Original Article

Logistic Regression Analysis to Predict Medical Licensing Examination of Thailand (MLET) Step1 Success or Failure

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Abstract

Introduction: The aim of this paper was to assess factors that predict students' performance in the Medical Licensing Examination of Thailand (MLET) Step1 examination. The hypothesis was that demographic factors and academic records would predict the students' performance in the Step1 Licensing Examination. Materials and Methods: A logistic regression analysis of demographic factors (age, sex and residence) and academic records [high school grade point average (GPA), National University Entrance Examination Score and GPAs of the pre-clinical years] with the MLET Step1 outcome was accomplished using the data of 117 third-year Ramathibodi medical students. Results: Twenty-three (19.7%) students failed the MLET Step1 examination. Stepwise logistic regression analysis showed that the significant predictors of MLET Step1 success/failure were residence background and GPAs of the second and third pre-clinical years. For students whose sophomore and third-year GPAs increased by an average of 1 point, the odds of passing the MLET Step1 examination increased by a factor of 16.3 and 12.8 respectively. The minimum GPAs for students from urban and rural backgrounds to pass the examination were estimated from the equation (2.35 vs 2.65 from 4.00 scale). Conclusions: Students from rural backgrounds and/or low-grade point averages in their second and third pre-clinical years of medical school are at risk of failing the MLET Step1 examination. They should be given intensive tutorials during the second and third pre-clinical years.

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Key words: Basic science, National test, Prediction

Introduction

According to the new regulations established in 2002, the Thai Medical Council now requires that all Thai medical students who matriculated as of 2003 pass the Medical Licensing Examination of the Thai Medical Council in order to be a licensed physician in Thailand. There are 3 steps to the examination. Step 1, called comprehensive basic medical science, centres on the subjects covered in the pre-clinical curriculum (anatomy, biochemistry, epidemiology, microbiology, pathology, pharmacology, and physiology). Thai medical students who matriculated in 2003 were the first batch to sit for the Step1 examination in their third academic year in 2006. The Step 2 examination tests the knowledge on clinical science. The Step 3 examination includes OSCE (objective structural clinical examination) and MEQ (modified essay questions). The Step 2 and Step 3 examinations will be held in 2007 and 2008 respectively.

The Faculty of Medicine, Ramathibodi Hospital delivers a 6-year medical curriculum. High-school graduates qualify for admission by the National University Entrance Examination (NUEE) and an interview process. The first 3-year (pre-clinical) courses include several disciplines relating to basic medical science. Community medicine and introduction to clinical medicine are introduced during the second semester of the third academic year. The students sit for the Medical Licensing Examination of Thailand (MLET) Step1 at the end of their third year.

This report describes the Ramathibodi medical students' results in their first attempt sitting for the MLET Step1 examination and factors predicting success or failure.

Materials and Methods

MLET Step 1 tests the medical students' knowledge in a problem-solving framework using clinical vignettes. It is a 1-day, 6-hour, multiple-choice examination (MCQ) divided

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into 2 blocks (each block containing 150 questions). The examination items are created in accordance with the Thai Medical Council's Table of Specification on Basic Science Subjects, similar to that of the United States Medical Licensing Examination (USMLE) Step1. Subjects include anatomy, behavioural science, biochemistry, epidemiology, immunology, microbiology, pathology, pharmacology and physiology. The examination items are developed by all 13 Thai medical school faculties and pooled at the meeting of the Thai Medical Council Committee. The committee finally selects the 300 questions for the examination and establishes the minimum passing score based on the examination results.

One hundred and seventeen third-year Ramathibodi medical students (male:female = 53:64) first attempted the MLET Step 1 in 2006. Objective data on demographic factors (age, gender and residence), high school grade point average (GPA), National University Entrance Examination (NUEE) score, and GPAs at year 1, year 2 and year 3 in medical school were retrieved from the Medical Education Unit.

The system of grading for GPA is as follows:

A = grade 4.00, B+ = grade 3.50, B = grade 3.00, C+ = grade 2.50,
C = grade 2.00, D+ = grade 1.50, D = grade 1.00, F = grade 0.00

The GPA is averaged from each clerkship grades (weighted with the number of credits of the clerkship). Each clerkship grade is obtained by multiplying the grade with the number of credits of that clerkship.

The result of the Medical Licensing Examination Step1 was obtained from the Thai Medical Council after the examination. Logistic regression analysis was performed with SPSS software.

