Statistics

A manual for teachers of medical students

EDITED BY
C.R. Lowe and S.K. Lwanga

A HANDBOOK SPONSORED BY THE I.E.A. AND W.H.O.

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A manual for teachers of medical students

Edited for the International Epidemiological Association and the World Health Organization by

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Foreword

Dr. B. SKRINJAR-NERIMA
Chief, Development of Health Statistics
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This manual was initiated by people concerned about statistics and their use in medicine. Many meetings have discussed ways of improving the doctor's attitude towards statistics, and have emphasized the important role which education plays in this respect. They have also stressed the importance of adequate educational technology and planning in this area. That is why this manual is directed towards teachers of statistics.

To a great extent educational programmes in statistics have not yet been tailored by the needs of the learner. It has been only recently that the teachers in statistics have started to ask themselves *why* and *what* their student should learn. This book has been written to introduce this principle into teaching practice. It has been sponsored by the World Health Organization, Division of Health Statistics, in the strong belief that through adequate education in statistics during medical studies the medical doctor will learn how to appreciate statistics and will become motivated to use them in his daily work. This will lead to better management of the health services.

The manual has been written by teachers of statistics in order to improve teaching and contribute to learning of medical students. It is the result of several discussions, consultations, exchange of ideas, and comments from many people interested in this area.

The compilation of the manual has been stimulated by the interest that the International Epidemiological Association has shown in it. To emphasize the value of the guidance on *why*, *what*, and *how* to teach, which this book provides to teachers of statistics and related subjects, the book was produced under the auspices of both IEA and WHO.

Foreword

Sir KENNETH PORTER, K.C.B., C.B.E.
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The aim of teachers should be that all and not only some of their students learn what they have been taught; it is particularly important that teachers of health statistics should strive to attain this aim because, after graduation, all and not only some of their ex-students will need to be able to interpret health statistics correctly and to use them competently in their subsequent careers. The teacher's ability to achieve this aim is dependent upon a number of factors: the degree of motivation of the students to acquire the necessary knowledge and abilities; the understanding by the students of the precise knowledge and abilities they will need to acquire; the ease with which the students are able to learn; and the efficiency of the teaching. This book has been written to help teachers of health statistics to teach all their students successfully.

In the following pages the ways in which health statistics are used by medical practitioners are described, so that the relevance of the subject to the practice of medicine may be demonstrated to the students; a list is given of the health statistical knowledge and abilities which it is suggested medical students should be taught; the basic techniques of efficient teaching and the various methods of applying these techniques to make it as easy as possible for students to learn are described in clear and simple terms; and examples are give of precise objectives for the teaching of health statistics, of a health statistics programme, and of evaluation tests.

All in all, this is a very comprehensive and valuable reference book on the teaching of health statistics which should be read not only by teachers of medical students but also by teachers of health statistics to other types of student. There is no doubt that if the teaching techniques described in the following pages are used, far more medical students than in the past will learn to interpret and use health statistics competently, and they will also acquire this knowledge more easily. In turn, the teachers will find that their task has been made easier, more enjoyable, and much more rewarding.

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Several other teachers contributed to this guide by giving the editing committee their comments and ideas on the contents and form of the publication. They also offered practical examples which they use in their own teaching practice. Several teaching syllabi were received for inclusion in the guide. In order to reduce the volume of the book not all examples have been used and neither have all the syllabi been presented.

Introduction

This is not another textbook on statistics. As the title indicates, its purpose is to help those responsible for teaching statistics in medical schools to carry out the difficult task of designing and implementing effective teaching programmes for medical students.

In its efforts to improve the quality of national health statistics and the effectiveness of their use in the management of health services, the World Health Organization has paid a great deal of attention to education and training in health statistics. In 1968 an inter-regional conference in Kampala, Uganda was devoted to discussing the training of health statistical personnel. In 1971, a consultation was organized in Geneva to discuss the education of professional health statisticians and consumers of statistics. A travelling seminar in 1973, and a workshop in 1975, discussed problems facing teachers of health statistics. A number of regional meetings have also been concerned with education and training in health statistics, beginning with a symposium on the teaching of statistics to undergraduate medical students in Europe held in 1962. An inter-regional conference on the statistical education of medical undergraduates was sponsored in Pakistan by WHO and the International Epidemiological Association in 1977.

This manual is the result of the recommendations made by the 1971 Consultation on Education and Training in Health Statistics and by members of the 1973 Travelling Seminar for Teachers of Vital and Health Statistics. Both these groups of experienced teachers felt there was a need for a guide to help teachers in the planning and delivery of teaching programmes in health statistics and agreed that the most urgent need was for one which focused mainly on the problem of teaching medical undergraduates. It is true that teachers of statistics for various other groups of personnel working in the health field need guidance about what to teach and how to teach it, but for them a fair amount of teaching material is already available. For those teaching medical students, however, there is very little suitable and readily accessible material available although medical students after qualification become the single most important producers of primary medical data, and in whatever fields of medicine they choose to work will also be consumers of health statistics.

