Profile of research methodology and statistics training of undergraduate medical students at South African universities

Dommisse J, MMedSc **Joubert G,** BA, MSc
Department of Biostatistics, University of the Free State
Correspondence to: Prof Gina Joubert, e-mail: gnbsgj.md@ufs.ac.za
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Abstract

Background: Medical practitioners need to have knowledge of statistics and research principles, especially with the increasing emphasis on evidence-based medicine. The aim of this study was to determine the profile of research methodology and statistics training of undergraduate medical students at South African universities in terms of which topics are taught, by whom teaching is done, when these topics are taught and how they are taught.

Method: Respondents for this descriptive study were persons responsible for the teaching of statistics and research methodology at the eight medical schools in South Africa. They were identified by the head of each school who also gave permission for the school to participate. The respondents completed a questionnaire and checklist after giving informed consent. No response was obtained from one university. Responses were compared to international guidelines.

Results: At five universities the material is taught in the first year, at one in the second year and one in the third or fourth year, depending on when it is selected as an elective. The material is reinforced in other modules in the medical programme at three universities. The persons responsible for teaching are mainly statisticians (six universities). Class sizes vary from 40 to 320 students with four universities having 200 or more students per class. At two universities the current course has been in place since 2003, at two since 2000, and at two since the 1970/80s. The following topics are taught at the majority of universities: study designs in medical research, exploring and presenting data, summarising data, probability, sampling, statistical inference, analysis of cross tabulation and critical reading. At four universities there are practical classes, three of these mainly for computer work. At three universities tutors are used, at two of these the tutors are postgraduate students in statistics whereas at one university registrars, doctors and researchers are used as tutors. Students at three of the universities complete a research project, at two of these the students complete the full research process from planning up to reporting, whereas the project at the other university focuses mainly on the analysis of data.

Conclusion: Recommendations have been made regarding topics which should be covered and teaching methods which should be used at all universities. Doctors should be involved in the training to ensure clinically appropriate material and examples.

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Introduction

In an era of evidence-based medicine and continuous professional development of medical practitioners, medical practitioners need a basic understanding of research methodology and statistics so as to interpret research findings and to be able to conduct their own research projects. It is the responsibility of medical practitioners to equip themselves to the extent that they are able to discern between good and bad research studies, are able to verify whether the conclusions of a study are valid and to understand the limitations of such studies.[1]

The Health Professionals Council of South Africa (HPCSA) oversees the quality control of undergraduate curricula. Guidelines laid down by the HPCSA are comprehensive, but not too restrictive, so that some measure of freedom of choice is allowed for the different schools. This is also one of the main reasons why differences exist[2] between the curricula of different medical schools. From the framework of the undergraduate curriculum in medicine and the profile of a basic medical practitioner as given in the guidelines of the Health Professions Council of South Africa, it is clear that research methodology and statistics should form part of the undergraduate training of medical students in South Africa.[3] It is stated that on completion of the undergraduate curriculum, students should have an understanding of research methods and should show an acceptance of the responsibility to contribute to the advancement of medical science, that is a research approach in practice.

The most important reason for teaching specific topics to medical students must be the relevance of such topics.[4] In general, a medical student's focus is on the acquisition of skills needed to practice clinical medicine and great care must be taken to explain why disciplines such as statistics are relevant to this practice. The use of real examples and an emphasis on the need for evidence have meant that medical students are increasingly aware of the pressure experienced by clinicians to justify their treatment decisions and the associated need to be able to understand and critically appraise medical research.[5] Surveys in the UK and USA have investigated which topics currently being taught, should be taught.[6,7]

Exactly when teaching of research methodology and statistics should take place is a difficult question, but what has been found to be successful is an early pre-clinical course (so that the jargon of statistics is familiar) and a reinforced course during the latter studies and the clinical years.[8] However, due to the full programme in the clinical years, such courses are often presented during the first semester, when the medical student still exists in a "vacuum of medical knowledge". The lecturers should be able to provide students with a frame of reference and lecturers should consequently also possess knowledge of, and insight into, medical literature.[9] The lecturing of service courses is, however, often left in the hands of junior lecturers. This can result in a teacher who is in a "medical vacuum" teaching students in a "medical vacuum". Students consequently merely try to pass a course for which they see no purpose in the medical profession.[9]

Research methodology and statistics involve the learning of new skills, almost a new language, thus necessitating a more interactive form of teaching. Problems and methods need to be discussed and feedback given to students to help ensure that their understanding is correct. Small group teaching sessions are therefore an appropriate and necessary format. Some difficulties are, however, experienced with this approach, due to the limited supply of qualified staff and suitable tutor rooms for conducting 15 or more tutorial sessions.[5]

The aim of this study was to determine the profile of research methodology and statistics training for undergraduate medical students at South African universities in terms of the following:

(1) Which subjects (topics) are taught?

