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Difficulty in Understanding Statistics: Medical Students' Perspectives in a Nigerian University

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Abstract

PURPOSE: The study was conducted to examine the characteristics of medical students vis-à-vis difficulty in understanding statistics and to explore the perceived causes of this difficulty among those affected.
METHODS: In a descriptive cross-sectional questionnaire-based survey, 293 consenting final year medical students of the University of Benin were interviewed.
RESULTS: Eighty-seven (29.7%) respondents expressed difficulty in understanding statistics. Their major reasons (from multiple-response questions) were the unsatisfactory teaching of statistics, 58, (66.7%); their unseriousness about statistics, 21, (24.1%); and a perception that statistics itself was difficult, 19, (21.8%). Females were more likely than males to blame their difficulty on the unsatisfactory teaching of the subject (p=0.09; OR=0.34). Respondents whose interest in statistics ranged from "good" to "excellent" were also more likely to blame their difficulty on the unsatisfactory teaching of the subject (p=0.034; OR=0.37) but less likely to blame this on their unseriousness about the subject (p=0.00; OR=9.84) than those whose interest ranged from "fair" to "very low".
CONCLUSION: Most medical students who had difficulty in understanding statistics blamed the situation mainly on poor teaching of the subject and their self-rated unseriousness about the subject. Skilled medical statistics teachers should be engaged to teach the subject and to motivate students to learn it.

Key words: Medical students, Medical education, Statistics, Gender, Nigeria.

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Introduction

Biostatistics is well recognised as an essential tool in medical research, clinical decision making and health management[1]. The inclusion of biostatistics in the training curriculum of undergraduate medical students is geared towards preparing them for these applications of the subject in their future practice. This fact is all-the-more important as there is increasing emphasis on the need for evidence-based inferences and decisions in medical practice[2]. Teaching statistics to medical students makes it possible for the right aptitude to develop early enough in the medical career. However, medical students, as frequently confirmed by their medical statistics teachers and medical researchers, sometimes complain that they have difficulties comprehending the subject. The potential impact of this deficiency may not show up until after graduation when medical doctors are faced with the challenge of applying statistics to clinical, research and management situations.

Writing on the teaching and learning of medical statistics in South Africa, Stander[3] remarked that medical practitioners were "totally intimidated by the idea of statistics." He used this as grounds on which to query the success of the medical statistics curriculum for undergraduate medical students. The author discussed this situation and faulted the teaching of statistics, contrary to students' and lecturers' preferences, in the preclinical, rather than the clinical segment of the degree programme[3]. The author further remarked that the teaching and learning of statistics appeared to be challenges to both teachers and students respectively, as had been similarly observed by Wakeford in the United Kingdom as well[3,4]. Stander's observation that these problems are global also suggests that information sharing on the nature of and solutions to such challenges is globally desirable.

In a study of medical students' perspective on the teaching of medical statistics, two undergraduate medical students of the University of Bristol commented on their learning experiences and expectations. On one hand, the students identified their need and desire for statistical skills to substantiate the clinical decisions taken by doctors. On the other hand, they appeared to be averse to data analysis, preferring, instead, an emphasis on critical appraisal skills in medical research[5]. While the authors seemed to share the students' view, it is remarkable that skills in data analysis are essential requirements for substantiating clinical decisions and for critical appraisal in medical research. It is noteworthy, though, that the fact that the views of students converged with that of their lecturers buttresses the point that students' perspectives on the teaching and learning of statistics should always receive, at least, as much attention as their teachers'. Addressing the barriers to the teaching and learning of data analysis and critical appraisal skills in medical research would be desirable.

In Nigeria, each of two regulatory authorities – the Medical and Dental Council of Nigeria (MDCN) and the National Universities Commission (NUC) – has a guideline that outlines minimum requirements (which includes a curriculum in statistics) for the training of undergraduate medical students. From these guidelines, the statistics curricula are drawn by individual medical schools. Statistics is taught in both preclinical and clinical years by way of conventional lecturing in Nigerian medical schools. Often, clinical and public health examples are given during the lectures. Over the years, it has been observed that medical students in different medical schools complain of difficulty with the understanding of statistics. In this sense, understanding statistics means being able to appreciate basic statistical concepts and computations and being generally comfortable with the subject. As with many medical schools globally, the commonly known reasons for their difficulties, as perceived by medical students

themselves, usually fall into three major categories - subject, teacher and student factors. Early signs of consequent functional limitations in statistics applications show up when they conduct their small-group theses. Correction at this stage is usually a group process that has little room for addressing comprehension difficulties at individual level.

