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EVALUATING BIOSTATISTICAL COMPETENCIES FOR MEDICAL STUDENT: THE BENEFITS OF A BIOSTATISTICS CENTRE DEVELOPMENT

Gita Sekar Prihanti

Faculty of Medicine University of Muhammadiyah Malang, Malaysia

Email: gitasekarprihanti@gmail.com

Abstract: Biostatistics represents a critical methodological skill for medical and health researchers, as statistical methods are increasingly a important part of medical and health research. The need for medical and health researchers to understand the process of statistical investigations and be able to plan statistical inquiry in medical and health related decisions justifies the ongoing integration of biostatistical training into medical institution educational settings. In this respect, Faculty of Medicine University of Muhammadiyah Malang (FMUMM) initiate to develop Biostatistics Center for Medical and Health Research (BCMHR) called MEARS (Medical and Health Research Statistics) for medical student. Thus there exists a need to investigate the difference of biostatistical competencies between medical students who collaborated with MEARS in their research and the others who not collaborated with. A cross sectional study was conducted on 221 medical student in FMUMM. The study subjects were distributed questionnaire which related to the knowledge regarding the practice of biostatistics among the study subjects. The result of medical students who collaborated with MEARS were significantly higher than those who not collaborated with (p = 0,0000). This indicating the benefits of a biostatistics centre development in medical faculty that can help medical student to develop a conceptual understanding of statistical ideas and their applications.

Keywords: biostatistics, Evidence-Based Medicine, research, methodological skill

Introduction

Students in medical and health-related fields as well as medical practitioners need to understand the issues related to the process of planning a scientific study, conducting the study, analysing data and reporting the findings. Medical doctors and health-related professionals are expected to be familiar with statistical thinking and understand the process of statistical investigations. Such familiarization requires a set of knowledge, skills and attitudes in not only analysing the impact of different treatments on patients, but also in applying statistical methods to improve the efficiency and effectiveness of medical and health services. (Bazargan, A., 2006)

Biostatistics represents a critical methodological skill for medical and health researchers, as statistical methods are increasingly a important part of medical and health research. (Enders, F., 2011) This competencies are emphasized in "Standard Kompetensi Dokter Indonesia" (SKDI). In this context, improved statistical knowledge and skills are urgently required. The need for medical and health researchers to understand the process of statistical investigations and be able to plan statistical inquiry in medical and health related decisions justifies the ongoing integration of biostatistical training into medical institution educational settings. (Batra, M., Mudir, G., Subbha, S. D., and Preshant, R., 2014)

Statistics in most literature is reported to be the cause of negative perception (Sami, Waqas, 2010). It is very difficult for a medical professional to understand the statistical concept. (Wadhwa, M., Pulkit, K., and Thanveer, K., 2015) Many physicians likely have increased difficulty today because more complicated statistical methods are being reported in the medical literature. (Windish, D.M., Stephen, J.H., and Michael, L.G., 2007) In this respect, Faculty of Medicine University of Muhammadiyah Malang (FMUMM) initiate to

develop Biostatistics Center for Medical and Health Research (BCMHR) called MEARS (Medical and Health Research Statistics) to help bridging the gap between medical and health sciences researchers and the understanding of biostatistics that could justify the disinterest of medical and health sciences students. We propose that an understanding of student's knowledge about biostatistics provides important elements in the development of enhanced MEARS role in educational strategies leading to better learning outcomes. The main objective of the current study was to assess the biostatistic knowledge of medical students who have been passed the Biostatistics and research methodology module. Furthermore there exists a need to investigate the difference of biostatistical competencies between medical students who collaborated with MEARS in their research and the others who not collaborated with.

Biostatistics and research methodology are taught together in year 2 at FM UMM as a short course of 7 weeks. The objectives of this course are (1) to enable medical students to understand the language and principles of biostatistics and research methodology (2) to teach students to design their own research projects, as well as to be able to critically read and understand scientific papers in medical journals. Thus it covers basic theoretical concepts about research methodology and biostatistics along with hands-on sessions of computer application software. The software includes Statistical Package for Social Sciences (SPSS). In this module emphasis was given to the understanding of concepts rather than carrying out routine statistical computations. The module is composed of formal lectures, computer lab sessions for hands-on exercise, directed self learning sessions, and problem based learning sessions. The sequence of the topics was carefully observed so that research methodology and biostatistics were taught in a parallel manner to enhance the knowledge of the two topics. Several lecture of biostatistics was followed by a hands-on session when applicable. The hands-on sessions are to train students to do basic statistical analyses using computer software. At the end of each week of the module the students undertake a directed self-learning session. The session is a scenario of a common problem that includes topics taught in that specific week, and based on that scenario the students have to answer a number of questions that integrate knowledge of research methodology and biostatistics. Thus, in the same question there may be research methodology and statistical concepts. Problem based learning sessions are meant to integrate other basic science knowledge in the context of research methodology and biostatics.

