Formative Evaluation and Learning Achievement in Epidemiology for Preclinical Medical Students

Varisara Luvira, Sauwanan Bumrerraj, Sompong Srisaenpang

Department of Community Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand

Abstract

Background: Teaching epidemiology and biostatistics is a challenge for medical teachers. Formative evaluation has been shown to improve the learning outcomes in various medical subjects. However, the effectiveness of formative evaluation in the subject of epidemiology has yet to be clearly demonstrated. Objective: The aim of this study is to investigate the association between formative evaluation and learning outcomes of medical students. Materials and Methods: We retrospectively reviewed the prospectively collected learning data of 266 third-year medical students who were enrolled in an epidemiology course in 2016. All learning data and outcomes were analyzed. Results: Nearly all students (97.4%) attended the formative evaluation. Learning outcomes were deemed unsatisfactory in 9.8% of cases. Multivariate analysis revealed that gender, the students' medical training program, laboratory attendance, and the amount of calculation students do during the formative examination were factors that were associated with learning outcomes. Conclusion: The formative evaluation was effective at improving learning outcomes in the subject of epidemiology. The parameters indicated that the attention of the medical students, such as laboratory attendance, and the amount of calculation done during the formative examination, were associated with learning outcomes.

Keywords: Biostatistics, epidemiology, formative evaluation, medical education, medical student

Introduction

Epidemiology and biostatistics, which mostly concern quantitative research and research methodology,[1] are the two of the most important subjects that medical students take.[2,3] However, some medical students do not place importance on these subjects[4] because they see them as being unrelated to the skills they will need in future medical practice. It is difficult for students to keep up, as they tend to focus their efforts on clinical courses at the expense of their epidemiology and biostatistics courses.[5,6] This makes teaching these subjects challenging for educators in medical schools.

In the past, summative evaluation was the only way to evaluate students’ knowledge and the comprehension in these subjects. This evaluation was usually performed once after completion of the epidemiology course, making it difficult to identify and offer assistance to students having problems in the subject. Formative evaluation performed repeatedly throughout the course offers qualitative feedback regarding medical students’ knowledge.

Moreover, it provides a chance to improve prospective teaching methods.[7]

There is evidence that formative evaluation can improve the learning outcomes of medical students.[8,9] At our center, a method of formative evaluation has been adapted to improve students’ learning outcomes over the course of 3 years. However, the effectiveness of formative evaluation in the subject epidemiology has yet to be clearly demonstrated.

We, thus, investigated the association between formative evaluation and medical students’ learning outcomes to achieve a better understanding of the effectiveness of this tool in teaching epidemiology.
Materials and Methods

Study design

This retrospective study ran between July 2015 and May 2016. We retrospectively reviewed the prospectively collected learning data of 266 3rd-year medical students at Khon Kaen University’s Faculty of Medicine. The learning data included number of laboratories attended, formative evaluation scores, final examination scores, and overall grades in the course.

The 3rd-year epidemiology course at our center takes 5 months to complete. The course examined in this study ran from November 2016 to March 2017. The students were also concurrently enrolled in courses in other subjects (i.e., correlated basic medical science and clinical science, introduction to clinical science, and English for medical sciences). During the course, the medical students attended 30 epidemiology lectures and 11 laboratories. The formative evaluation was 3 h long, consisting of 25 multiple choice questions (MCQ), and was performed in the middle of the course. After 20 min had passed from the beginning of the examination, students were allowed to return their answer sheets. All students were given a choice as to whether or not they would attend the evaluation. The final examination consisted of 90 MCQs. The final grades were classified into eight tiers, namely, A, B+, B, C+, C, D+, D, and F, according to a weighted T score based on laboratory performance and final examination score.

Ethical consideration

This study was reviewed and exempted by the Institutional Review Board, Office of Human Research Ethics, Khon Kaen University (HE601147).

Outcome variables

The primary outcome of this study was the learning achievement, which was classified as either “satisfactory” or “unsatisfactory.” The latter was defined as a grade of C or below. We also examined a variety of factors to determine whether or not they affected the learning achievement outcome, including gender, medical training program, attendance of epidemiology laboratories, attendance of the formative evaluation, use of note paper for calculation during the formative evaluation, and time spent taking the formative evaluation.

Statistical analysis

The descriptive data are presented as median (min: Max), or as number and percentage. Pearson correlation was used to determine the association between two numerical variables. Univariate and multivariate analyses were conducted using the logistic regression model to evaluate potential confounders. A value of $P < 0.05$ was considered to be statistically significant. All statistical analyses were performed using STATA version 10 (StataCorp LLC, College Station, TX, USA).

Results

Demographic data

There were 266 3rd-year medical students enrolled in the 2016 school year. The male-to-female ratio was 1:1. Most of the students (60.2%) were in the ordinary program. The remaining students were in the Collaborative Project to Increase Production of Rural Doctors (CIPIRD) and One District One Doctor program (ODOD). Ninety-five percent of the students attended all of the laboratories.

Nearly all students (97.4%) attended the formative evaluation. Only 11.7% of those who attended finished the evaluation and returned the answer sheet at 20 min of the examination. During the formative examination, most of the students (54.9%) used more than 50% of the note paper for calculation, whereas only 6.8% did not have any written calculations.

Learning outcomes

The numbers of the students who received grades of A, B+, B, C+, C, D+, D, and F were 27 (10.2%), 72 (27.1%), 88 (33.1%), 53 (19.9%), 19 (7.1%), 6 (2.3%), and 1 (0.4%), respectively. According to our definition, the proportion of students with unsatisfactory learning outcomes was 9.8%.