A global challenge is that a systematic data-based assessment of students' perceptions and understanding of statistics among medical students in universities is probably not widely practiced or published. While a lot continue to be written as reviews on the problems and recommendations on the teaching and learning of statistics[6-8], surveys on these issues are uncommon in the literature. Thus, research problems related to the teaching and learning of statistics and associated variables are often not quantified or unpublished; interventions, if any, may be suffering the same fate. Yet, data on these situations are required in learner-focused reviews of curricula and teaching and learning methods.

This study was embarked upon to examine the characteristics of medical students with respect to whether or not they have difficulty in understanding statistics and to explore the perceived causes of this difficulty among those who have this complaint. Studying students' perspectives on this subject would provide better insight into barriers to their understanding of statistics. This insight will, in turn, enable appropriate reviews of teaching and learning of statistics in the light of local circumstances and global trends. This survey contributes to filling the knowledge gap on this subject. Without such surveys as these and subsequent interventions, there is the risk of continuing the status quo where medical students and doctors have an unsatisfactory orientation and weak appreciation of statistics in their career – where statistics continues to be viewed mainly as a subject that is difficult to understand.

Methods

Study Population

The study population consisted of final year medical students of the University of Benin, Benin City, South-South Nigeria. The university is one of the first-generation universities in Nigeria and was ranked 1st among Nigerian universities in the 2009 world webometric ranking. The university's medical school is accredited by both the Medical and Dental Council of Nigeria and National Universities Commission. Entry requirements into the six-year programme of the medical school include credit grades in at least five subjects (including Mathematics) and a pass at the national Joint Matriculation Examination and the university's entrance examination; direct entry into the five-year programme requires a first degree in a related field in the sciences. The first of the six-year study is preparatory in which basic science courses are taught. This is followed by one-and-half and three-and-half years spent respectively in preclinical and clinical studies. In keeping with the regulations of the two accrediting bodies, medical students are taught statistics in different modules in the preclinical and clinical segments of their studies as parts of the Community Health curriculum. The statistics teachers have all studied biostatistics as a subspecialty in their Fellowship qualifications in public health, but do not have a separate degree in statistics. The number of students per class has been rising over the years to more than 200 in recent years, contrary to the MDCN upper limit regulation of 50 per class. The use of minimum national requirements and the engagement of external (peer) accreditation panels and examiners in all examinations in Nigerian medical schools confer some comparability among those accredited.

Study Design

The study design was a questionnaire-based descriptive cross-sectional survey. The questionnaire, which was designed to

contain open-ended and closed-ended questions, was standardised, structured, pre-coded, pre-tested and modified accordingly as an instrument to build a larger database on the students' basic biodata and on subjects that included difficulty in understanding statistics. The questionnaires were self-administered. The respondents who complained of this difficulty were further asked to indicate the perceived reasons - whether the subject itself was difficult (subject factor), whether it was not well taught (teacher factor), whether they considered themselves to be lazy or unserious about the subject (student factor), or whether other reasons existed.

Minimum Sample Size Calculation

In a recently published study in the UK, about 22% of respondents (medical students) indicated difficulty with understanding statistics (they disagreed with a statement that they felt comfortable with the basics of medical statistics)[9]. With 31% (additional 9%) of a similar variable projected for this study and a power of 90%, the minimum sample size, computed for a two-tailed one-sample binomial[10] was 244. A power ≥90% was desired.

Study Participants

The participants were drawn from two consecutive final year medical classes with 215 and 201 students respectively, totalling 416. Two classes were required in order to exceed the calculated minimum sample size, while making provision for those who may withhold or withdraw consent. Simultaneous data collection in both classes was made possible because of overlap in academic sessions. Both classes had completed the statistics curriculum at the time of data collection. The curriculum, teachers and teaching methods were the same. Two hundred and ninety three students consented and were enrolled for the study.

Ethical Considerations

Approval for the study was given by the Department of Community Health in the medical school. After explaining the purpose and nature of the study to the students, assurances of confidentiality were given and voluntary informed consent sought. A questionnaire was then administered to each student who thus gave consent. Participants' personal identifiers were disallowed.

