Estimating Students' Academic Success in the Preclinical Stage of Undergraduate Medical Education Using the Admission Test Approach

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Abstract

Introduction: Medical schools face substantial challenges in objectively selecting the best applicants, and the admission process can impact medical students' academic performance. This study aimed to estimate the students' academic success in the preclinical stage of undergraduate medical education using admission tests.

Methods: This cross-sectional study was conducted on 1,193 students' records from the 2014 to 2019 cohorts. The students' admission data comprised the cohort, sex, admission track, psychological test, and academic tests. The academic success was based on the student's end-year academic evaluation. Data were analyzed using contingency and Kendall's tau b tests with IBM® SPSS® Statistics version 16.0 for Windows.

Results: Most of the 1,193 preclinical medical students' records included in the study were females (68.1%), from the regular admission track (78.5%), from the considered psychology test category (52.8%), and had an academic admission test of less than or equal to the median. (51.6%). Most students (89.7%) met all the academic requirements to pass the end-year evaluation. The bivariate analyses showed significant correlations between academic success and cohort (P<0.001), psychology test (P=0.005), and academic test (P<0.001). The analyses showed no significant correlation between academic success and sex (P=0.324), and admission track (P=0.128).

Conclusions: This study indicated that cohort and psychology tests could estimate the student's academic success at the preclinical stage of undergraduate medical education. The admission criteria related to the academic tests during the admission process should be re-evaluated, so that the academic tests could select the best students among the applicants.

Keywords: Academic success, College admission test, Medical education

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Introduction

As of 2023, Indonesia had 159,977 medical doctors to serve 278.69 million populations. The increase in population growth in Indonesia led to the need for more medical doctors to meet the doctor-to-population ratio of 1:1,000 (1). The shortage of medical doctors made the Indonesian government support establishing new medical schools to fulfill the need. As of 2022, there were 92 medical schools in Indonesia, of which 40% were public medical schools, and 60% were private medical schools. New medical schools are mushrooming in the future. Accordingly, medical schools face significant encounters in objectively choosing the best applicants, while the admission process can impact medical students' academic performance (2).

The admission or selection processes to enter medical schools are the gatekeepers of the medical profession. Therefore, it is fundamental to admit the right applicants to maintain the healthcare standards. Medical schools worldwide use variability criteria in choosing potential students, including prior academic performance, academic admission tests, aptitude tests, personal statements, and interviews (3). Admission to public universities in Indonesia, including medical school, is conducted once a year nationally and regulated by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia. The admission consists of two tracks: the invitation (non-test) track based on the selection of the high school academic achievement and the written test track based on the academic ability and science subject tests. Moreover, public universities may add local selection methods at the preference of the university. Private universities in Indonesia may develop their admission tests, and most also have two tracks similar to public universities, but with different time frames. All medical schools in Indonesia admit high school graduates (4).

The Directorate General of Higher Education, Ministry of Education and Culture of the Republic of Indonesia issued a letter (no. 576/E/HK/2013) on 25 June 2013 concerning the quota for new student admissions to medical faculties or study programs. The letter explained that the quota was based on the medical school or accreditation of the study program and the results of the Indonesian physicians' competency test. The competency test was the national exit exam in Indonesian medical education. On 22 June 2017, the Ministry of Research, Technology, and Higher Education of the Republic of Indonesia issued regulation no. 43/2017, concerning the national quota and new student admission selection for medical and dental study programs. The new regulation required that the quota should be based on accreditation, the results of the Indonesian physicians' competency test, the networking of the teaching hospital, and the ratio of lecturers and students.

The undergraduate medical education in our private medical school was established in 1987 and consisted of two study programs: preclinical and clinical stages. The preclinical stage can be completed in seven semesters, while the clinical stage can be completed in four semesters (5). Since its inception, the undergraduate medical education at our university accepts high school graduates from natural science majors only through one of four admission tracks: regular, invitation, *Bidik Misi* scholarship, and naval/Nala foundation families. The invitation track is for high school graduates with a high grade point average (GPA) and has won academic or non-academic competitions at least at the district level. *Bidik Misi* scholarship is granted by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia. The scholarship provides financial support for tuition to economically disadvantaged students who demonstrate strong academic potential and wish to pursue higher education. All prospective students except those from the invitation track must take the academic test.

Prior studies indicated that cognitive tests, such as academic admission tests, may predict the students' academic success better than non-cognitive tests (6-8). In contrast, studies in Iran and China found a positive and significant correlation between motivation and positive emotions in academic performance (9-11). Moreover, a study in the US found a higher level of trait-like perseverance correlated with medical student performance (12). This study aimed to estimate student's academic success in the preclinical stage of undergraduate medical education using the admission test approach.

Methods

Study design and subjects

This study used a cross-sectional design, in which the admission data from the 2014 to 2019 student cohorts and their academic performance from the first to the fourth year of the preclinical stage were collected simultaneously in 2023. Our medical school received a "B" accreditation from the National Accreditation Board for Higher Education (BAN-PT) in 2014, and a "B" accreditation from the Indonesian Accreditation Agency for Higher Education in Health (LAM-PTKes) in 2019. Based on the 2013 and 2017 regulations, our institution was allowed to receive a maximum of 200 new medical students each year.