We carried out a univariate analysis of six variables to determine what factors affected students’ learning outcomes. We found several significant prognostic factors for satisfactory learning outcomes including gender, laboratory attendance, formative evaluation attendance, and amount of calculation during the formative examination (Table 1). The significant prognostic factors determined by univariate analysis were then further analyzed via multivariate analysis. This analysis revealed that gender, medical training program, laboratory attendance, and amount of calculation during the formative examination were significant prognostic factors (Table 2). We also determined the relationship between formative examination and final examination scores using Pearson’s correlation and found no correlation (corr. =0.512) between these scores.

Discussion

This study showed that medical students’ learning achievement could be accurately predicted using various parameters, especially those examined in the formative evaluation. Although students’ scores on the formative evaluation were not correlated with those on the final examination, aspects of the formative evaluation process, itself, were able to predict learning outcomes.

Owing to the difficulty of epidemiology, students who spend more time learning the subject and who have more attention tend to have the better learning outcomes. We found that the higher laboratory attendance and more written calculation during the formative evaluation were significantly associated with better learning outcomes. Both of these parameters indicate the attention to epidemiology of the medical students. The evidence suggests that affective entry characteristics are associated with learning outcomes. Moreover, the more time that students spend in the laboratory, the more opportunities they have to practice biostatistics and epidemiology, further increasing their attention. This is the first study showing...
At our center, there are several programs for medical students. They are categorized into two main programs as follows: the ordinary program and the project to increase the production of rural doctors. The latter is subdivided into ODOD and CPIRD. The medical students in these two programs will work at a rural hospital after they graduate from medical school. This means that these students tend not to concern themselves with epidemiology, instead focusing on subjects that they see as relating to the skills they will need in their future practice. This may explain why the medical students in the ordinary program had better learning outcomes in this subject.

There is significant evidence suggesting that attention is critical to successful learning in any subject. Planning of the formative evaluation should not focus only on the score but also on parameters that indicate the attention of the students. In the same way, assessment of attention should not rely solely on the formative evaluation but also on all activities during the first half of the course such as laboratory attendance. This will help identify students who are having difficulties so that educators can focus on them for the remaining duration of the course.

To the best of our knowledge, this is the 1st study to show the benefit of formative evaluation for medical students studying epidemiology. The strengths of this study include the following: (i) it was conducted at a medical school that has a large number of students and (ii) all data were collected prospectively. However, some limitations should be considered. First, the curricula of medical programs in various countries differ. Second, because of the way Thailand’s education system is structured, medical students in Thailand are usually younger than those in other countries. Therefore, the findings of the current study should be adapted accordingly if it is to be applied in other countries.

**Conclusion**

This study demonstrated the effectiveness of the formative evaluation in the subject of epidemiology. Moreover, we found that parameters indicating medical students’ attention were associated with learning outcomes. We suggest that these
parameters should be assessed in both the formative evaluation and throughout the course.

**Financial support and sponsorship**
Nil.

**Conflicts of interest**
There are no conflicts of interest.

**REFERENCES**
1. Center for Medical Competency Assessment and Accreditation (CMA). Available from: https://www.cmathai.org/. [Last accessed on 2017 Oct 01].
2. Ercan I, Ozkaya G, Ocakoglu G, Yazici B, Sezer A, Ediz B, et al. Determining biostatistics knowledge of students and physicians in medical school. InterStat 2008;3:1-17.
3. Vasudevan S. Biostatistics teaching to the undergraduate medical students through research-oriented medical education posting program in a teaching medical institute in coastal area of Pondicherry: An experience of a biostatistician. J Pharm Bioallied Sci 2016;8:78-9.
4. Ernster VL. On the teaching of epidemiology to medical students. Am J Epidemiol 1979;109:617-8.
5. Novick LF, Greene C, Vogt RL. Teaching medical students epidemiology: Utilizing a state health department. Public Health Rep 1985;100:401-5.
6. Appleton DR. What statistics should we teach medical undergraduates and graduates? Stat Med 1990;9:1013-21.
7. Spolsky B, Hult FM, editors. The Handbook of Educational Linguistics. Oxford, UK: Blackwell Publishing Ltd.; 2007. p. 469-82. Available from: http://doi.wiley.com/10.1111/b. 9781405154109.2007.00034.x. [Last accessed on 2017 Oct 01].
8. Abu-Zaid A. Formative assessments in medical education: A medical graduate’s perspective. Perspect Med Educ 2013;2:358-9.
9. McNulty JA, Espiritu BR, Hoyt AE, Ensminger DC, Chandrasekhar AJ. Associations between formative practice quizzes and summative examination outcomes in a medical anatomy course. Anat Sci Educ 2015;8:37-44.
10. Bloom BS. Human Characteristics and School Learning. New York: McGraw-Hill; 1976.
11. Daher AM, Amin F. Assessing the perceptions of a biostatistics and epidemiology module: Views of year 2 medical students from a Malaysian university. A cross-sectional survey. BMC Med Educ 2010;10:34.
12. History of CPIRD. Available from: http://www.cpird.in.th/index.php/about_cpird/history.html?id=95. [Last accessed on 2017 Oct 01].
13. Nissen MJ, Bullemer P. Attentional requirements of learning: Evidence from performance measures. Cogsci Psychol 1987;19:1-32.
14. Posner MI, Petersen SE. The attention system of the human brain. Annu Rev Neurosci 1990;13:25-42.
15. Ashby FG, Maddox WT. Human category learning. Annu Rev Psychol 2005;56:149-78.