Data Management

Data were collected from the retrieved questionnaires and transferred into a matrix format in the Statistical Package for Scientific Solutions version 16[11] from which simple frequency tables and cross-tables were constructed. X^2 tests were conducted and odds ratios computed to examine associations between difficulty in understanding statistics on one hand and some bio-data and self-judged interest in statistics on the other hand. Similar tests were further conducted to explore variables associated with the reasons proffered for the difficulty. Statistical significance was taken as at least one of the following: a p value of <0.05; an odds ratio of ≥ 2.00 or ≤ 0.50 or that includes these values within its 95% confidence interval. But such statistical significance was regarded with caution if the confidence interval of its odds ratio included the null value of 1.00.

Results

A total of 293 respondents out of 416 participated in the study, giving a response rate of 70.4%. The respondents did not markedly differ from the population in an identifiable systematic way, their male:female percentage ratios being 73.4:26.6 compared to 74.8:25.2 for the population. With this sample size and 29.7% of respondents expressing difficulty in understanding statistics, the power of this study was computed to be 98.8% (see rationale in methodology). Table 1 shows

that the measures of central tendency for the ages were similar, the mean age being 25.9 years. The majority of the respondents were males (73.4%) and single (96.9%).

Table 1: Demographic characteristics of respondents

Demographic characteristics (n=293)	Frequency (%) N=100.0%
Age in years	
21 – 25	155 (52.9)
26 – 30	128 (43.7)
31 – 35	6 (2.0)
36 – 40	4 (1.4)
Sex	
Male	215 (73.4)
Female	78 (26.6)
Marital status	
Single	284 (96.9)
Married	9 (3.1)

**Mean=25.9 years; mode=median=25.0 years; standard deviation=2.6 years (all computed from the ungrouped data)*

Forty three, (50.6%) of the 85 students with "fair" to "very low" self-rated interest in statistics compared to 44, (21.2%) of those with "good" to "excellent" self-rated interest said that they found it difficult to understand statistics. Of these variables, the strongest association with difficulty in understanding statistics was with self-rated interest in statistics; respondents whose interest in statistics ranged from "good" to "excellent" were less likely to find statistics difficult to understand than those whose interest ranged from "fair" to "very low" (X^2=25.04; p=0.00; odds ratio=3.82), and this association was statistically significant. Respondents who included public health as a likely future specialty and females were more likely to find statistics difficult to understand than their counterparts, but the associations were statistically weak (X^2=0.67; p=0.414; odds ratio=1.33 and X^2=1.23; p=0.267; odds ratio=1.37 respectively).

Table 2 shows that 87, (29.7%) of the surveyed medical students expressed difficulty in understanding statistics. The table also shows the characteristics of respondents with respect to whether or not they had difficulty in understanding statistics. Of the 78 female respondents, 27, (34.6%) compared to 60, (27.9%) of the 215 males said that they found it difficult to understand statistics. Those who had this complaint were 48, (31.0%) of the 155 respondents aged 21-25 years old and 39, (28.3%) of the 138 aged 25-40 years. Eighty, (29.4%) of the 272 who expressed an intention to undertake a postgraduate study compared to 7, (33.3%) of those without the intention said that they had difficulty understanding statistics. Of the 241 that included public health as a likely future specialty, 74, (30.7%) had this difficulty compared to 13, (25.0%) who did not; the pattern was similar with other specialties.

Among the 87 medical students who indicated that they found statistics difficult to understand (Table 3), the major reasons (from closed-ended and open-ended multiple-response questions) adduced for the difficulty were that the subject was not well taught, 58, (66.7% of respondents); self-judged laziness or unseriousness about statistics, 21, (24.1% of respondents); and a perception that the subject itself was difficult, 19, (21.8% of respondents). Other reasons were also given, 8, (9.2% of respondents). A total of 106 responses of reasons were given by the 87 respondents and the corresponding relative percentages of responses are depicted in Figure 1.

The major reasons had different patterns and strengths of association vis-à-vis other variables. Females were more likely than males to blame their difficulty in understanding statistics on their opinion that the subject was not well taught (p=0.09; odds

Table 2: Characteristics of respondents and difficulty in understanding statistics