MEARS is an approach to provide participants with opportunities to understand more deeply than in biostatistic module about the process of formulating a research problem related to a medical and health-related education system; then designing an appropriate statistical investigation to solve the problem. Furthermore, in the MEARS process, participants are provided with opportunities to get hands-on experience more than in biostatistic module in carrying out statistical investigation, including statement of the problem, data collection, data analysis and interpretation of results.

Methods

Participant

The study targeted medical students at FMUMM who have research as final assigment. A total of 221 students, 124 (56.1%) who collaborated with MEARS and 97 (43.9%) who not collaborated with, were targeted in the study.

Instrument and procedure

To develop a questionnaire for this study, the researchers initially reviewed literature pertaining to knowledge of medical students in general, as well as biostatistics in particular. The study subjects were distributed questionnaire that consisted of 20 question which related to the knowledge regarding the practice of biostatistics among the study subjects.

To measure the knowledge of medical students a scale anchored by 1 = correct answer and 0 = wrong answer was developed. The researcher felt the use of such a scale would be relatively easy, and the interpretation of

the results straightforward. As a pilot, the first draft was given to a sample of 30 students to ensure face validity, to assess comprehension of the questionnaire, and to take into consideration any comments provided by the students. The resulting questionnaire had 20 items. Participants were also requested to provide information relating to their sex.

The aim of the study was explained to the students, and they were informed that participation was voluntary and the results would remain anonymous. The questionnaire was administered in Mei 2017 after completion of their research.

Statistical analyses

Data were entered and analyzed using SPSS version 21. Categorical variables were described by frequencies and percentage, and numerical variables with mean and standard deviation. Mann Whitney-test was used to compare the mean domain score for each independent variable. Significance level was set at 0.05.

Results

Table 1 shows the mean and standard deviation of the groups.

Table 1 Characteristics of study sample

Sex	Frequency	Percent
Male	60	27,1
Female	161	72,9

Table 2 Descriptive Test Results

Groups	N	Min	Max	SD
Collaborated with MEARS	124 (56.1%)	20	65	10,92016
Not collaborated with MEARS	97 (43.9%)	5	65	10,21488

The number of participants is 221 and divided into two groups, 124 (56.1%) who collaborated with MEARS and 97 (43.9%) who not collaborated with. First group who collaborated with MEARS doing their research analysis asisstances by the doctors and statistician in MEARS. Second group, analyse their research by them selves. Table 3 Shows the mean and the result from Mann-Whitney-test.

Table 3 Achievement Test Results

Groups	Mean	Mann-Whitney test
Collaborated with MEARS	47,26	p value=0.000
Not collaborated with MEARS	40,77	

The result of medical students who collaborated with MEARS were significantly higher than those who not collaborated with (p = 0,0000). This indicating the benefits of a biostatistics centre development in medical faculty that can help medical student to develop a conceptual understanding of statistical ideas and their

applications. An American study had shown that students' early participation in research activity improve their knowledge and attitude towards research. (Miles, S., Gill, M.P., Louise, S., Le, S., and Sam, J. L.,2010)

Suggestions for improving the research policy for medical student in FM UMM to include working in conjunction with MEARS and incorporating biostatistics into Evidence-based Medicine (EBM) practise and curriculum in order to increase biostatistic competencies. Students in Health sciences faculty and other medical and health professionals also could used MEARS assistances in their analysis to enhance quality of their research.

Medical and health sciences faculty have also become home to biostatistical programs. Here the focus is often on larger clinical trials and large healthcare database settings, different from the laboratory or clinical trials related studies that often predominated in medical centers. Biostatistics as a component of a medical center setting with or without Medical and health sciences faculty reflects a web of inter-related relationships and opportunities; supporting medical center clinical research, nursing related health outcomes research, basic science research and clinical trials oriented research. (Brimacombe, M. B.,2014) This provides many opportunities for real world application as an essential component of biostatistics training that can be offered by MEARS for medical and health professionals.