The logistic regression model was constructed using the forward selection procedure in an attempt to discover the predictors of MLET Step1 success and failure. At each step, the explanatory variable with the smallest significance level for the Wald statistic was entered into the model. The Wald statistics is a method in logistic regression to test the null hypothesis (H_0) that the associate parameter estimates are not significantly different from 0. The default entry criterion for the explanatory variables was a *P* value of 0.05. The Wald statistics for all variables in the model were examined and the explanatory variable with the largest *P* value of the Wald statistic was removed from the model. The default removal criterion was $P = 0.10$. If no explanatory variables met the removal criterion, the next eligible variable was entered into the model. The iteration process for selecting explanatory variables continued until no additional variables met the entry or removal criterion.

Table 1. Predictors of Pass/Fail Groups

Predictors	Pass group	Fail group
Age (mean ± SD)	21.37 ± 0.73	21.61 ± 0.66
Male (%)	79.25	20.75
Female (%)	81.25	18.75
Residence (Bangkok)	89.19	10.81
Residence (Rural)	76.25	23.75
Entrance examination score (mean ± SD)	454.01 ± 13.64	440.72 ± 14.23
GPA year-2 (<2.5 from 4.00 scale)	16.67	83.33
GPA year-3 (<2.5 from 4.00 scale)	41.38	58.62

GPA: grade point average; SD: standard deviation

Results

The passing score set by the Thai Medical Council, based on the minimum passing level and the standard error of measurement, was 54.33%. Ninety-four out of 117 (80.3%) Ramathibodi medical students passed the examination.

Predictors of the pass/fail groups are shown in Table 1. The passing rate was slightly higher in the younger age group, female sex and urban residence. Most of the students with year-2 GPA of <2.5 failed the examination.

The logistic regression method yielded the following logistic regression equation to predict the MLET Step1 passing status: the estimated probability of passing the MLET Step1 was:

$$P(X) = e^z / (1+ e^z)$$

where e is the base of the natural logarithm, approximately 2.718, and

$$Z = -14.16 + 1.66*\text{Residence} + 2.79*\text{GPAyr2} + 2.55*\text{GPAyr3}$$

Based on the contribution from each of the explanatory variables, the estimated probability could be derived from this equation for an individual student. If the calculated probability was ≥0.5, a student was categorised in the passing group of the MLET Step1. On the contrary, those with a probability of <0.5 would be classified in the fail group. The prediction accuracy of this equation was as follows: 93.5% for the pass group, 52.2% for the fail group and 85.5% for the combined pass and fail group (Table 2). The receiver operating curves is shown in Figure 1. The performance of the model was relatively good with an area under curve (AUC) of 0.85. The logistic enter (all variables) analysis serving as a benchmark for the stepwise model yielded similar result.

The minimum second- and third-year GPAs for students from urban and rural backgrounds to pass the examination (calculated from the equation) were 2.35 and 2.65 respectively.

Discussion

We were dissatisfied with the performance of our medical students in their first attempt sitting for the MLET Step1.

Table 2. Logistic Regression Model for Predicting MLET Step 1 Pass Status

Variables in the equation	Logistic regression coefficient (β)	SE (β)	OR (e^{β})	95% CI of OR
Residence (Bangkok)	1.656*	0.815	5.237	1.06-25.86
GPA-year 2	2.791*	1.072	16.293	1.99-133.24
GPA-year 3	2.553*	1.040	12.847	1.62-98.72
Constant	-14.162*	3.381	0.000	

95% CI: 95% confidence interval; GPA: grade point average; MLET: Medical Licensing Examination of Thailand; OR: odds ratio; SE: standard error
*P <0.01

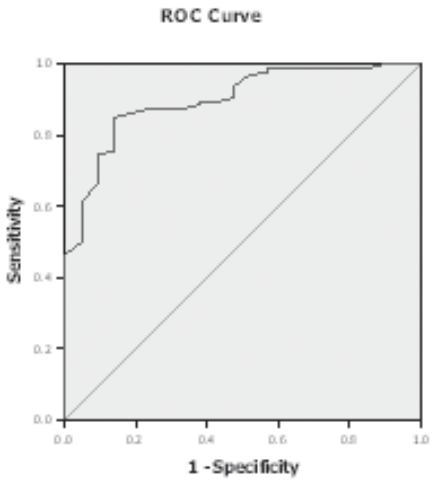

Fig. 1. Receiver operating curve (ROC).

The failure rate of almost 20% prompted us to search for factors influencing success and failure in the examination. The objective data collected for demographic characteristics were only age, gender and residence. Since all our students were middle-class and not in financial difficulties, we did not include socioeconomic status in our study.