Variables	N = 293	Finds it difficult to understand statistics (%)		X^2 (p)	Odds ratio (95% Confidence limits)
		Yes N=87 (29.7)	No N=206 (70.3)		
Sex	Females (n=78)	27 (34.6)	51 (65.4)	1.23 (0.27)	1.37 (0.76 - 2.47)
	Males (n=215)	60 (27.9)	155 (72.1)		
Age	21 – 25 years (n=155)	48 (31.0)	107 (69.0)	0.26 (0.61)	1.14 (0.67 - 1.94)
	26 – 40 years (n=138)	39 (28.3)	99 (71.7)		
Intends to do a post-graduate study	Yes (n=272)	80 (29.4)	192 (70.6)	0.14 (0.71)	0.83 (0.30 - 2.38)
	No (n=21)	7 (33.3)	14 (66.7)		
Likely future specialty options	Include Public Health (n=241)	74 (30.7)	167 (69.3)	0.67 (0.41)	1.33 (0.64 - 2.80)
	Exclude Public Health (n=52)	13 (25.0)	39 (75.0)		
Self-rated interest in statistics	"Fair" to "Very Low" (n=85)	43 (50.6)	42 (49.4)	25.04 (0.00)	3.82 (2.15 - 6.79)
	"Good" to "Excellent" (n=208)	44 (21.2)	164 (78.8)		

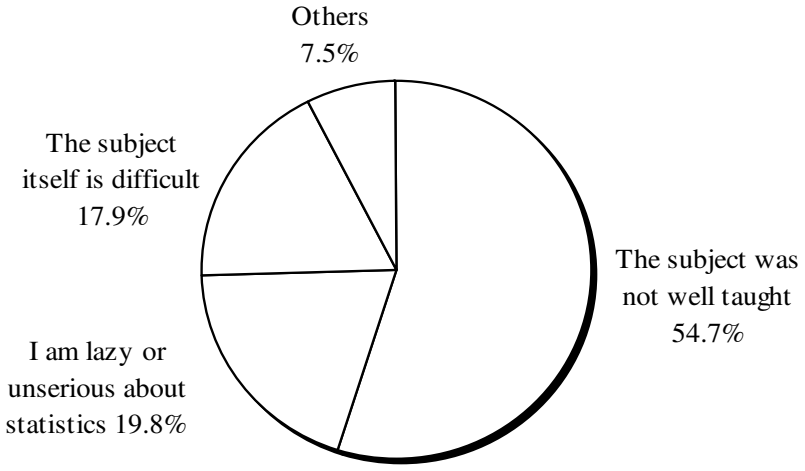

Figure 1: Relative percentages of reasons for finding it difficult to understand statistics. A total of 106 responses were given by 87 respondents. The percentages reflect the percentage of responses. "Others" refers to other reasons offered including: easily forgetting what was learnt in statistics; statistics textbooks not being available; and insufficient time being given to the teaching of statistics.

Table 3: Factors associated with reasons given for difficulty in understanding statistics (N = 87)

Variables	"The subject itself is difficult"		"The subject was not well taught"		"I am lazy or unserious about statistics"	
	Odds ratio (95% Confidence limits)	p	Odds ratio (95% Confidence limits)	P	Odds ratio (95% Confidence limits)	p
Age in years (21-25 versus 26-40)	1.15 (0.37 - 3.63)	0.79	0.65 (0.24 - 1.78)	0.36	0.67 (0.22 - 2.00)	0.42
Sex	1.92 (0.52 - 8.79)	0.43	0.34 (0.09 - 1.11)	0.09	2.27 (0.63 - 10.30)	0.27
Self-rated interest in statistics	0.90 (0.29 - 2.79)	0.84	0.37 (0.13 – 1.03)	0.03	9.84 (2.45 - 55.89)	0.00

ratio=0.34). Respondents whose interest in statistics ranged from "good" to "excellent" were also more likely to blame this difficulty on their opinion that statistics was not well taught (p=0.034; odds ratio=0.37) but less likely to blame this on self-judged laziness or unseriousness about statistics (p=0.00; odds ratio=9.84) than those whose interest ranged from "fair" to "very low".

Discussion

It is of concern that as many as 29.7% of final year medical students expressed difficulty in understanding statistics in this survey. This percentage may be compared to about 22% observed in a related survey of medical students in the UK[12]. The methodologies differ, but the data give an idea of the magnitude of the problem in different settings. This also applies to a related survey in South Africa which showed that 51.6% of third year allied health science students expressed difficulty in understanding an introductory course in statistics[13]. These and similar literature earlier discussed reinforce the suggestion that the problem is common. Ideally, however, virtually all medical students ought to understand statistics, even if individual proficiency in complex computations varies. This is because, as earlier explained, that understanding is needed in clinical practice and research. Furthermore, the number or percentage of final year medical students who had difficulty understanding statistics may reflect an early measure of threat to evidence-based medical practice and research among medical doctors from the onset of their career. As earlier noted, this is of concern especially in an era when evidence-based medicine is being promoted and statistics is seen as an important part of it[2,14].