The biostatistics curriculum in particular is a mixture of theory and application, reflecting the reality of modeling biological and medical phenomenon. This includes the analysis of real world datasets, which makes biostatistics and statistics somewhat unique in the mathematical world. The fitting of theorized mathematical models to data and the use of the resulting expected properties of these models for inference is the central challenge of much biostatistics. This requires exposure on the part of the student to consulting and collaboration, often with clinicians and basic scientists. This type of mentoring is a challenge but necessary to produce a quality biostatistician/researcher at the end of their studies. (Brimacombe, M. B.,2014) Working in conjunction with a statistician can be necessary too. (Huet, Beverley Adams, M. S., and Chul Ahn, PhD, 2009)

The teaching of mathematics has a long and studied history. These tend to focus on basic concepts and mostly undergraduate education. The philosophy of teaching statistics reflects similar considerations and the evaluation of various approaches to the teaching of statistics is an ongoing effort with many problems. (Sami, Waqas, 2010) In this case, Biostatistics and research methodology module in FM UMM is not enough to make medical students mastery biostatistics. Short course durations may prohibit a comprehensive explanation of the topic and may limit the students' participation and/or understanding. Lack of practical exercises and the need for contextual data collection sessions could be the major challenges faced by the students. Actions directed toward these challenges may involve spreading the module over a longer time period with increased time allotted for the module. Introducing data collection sessions and reading experts from published medical articles will provide practical experience and emphasize the role of biostatistics in health care. Other learning methods may involve the use of video films and other visual aids to clarify and reinforce a variety of statistical concepts, motivate the study of a new topic, and to make statistics an interesting and exciting subject. (Daher, A. M., and Farzana, A., 2010) With the aim of contextualize learning about Biostatistics, some new teaching initiatives has been proposed such as problem-based learning (PBL) approach, which uses cases or problems as starting points to learn about a subject and also team-based learning (TBL) which combines individual and small-groups learning in an interesting way. (Paes, Angela Tavares, 2015) Furthermore, biostatistic teaching need to apply spiral curriculum with continuing education.

Such a mixture of theory, practice and applied contextual oriented courses allows the student to blend the designing of mathematical models and their underlying optimality properties with the fitting of these models to biomedical data. Interpreting the actual import of the fitted models is often a joint exercise with both biostatistician and clinician/researcher discussing the relevance and importance of the results. In the context of medical and health areas for example, the need to be fluent in various statistical methodologies and knowledgeable in applications to health related issues is important. (Brimacombe, M. B.,2014)

We recognize several limitations of this study. First, there are no evaluation through hands-on-approach to assess student biostatistic competencies. Second, there was no comparison to the biostatistic competencies of the student at another faculty or institute in a different year. Finally, there were no open comments requested for assessing student perception of MEARS assisstance. However, such open comments require different methods of qualitative analyses.

Conclusions

Biostatistics are important subjects in the medical curriculum and are closely related to health care. Medical students should be able to understand and interpret biostatistics so that they can use these techniques both during training and most importantly at postgraduate stage when they will be treating patients. Working in conjunction with MEARS and incorporating biostatistics into Evidence-based Medicine (EBM) practice and curriculum are suggested in order to increase biostatistic competencies. The goal of MEARS assisstances is to enhance the quality of the research especially in health areas not only for medical student but also for health professional, so it could improve the efficiency and effectiveness of medical and health services.

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Appendix 1 Questionnaire to assess knowledge towards biostatistics

1. A researcher calculates the percentage of female students in a sample from a university. Unit (part) of analysis in this research are:

A. female student

B. gender

C. university

D. percentage

E. A sample

2. The General Social Survey asks respondents to rate their health whether it is categorized as excellent, good, bad and very bad. The measurement levels of the above variables are:

A. nominal

B. Ordinal

C. Interval / ratio

D. Not one of the above

E. There is no answer because the information is not enough

3. In general, ordinal-scale variables are displayed visually with:

A. Cumulative percentage

B. Pie chart

C. Bar chart

D. tabulation

E. Subset

4. There is data as follows: 0, 3, 1, 5, 1. The average obtained is:

A. 1

B. 2

C. 3

D. 5

E. Not one of the answers above

5. Based on the table below:

Tabel 1. Legalities of Cannabis by Sex (in%)