(2) Who does the teaching?

(3) At what stage of the medical curriculum is the material taught?

(4) How is the material taught?

Methods

The researchers approached all eight South African medical schools with a view to participating in this descriptive study. The heads of the eight medical schools were contacted via email to ask whether they would consent to their particular school participating in the research. They were also requested to provide the contact details of the person(s) responsible for the teaching of statistics and research methodology to medical students.

Measurement consisted of a quantitative checklist of topics (with subtopics listed below each) taught, when they are taught, by whom and to what depth, as well as a questionnaire containing both quantitative and qualitative questions. The topics listed on the checklist were compiled from suitable sources.[7, 10–12]

A pilot study was conducted at the School of Nursing Science at the University of North West. A few additions were made to the checklist and questionnaire on completion of the pilot study.

The relevant persons at all the universities involved in the study were contacted to seek the necessary consent for participation. At two universities personal interviews were conducted, while respondents from the other universities preferred to complete the questionnaire and checklist via email. Learning programme material was requested from the universities to see what the aims and objectives of their courses are.

In respect of the two personal interviews, the interviewer recorded all the data directly onto standardised questionnaires and checklists. The other respondents completed the checklist and questionnaire themselves and returned them via email. Data was then entered on an MS Excel spreadsheet.

Consent was obtained from both the relevant heads of the schools of medicine and the participants. The sources of the information were kept confidential and results were reported anonymously. Feedback was given to each respondent. The protocol was approved by the Ethics Committee of the Faculty of Health Sciences of the University of the Free State.

Results

The heads of all eight medical schools gave permission for their respective schools to participate, but due to unforeseen circumstances the appropriate person from one university could not participate. Seven out of the eight universities supplied information in respect of the checklist and six in respect of the questionnaire. Five universities supplied the learning programme material.

Five of the seven participating universities provide a formal biostatistics/research methodology course. At one university a few topics of statistics/research are taught and at the other one, the research subject is part of the electives, thus only those students who elect the research subject will be exposed to statistics or research methodology. For the study results presented, the elective programme was treated as though all medical students of that particular university were exposed to the concepts (because the topics are presented).

The persons who completed the questionnaires were a doctor (three universities), statistician (six universities) and applied mathematics lecturer (one university). At some universities more than one person completed the questionnaire and checklist.

At five universities the course is presented during the first year, at one during the second year, and the elective is offered during the third or fourth year. One university does a repeat of the statistics and research methodology course in the 3rd and 5th year of the medical curriculum. This entails a brief summary of the topics covered to refresh the medical students' knowledge and to equip them with the ability to critically appraise the medical literature that they are studying.

At two universities the current course has been in place since 2003, at two since 2000, and at two others since the 1970/80s.

Contact time varies from five sessions of 90 minutes each to 40-minute sessions six times a week for an entire semester. Class sizes vary from 40 (in the elective) to 320 students, with four universities having 200 or more students.

At four universities there are practical classes, three of which are mainly for computer work. At three universities tutors are used, at two of these the tutors are postgraduate students in statistics whereas at one university registrars, doctors and researchers are used as tutors.

A research project is done at three universities, two of which have their students complete the full research process from planning to reporting, whereas at the other university, the project focuses mainly on the analysis of data.

Table I gives a summary of the number of universities at which the topics and their subtopics are taught.

Table I: Number of universities at which topics are taught (n = 7)

Topic	
Introduction to medical research	7
Study designs in medical research	5
Sampling	5
Exploring and presenting data	6
Summarising data	7
Probability	4
Clinical measurement	3
From sample to population	4
Statistical inference	5
Analysis of the means of small samples	4
Analysis of cross tabulations	4
Methods based on rank order	2
Multiple comparisons	1
Correlation and regression	2
Other topic: Critical reading	7

At all seven universities students are introduced to medical research. The more common study designs (cross-sectional, cohort, case-control and case series) are taught at five of the universities. Random sampling is taught at six of the universities.

Most of the topics under exploring and presenting of data are taught at six of the universities. The basic summarising data tools (mean, median, mode, range, standard deviation and standard error) are taught at all seven of the universities. Testing hypotheses, the null hypothesis, the p-value and significance levels are taught at six universities. At five of the universities students are taught the topics of Type I and Type II errors, one- and two-sided tests of significance, degrees of freedom and confidence intervals. Four universities teach the topics of significant, real and important and statistical power.

Five universities introduce the topic of normal distribution to medical students and fewer universities cover the rest of the probability topics. At five universities the chi-squared test is taught and at four universities Fisher's exact test. Fewer universities covered the rest of the topics (validity of the chi-squared test for small samples, Yates' continuity correction for a 2x2 table, McNemar's test for matched samples) under analysis of cross-tabulations.

The topics under methods based on rank order are done only at a few universities in South Africa. The topic of the Mann-Whitney U test and Wilcoxon matched pairs test are taught at two universities.