The manual represents the views of experienced teachers from

many different countries, each with its own particular health problems and resource limitations. An introductory chapter presents a general account of the importance of statistics in all the health sciences and points out some of the difficulties teachers may have to face when presenting the subject. Part I, consisting of four chapters, is relevant to the teaching of statistics to any group of health workers. It gives an account of the modern approach to designing an educational programme, determining students' needs, developing learning objectives and measuring the outcome of the programme. The five chapters in Part II are designed specifically to meet the needs of those who teach statistics to medical undergraduates and Part III consists of an extensive set of appendices providing many useful and practical illustrations of the principles and methods discussed in the text.

The book makes no attempt to present a standard educational programme for teaching statistics to medical students. Its purposes are to help the teacher to:

(a) relate the teaching of statistics to human biology, medical practice and research, and the management of health services;
(b) assess what statistical knowledge, skills and attitudes a particular group of students will need to develop in relation to:
  (i) their level of education,
  (ii) their current interests and motivations,
  (iii) the jobs they will be doing, and
  (iv) the health needs of the areas they will be serving;
(c) write educational objectives so that the students are left in no doubt about why they are being taught statistics and what they will be expected to know, understand, and be able to do by the time they have reached the end of their course of study;
(d) design an educational programme appropriate to the needs of the students;
(e) choose learning experiences appropriate to those needs and to the defined learning objectives, the size of the class and the time, number of staff, financial resources, and supporting materials available;
(f) relate the objectives of an educational programme to the health needs of the area to be served;
(g) assess the competence of the students in relation to the defined learning objectives of the educational programme at the beginning, during and at the end of the course;
(h) use the feedback provided by assessments to improve the effectiveness of the educational programme;
(i) make the course relevant, lively, and interesting to the students by introducing a variety of learning experiences and drawing examples from the

real world in which the students are currently studying and in which they will be working after graduation.

Contents

Statistics in the biological and medical sciences

The purpose of this chapter is to remind teachers of the importance of statistics in all the health sciences and to indicate why it is not an easy subject to put over effectively. This will point the way to how it can best be introduced into an educational programme so that it is seen by students to be relevant to their educational needs. It will also underline the importance of organizing the teaching–learning process in such a way that students will develop the necessary competence to identify and solve the problems they will face in their professional lives.

1. DEFINITION OF 'STATISTICS'

There are almost as many definitions of the word 'statistics' as there are books on the subject, and as this is the first chapter we must define the way in which we shall be using it. The word has the same root as 'State' and was first used to describe that branch of political science which was beginning to concern itself with the collection and classification of facts required by the State for official purposes. It was the name given to the art by which rulers estimated the resources they would need to make war on their neighbours and how far they could safely go in taxing their subjects. As we shall use it, the word will have two meanings, a plural meaning and a singular meaning. When we use the word in its plural sense we mean pieces of information about health, disease, and the use of health care facilities which have been assembled, classified, and tabulated. When we use it in the singular sense we mean the science which embraces the methods by which the pieces of information are assembled, classified, tabulated, and analysed, and the concepts behind this process.

2. THE PROBLEMS OF TEACHING STATISTICS

Today it should hardly be necessary to argue the need for a place for statistics (singular or plural) in an educational programme in any of the health sciences. As we shall point out in this chapter and in Chapter 5, statistical concepts and methods are central to the identification and definition of problems in human biology, laboratory work, clinical practice, medical research, public health and preventive

medicine, and the management of health services. Indeed it can be said that there is hardly any field of human endeavour which cannot benefit from the application of statistics to its problems (from dice throwing, card playing, and insuring ships and their contents to research in atomic physics). Nevertheless, it is in fact still necessary to argue the case, particularly in medicine. We will begin by considering briefly some of the reasons for this. To recognize them will be to begin to understand how they can be sympathetically counteracted.

2.1 *Clinicians' suspicion of statistics*

In the past the main barrier to the advance of statistical teaching has been an aversion on the part of most clinicians to thinking in a numerate way about the problems they face when caring for patients. This was in part due to a feeling that the statistical approach to patients conflicted in some way with the traditional humanitarian, bedside approach. It was also due to the fact that until recent times very few of the remedies they recommended could stand up to critical appraisal, so there was an understandable reluctance to put them to the numerical test. The introduction of effective immunization procedures, insulin, the sulphonamides, and then the antibiotics changed all this. Health workers today have a great deal more to offer their patients than diagnostic acumen, relief from pain, and sympathetic advice, important as these still are. They can now provide preventive, curative, and palliative therapies the effectiveness of which has been convincingly demonstrated by statistical methods. Nevertheless, in clinical medicine traces of the old attitude to numbers remain. And of course it is natural for students in the health sciences to get more satisfaction from personal contact with patients and from playing a part in alleviating their suffering than from the impersonal statistical approach to groups of patients and to populations.