Ganja Opinion	Sex	
	Male	Female
Must Legal	38	30
Not Must Legal	62	70
Total (N)	100	100

The independent variables are:

A. Opinion on the legality of marijuana

B. man

C. gender

D. Must be legal

E. Not one of the answers above

6. Correlation is:

A. The test used to find the influence between the response variable and free

B. The test used to find the relationship between the variables with the output of correlation coefficient

C. The test used to find relationships between variables with comparison output or difference

D. The test used to find the relationship between numerical variables with numerical, numerical with categorical and categorical with categorical

E. The answers b and d are correct

7. The correlation range is:

A. -1

B. 1

C. 0 to 1

D. -1 to 1

E. Not one of the answers above

8. The relationship between smoking behavior (yes and no) with coronary heart disease (CHD) (yes and no) from 2 different sample groups including test:

A. Comparative categorical pairs

B. Pairwise numerical comparability

C. Comparative categorical unpaired

D. Comparative numerical unpaired

E. Not one of the answers above

9. Comparison of TNF alpha levels with atopic dermatitis (yes and no) from 2 different sample groups including test:

A. Comparative categorical pairs

B. Pairwise numerical comparability

C. Comparative categorical unpaired

D. Comparative numerical unpaired

E. Not one of the answers above

10. A total of 10 patients observed their HDL levels in weeks I, week II and week III to see if there was a decrease or increase. Estimated test that can be used is:

A. Comparative categorical pairs with 3 repetitions

B. Numerical comparative paired 3 times repetition

C. Comparative categorical unpaired 3 repetitions

D. Comparative numeric unpaired 3 times repetition

E. Not one of the answers above

11. The statistical tests used for the statement "patients who have high cholesterol will suffer more from hypertension" are:

A. Test t

B. Regression Analysis

C. Pearson Correlation

D. ANOVA

E. Not one of the answers above

12. Assume that two variables have a positive relationship. Which of the following regression equations describes the relationship:

A. $Y = 3.2 + 2.4 X$

B. $Y = -0.45 - 4.1 X$

C. $Y = -1.2 X$

D. $Y = -3.4 - 1.2 X$

E. Y = 0.54

13. There is a regression equation: Y = 3.21 - 6.57 X. The meaning of the equation is:

A. If 1 unit X increases then Y increases by 3.21

B. If 1 unit X increases then Y increases by 6.57

C. If 1 unit X increases then Y decreases by 3.21

D. If 1 unit X increases then Y decreases by 6.57

E. Not one of the answers above

14. The correlation value obtained from a researcher is -0.5. Which of the following statements is true?

A. The variable X describes 25% of the variable diversity of Y

B. The variable X describes -25% of the variable diversity of Y

C. The variable X describes 50% of the variable diversity of Y

D. The variable X describes -50% of the variable diversity of Y

E. The variable X describes -0.5 of the variable diversity of Y

15. One of the uses of regression analysis is:

A. To determine if change X causes a change of Y

B. To estimate Y changes in 1 unit of change X

C. Answers a and b are true

D. To see X and Y relationships

E. Not from one of the answers above

16. Chi Square test is used for:

A. Comparative numerical test paired table 2x2

B. Uncompared numerical comparative test table (> 2) x (> 2)

C. The categorical comparative test is not paired 2x2 table

D. Comparative categorical test pairwise table (> 2) x (> 2)

E. The answers c and d are correct

17. Test alternative chi square for table (> 2) x (> 2) if the condition is not fulfilled is:

A. Merging cells

B. Kruskal Wallis

C. Mann-Whitney

D. Answers a and b are true

E. All answers are correct

18. What is the minimum sample size recommended for experimental research?

A. <10

B. 10-20

C. > 20

D. Not one of the answers above.

19. A researcher wanted to know the relationship between somatic complaint score and social problem score. After the normality test obtained results that the data is not normal. What test should be used?

A. Pearson Correlation

B. Spearman Correlation

C. Chi Square

D. Contingency coefficients

E. Not one of the answers above

20. You want to know the relationship between smoking behavior (smokers and not) with the fertility status of a man (infertile and fertile). The desired output is the proportion ratio. What tests should be used?

A. Chi Square test if conditions are met

B. Fisher test if conditions are not met

C. Spearman Correlation

D. Contingency coefficient

E. Answers a and b are true