Our univariate analysis showed a trend of negative correlation between age and success or failure in the examination. However, there was no statistical significance. Our medical students' ages were very close, ranging from 20 to 23 years, which probably explained the non-significant difference in their performance. The association of age with the performance on medical licensing examinations has not been extensively studied. Ramsbottom-Lucier et al[1] reported no differences on the NBME Part I performance by age. Of particular note was the matriculation ages of their students, which ranged from less than 23 to 28 years or older. They also noted a modest gender difference on the NBME I result, with males performing better than females. In the new era of USMLE, Case et al[2] also reported that males outperformed females in the Step1 examination. However, we could not replicate their findings. The pass rates of our male and female students were 79.2% and 81.3% respectively, which were not statistically significant. Haist et al[3] explored the interaction between gender and age. They found a significant gender effect on age in predicting academic performance. We did not study this interaction due to the narrow age range of our students.

The only demographic factor found to significantly predict the MLET Step1 performance was the students' residences. According to the equation, the odds of students passing the MLET Step1 increased by a factor of 5.2 if they were from the capital as compared to those living in rural areas. This finding was consistent with a Croatian study carried out by Polasek and Kolcic[4] where students from urbanised backgrounds outperformed those from rural backgrounds. This similarity could be explained by the nature of developing countries, where access to knowledge and information is markedly different in urban and remote areas. The higher standard of teaching and extra lessons in highly urbanised high schools may have enhanced the students' critical thinking skills, resulting in better performance in examinations.

GPAs and scores have been extensively investigated in relation to examination outcome. Veloski et al[5] found that MCAT scores and science GPA were good predictors of USMLE Step1 performance. Basco et al[6] and Kasuya et al[7] reported similar results. Our study included high school GPA, National University Entrance Examination (the NUEE equivalent to MCAT) score, and undergraduate GPAs. It was evident that high school GPA was not correlated with MLET Step1 performance since marking and grading systems in our high schools were still not standardised. NUEE score was not a significant predictor because the subjects tested were purely science subjects, e.g., chemistry, physics, biology and mathematics. Again, the freshmen's GPA could not predict examination performance for the same reason as it is derived purely from the science subjects. Only the sophomore and third-year GPAs significantly predicted MLET Step1 results. The obvious reason was that the subjects taught in the second and third years were mainly basic medical sciences compatible with the Table of Specification of the examination. When sophomore and third-year GPAs increased by an average of 1 point, the odds of passing the MLET Step1 increased by factors of 16.3 and 12.8 respectively. The wide confidence interval is due to the rather small sample size. These values indicate that the effect was very significant. This implies that there should be prompt intervention or tutorials of students with low GPAs in their second year. Delaying such intervention until the outcome of third-year GPA may be too late and result in a high possibility of failing the MLET Step 1 examination.

In conclusion, our study found that Thai students from rural backgrounds and low sophomore GPA were at risk of performing poorly on the MLET Step1 and required intensive academic supervision to prevent unsatisfactory outcomes in the medical licensing examination.

REFERENCES

1. Ramsbottom-Lucier M, Johnson MM, Elam CL. Age and gender differences in students' preadmission qualifications and medical school performances. Acad Med 1995;70:236-9.
2. Case SM, Swanson DB, Ripkey DR, Ripkey DR, Bowles LT, Melnick DE. Performance of the class of 1994 in the new era of USMLE. Acad Med 1995;71(Suppl):S91-S93.
3. Haist SA, Wilson JF, Elam CL, Blue AV, Fosson SE. The effect of gender and age on medical school performance: an important interaction. Adv Health Sci Educ Theory Pract 2000;5:197-205.
4. Polasek O, Kolcic I. Academic performance and scientific involvement of final-year medical students coming from urban and rural backgrounds. Rural Remote Health 2006;6:530.
5. Veloski JJ, Callahan CA, Xu G, Hojat M, Nash DB. Prediction of students' performances on licensing examinations using age, race, sex, undergraduate GPA, and MCAT scores. Acad Med 2000;75(Suppl): S28-S30.
6. Basco WT Jr, Way DP, Gilbert GE, Hudson A. Undergraduate institutional MCAT scores as predictors of USMLE step1 performance. Acad Med 2002;77(Suppl):S13-S16.
7. Kasuya RT, Naguwa GS, Guerrero AP, Hishinuma ES, Lindberg MA, Judd NK. USMLE performances in a predominantly Asian and Pacific Islander population of medical students in a problem-based learning curriculum. Acad Med 2003;78:483-90.