Another barrier, also largely in the past, amounts to a resentment by professionals caring for the sick that statisticians should presume to probe the mysteries of their arts. This was well expressed in a leading article in *The Lancet* (1937) when chapters of Sir Austin Bradford Hill's *Principles of medical statistics* were being published weekly in that journal. 'Statistics . . . tends to induce a strong emotional reaction in non-mathematical minds. This is because statisticians apply to problems in which we are interested a technique which we do not understand. It is exasperating, when we have studied a problem by methods that we have spent laborious years in mastering, to find our conclusions questioned, and perhaps refuted,

by someone who could not have made the observations himself. It requires more equanimity than most of us possess to acknowledge that the fault is in ourselves.' The remedy for this, proposed in essence by Bradford Hill himself, is that professionals in clinical and laboratory medicine, like those in preventive medicine, should learn how to think statistically about the problems they encounter and how to apply statistical techniques to the data they accumulate. The remedy is now widely applied, and certainly most medical research workers are well versed in statistical techniques, if not always fully conversant with statistical concepts. However, the remedy, a teaching-learning process beginning in the student years, is not always applied as skillfully or as effectively as it might be, and some of the resentment to which we have referred lingers on.

2.2. *Misuse of statements*

Another reason for an antipathy to statistics, more insiduous and therefore more difficult to counteract, is expressed in the derogatory phrase 'lies, damned lies and statistics'. Statistics is an essential tool for handling the infinite variability of biological and natural phenomena. But statistics, in the plural sense, are too often used dishonestly to reinforce tendentious arguments. Politicians, propagandists, and sponsors of commercial products all too commonly select from the mass of data available only those statistics that appear to lend support to their beliefs or the course of action they are prescribing and present them in a deliberately misleading way, for example in graphs with exaggerated or compressed scales. It is the function of the teacher of statistics in the health sciences not only to provide students with the opportunity to learn how to think statistically about problems in their own particular scientific disciplines, and how to apply statistical methods to solving those problems, but also to show, with appropriate examples, how statistical principles when ignored and statistical methods when misapplied can lead deliberately, or in ignorance, to false, misleading or foolish conclusions. In fact to teach them how not to lie with statistics.

2.3. *The time spent on data handling*

A commonly met difficulty is that a teaching programme becomes unacceptable to most students if a great deal of time is spent on repetitive and mechanical data-handling tasks – on the sorting and tabulating of information and on the arithmetic of summarizing indices, tests of significance and correlation coefficients. All health science students, whatever their future professions, need to acquire

some competence in carrying out the common statistical procedures, and ideally they should be given the opportunity to sort, analyse, and interpret data they have collected themselves in a project related to their professional interests. But the first purpose of providing them with learning experiences in statistics is to give them a firm grasp of statistical concepts and principles and to ensure that they will be able to apply these to their thinking about the biological and health care problems they will encounter in their professions.

2.4. *Shortage of suitable teachers*

An important contributory cause to the often unsatisfactory position of statistical teaching in the health sciences is the shortage of experienced teachers with the appropriate background. Teaching material and learning experiences must be seen by the students themselves to be relevant to their felt needs, the other educational programmes to which they are being exposed, and the jobs they will be doing after qualification. This calls for a statistician with wide knowledge and research experience in the health sciences or a medically qualified person with a special knowledge of statistics. There are very few medically qualified statisticians, and non-medical statisticians with a health science background are not easy to find – and when found have to be persuaded that the academic life has advantages which outweigh the attractions of the salaries they can command in commerce or industry.

3. THE CENTRAL ROLE OF STATISTICS IN THE HEALTH SCIENCES

Knowledge of and competence in the application of statistical principles and methods are necessary to an understanding of any of the biological or medical sciences (anatomy, physiology, genetics, psychology, microbiology, pathology, clinical medicine, etc.). Some knowledge of and a degree of competence in statistics are also necessary for effective practice in any of the health professions (as a medical doctor, nurse, environmental hygenist, pathologist, medical biochemist, etc.). In some aspects of the health sciences and health services statistics is not only necessary but central. We will discuss briefly four of these.

3.1. *Biological variability*

All living things show variation of characteristics and measurements. Species are defined and individual members of the species are recognized by the grouping together of these characteristics and this is essentially a statistical exercise. The recognition that certain characteristics appear together more often than others to form meaningful