The very strong association between the difficulty in understanding statistics and self-rated poor interest in the subject is not surprising; it stands to reason that poor interest in and poor understanding of statistics can be mutually facilitative.

Despite the lack of statistical significance, there may be career-related significance in the observation that a higher percentage of respondents who included public health as a likely future specialty option indicated difficulty in understanding statistics than

those who did not. The reverse fits better into expectation since biostatistics is a subspecialty in public health, and difficulty in understanding it would be expected to be a dissuading factor from the specialty; this study did not show such dissuasion. It is possible that there are motivating factors towards postgraduate public health study that are not overcome by difficulty in understanding statistics.

With more than half of the respondents who found statistics difficult indicating that the subject was not well taught, there are reasons for concern about the quality of teaching of statistics. The significant odds ratio between the variables "the subject was not well taught" and "the subject itself is difficult" suggests that the former influences the latter. But the idea that statistics is a difficult subject is not always easy to define. In a survey in Spain, the investigators observed that students' perception of the subject being difficult may be related to its mathematical features[15]. It is important to bear this in mind whenever interventions are being contemplated in addressing the problem. It should also be borne in mind that basic concepts need to be clearly understood as a prerequisite to understanding the computations. Thus, difficulty with the former is likely to lead to difficulty with the latter, and difficulty with the latter should be distinguished from difficulty with the former. Obviously, these constitute important challenges for curriculum planners and teachers of statistics.

It is surprising that a significantly higher proportion of females than males blamed their difficulty in understanding statistics not only on unsatisfactory teaching of the subject but also on their self-judgement of laziness or unseriousness about the subject. The fundamental determinants of these gender differences are unclear and difficult to explain or parallel without inferring a yet-unidentified gender-related factor. The finding would require more detailed enquiry, including the potential implications for career opportunities socially available and ergonomically suitable for females compared to males. It is also interesting that a strong association exists between a good-to-excellent interest in statistics and the view that the subject was not well taught. Thus, it is important to keep in mind that strong interest in statistics may remain intact despite its being unsatisfactorily taught and that it is not advisable to use either of these variables as a measure or estimate of the other. The virtual absence of a relationship between interest in statistics and the perception that the subject itself was difficult also suggests similar inferences. The strongest association in this study was between "fair-to-very low" interest in statistics and self-assessment of laziness or unseriousness about the subject. The finding appears logical, since very strong interest in an undertaking is usually consistent with seriousness with it. In a longitudinal prospective study examining learning styles of medical students in the UK, the researchers highlighted the fact that little real interest in a subject is associated with inappropriate motivations based on the fear of failure and a desire to complete the course[16]. Thus, the importance of poor interest in statistics goes beyond its association with the lack of seriousness in the subject or difficulty in understanding it.

Mention must be made here of the implications of having more than 200 medical students per class. It is quite reasonable to see this not only as a strong barrier to students' understanding of statistics and but also as a possible determinant of their perception that the subject is difficult or that it is not well taught.

Conclusion

This study shows that students perceive themselves, their teachers and perceived intrinsic difficulty of statistics as contributors to their difficulty in understanding the subject. Poor teaching of the subject was the main

reason given. Teaching and learning methods, including feedbacks from the students, need to be continuously evaluated. Self-directed learning approaches using easy-to-read statistics handbooks containing locally relevant examples would be useful. Problem-based learning methods[17-19] and dynamic softwares[20,21] are tested methods worth exploring. Substantial change in statistics teaching methods has been recommended in order to make the subject interesting[3]. Skilled medical statistics teachers should be engaged to teach the subject and to motivate students to learn it. Innovative approaches are also desirable.

Some statisticians have called for the teaching of statistical concepts only or mainly[22-24]**;** others have proposed analytical and computational contents in addition[25,26]. Viewed chronologically, the latter proposition is generally a more recent trend. The implication is that it is unlikely that restrictive curricula will be introduced in the hope of relieving difficulties in understanding medical statistics.

This study focused on the perspectives of students as regards difficulty in understanding statistics, rather than a detailed exploration of factors affecting their understanding of the subject. Thus, researchers are challenged to carry out further studies to broaden and deepen understanding of the challenges of and solutions to the teaching and learning of statistics.

It is hoped that with the application of the lessons learnt and recommendations made in this study, medical students will be better able to understand statistics and this would have positive implications for statistical applications in epidemiology, medical research, clinical practice and health management.

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