Three universities introduce the concepts of ANOVA and one university introduces the concept of Bonferroni adjustments. Only one university indicated that they taught the concept of meta-analysis.

The topics of scatter diagrams and confidence interval and/or significance test for the correlation coefficient are taught at four universities. Fewer universities covered the rest of the topics (method of least squares, regression, multiple regression, logistic regression and comparisons of assumptions between correlation and regression).

Clinical measurements are taught at only a few universities. Only three universities teach the topics of sensitivity, specificity, positive predictive value and negative predictive value.

At all seven universities medical students are introduced to the topic of critical reading.

Other topics mentioned by respondents of two or more universities were: protocol development (three universities), questionnaire design (two universities), ethics (two universities), field trials (two universities) and report writing (two universities).

In response to an open question regarding problems experienced with the courses, four basic areas of concern were identified: (1) students, (2) data, (3) presentation and (4) time. The problems surrounding students are that they are not interested in the subject, since they do not see the value of the course. Numeracy and literacy skills were also lacking in some cases. As far as data is concerned, some respondents indicated that they had difficulty obtaining appropriate (mainly epidemiological) data. There were also concerns about lack of time to present complex subjects, thus resulting in brief and inadequate courses.

Five of the universities expose their students to computer programs, directly in practical classes and indirectly through the research projects that the students must do. Three of the universities do not give any exposure to any statistical software package and one university does not give any exposure to any computer program (not Excel or any statistical software package).

At one university the respondent did not know whether the content is implemented again later in the course, whereas at two universities the respondents knew that it was not implemented at all. At the other three universities the content is implemented across the medical curriculum.

Suggestions by the respondents on improvements to the courses centred on timing, more practical examples and more critical reading. Timing relates to the timing of the course in terms of when in the course of the medical curriculum it must be taught and timing in the sense of the amount of time allocated to this part of the curriculum.

Discussion

The checklist and questionnaire had certain shortcomings in that not enough detail was obtained on certain topics or on the different modes of teaching used at the various institutions. After some of the universities had indicated that they taught some extra topics over and above the topics mentioned in the checklist and questionnaire, the researchers should have contacted the rest of the universities again to establish whether they too taught these topics.

Despite these shortcomings, the study gave insight into whether important research methodological and statistical topics are taught at South African medical schools. From the literature the value of such topics is clear. Knowledge of study designs is crucial for an understanding of the conclusions that can be drawn from specific studies.[12] Since errors in design can lead to major flaws, it is critical to teach students which study design they need to use, and when.[13] Summarising of data is important because students need to know what it means when they are confronted with the terms in medical literature. It is not necessary for medical students to know exactly how each of the summary tools is calculated because it will be done by a statistical computer software package. As long as they can distinguish between the different descriptive statistics and know when to use the different statistical tools, they will master the medical literature.[5] Probability concepts are helpful for understanding and interpreting data presented in published articles. In addition, the concept of probability allows us to make statements

about how much confidence we have in estimates such as means, proportions or relative risks. Understanding probability is essential for the understanding of the meaning of p-values given in journal articles.[12] It is important for medical students to read literature and the importance of reading journal articles[4] in particular, needs to be reinforced. According to Hazlett, the use of information technologies (to search medical literature databases) and critical appraisal skills (to evaluate and select retrieved articles) will enable a clinician to find the manageable amount of valid information (evidence) that is relevant to his/her practice.[14]

Students at South African universities are introduced to most of the research topics mentioned in this study. Based on the literature, the researchers suggest that the following topics be covered at all universities: all study designs, all sampling techniques, incidence and prevalence, sensitivity and specificity, cross-tabulations, meta-analysis, regression and correlation. Only the fundamentals need to be covered and not too much extra coursework must be added without first removing other unnecessary coursework. In addition, doctors should be involved in the research methodology and statistics training at all universities, either on a teaching or tutoring level or at least in the development of course material. This will ensure clinically appropriate material and examples. Where possible, work should be done in small groups to enhance participation and understanding. All students should be required to do a research project since this will expose them to all the important steps of medical research and teach them important skills such as report writing and groupwork.

Conclusion

All medical schools in South Africa expose undergraduate students to research methodology and statistics training, but at one university it is only available as an elective. The topics taught vary and recommendations have therefore been made regarding topics which should be covered at all universities. Appropriate teaching methods such as those involving small groups should be used. Teaching is mainly done during the first year of the programme and statisticians mainly are responsible for the teaching. Involving doctors in the course preparation or presentation should ensure clinically appropriate material and examples. Reinforcement of the work during the clinical years should enhance the students' understanding of the material and its value.

Further insight into this topic can be gained by determining the following:

- Opinions of doctors and medical students regarding the value of the statistics and research methodology training they received.
- Whether medical students and doctors understand and can interpret research methods and statistical analyses reported in the literature.

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