This study was conducted on a total population of 1,193 complete students' records from the 2014 to 2019 cohorts. The 2014-2017 cohorts consisted of 200 students' records each. The 2018 cohort consisted of 199 complete students' records, and the 2019 cohort consisted of 194 complete students' records. We excluded seven incomplete students' records from the 2018 and 2019 cohorts.

Procedure

The admission data were obtained from the university registrar, while the students' academic performance was obtained from the academic and student affairs at the medical school. Both admission and students' academic performance data were merged based on the students' names and IDs. The data were then checked for the completeness of information. The complete data included admission data (cohort, sex, admission track, psychological test, and academic test) and academic performance data (end-semester and end-year academic evaluations).

The academic admission test comprised mathematics, biology, chemistry, physics, and English. The psychological test consisted of three types of tests: 176 items of the Intelligence Structure Test (IST), 225 items of the Edwards Personal Preference Schedule (EPPS), and the Kraepelin test. At the admission test, all candidates were given 240 minutes to complete the psychological test and the personal interview.

The IST was developed by Amthauer in 1953 and consists of nine subsets of the basic components of reasoning ability and verbal and nonverbal intelligence (13). The results of the test allow us to predict the success of educational activities. The test was broadly used in many countries as a college admission test (14). It was adapted to the Indonesian language and has been used widely since 1973. The Indonesian version of the IST construct validity met the three goodness of fit index: the root mean square error of approximation (RMSEA) of 0.084, the Tucker-Lewis Index (TLI) of 0.905, and the comparative fit index (CFI) of 0.929; however, the reliability with omega (ω) coefficient was 0.845 (15). The 225 items of EPPS were developed by Edwards in 1959, to measure personality, such as achievement, autonomy, and affiliation (16). The construct validity of the Indonesian version of EPPS was 0.29, while the reliability was 0.86 (17). The Kraepelin test was developed by Kraepelin in 1922 (18). It is a work aptitude test to assess an individual's endurance, accuracy, consistency, and speed of time in completing a task (19).

Data analyses

This study used the Kolmogorov-Smirnov test to evaluate the normality distribution of the continuous data. In the academic admission tests, it was found that the students' admission academic test scores were not normally distributed; therefore, the median score was used as the basis for the classification of the academic test into two categories: higher than the median and less than or equal to the median.

The quantitative comparison was chosen to compare the results of the 2014-2019 student cohort admission academic tests with their academic performance from the first to the fourth year of the preclinical stage. The analysis compressed the psychological test results into three categories: recommended and moderately recommended for those with good performance at the psychological test, considered and can be suggested for those with moderate performance at the psychological test, and less recommended for those with poor performance at the psychological test.

The Faculty of Medicine in Indonesia uses the A-E grading system. Our study classified the students' academic success into success or failure. Students were included in the success group if they met the requirements at the end of the academic year, such as GPA, no E grade, and the number of credits for D was less than 25% of the total credits in the related academic year, and the others included in the failure group. The time variable recorded the failure of each student from the first to the fourth year of the preclinical stage of undergraduate medical education. Students who were in the success group were those who graduated on time, while those in the failure group could not graduate on time.

Data were analyzed using contingency and Kendall's tau b tests. All tests were carried out using IBM® SPSS® Statistics version 26.0 for Windows with an alpha of 0.05 (20).

Ethical consideration

All procedures followed were under the ethical standards of the ethics committee of human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and its later amendments. This study did not involve any identifying data that could breach privacy. Approval for this study was sought from the Human Research Ethics Committee at the Faculty of Medicine, Hang Tuah University No. I/022/UHT.KEPK.03/II/2022.

Results

The undergraduate medical education at our institution accepted 200 new students each year from 2014 to 2019. Table 1 shows that most of the 1,193 students included in the study were

Table 1. Characteristics of the students

Characteristics	Frequency (n=1.193)	Percentage
Cohort		
2014	200	16.8
2015	200	16.8
2016	200	16.8
2017	200	16.8
2018	199	16.7
2019	194	16.3
Sex		
Male	380	31.9
Female	813	68.1
Admission track		
Regular and *Bidik Misi* beneficiaries	936	78.5
Naval and Nala Foundation families	219	18.4
Invitation	38	3.2
Psychology test		
Less recommended	320	26.8
Considered and can be suggested	630	52.8
Recommended and moderately recommended	205	17.2
Academic admission test		
Higher than the median	578	48.4
Less than or equal to the median	615	51.6
Academic Success		
Failure		
First-year	84	7.0
Second year	25	2.1
Third year	8	0.7
Fourth-year	6	0.5
Success	1.070	89.7

Table 2: Student's academic performance in the preclinical stage

	Success [n (%)]	Failure [n (%)]	P
Cohort [a]			<0.001
2014	159 (79.5%)	41 (20.5%)	
2015	177 (88.5%)	23 (11.5%)	
2016	177 (88.5%)	23 (11.5%)	
2017	185 (92.5%)	15 (7.5%)	
2018	186 (93.5%)	13 (6.5%)	
2019	186 (95.9%)	8 (4.1%)	
Sex [a]			0.324
Male	336 (88.4%)	44 (11.6%)	
Female	734 (90.3%)	79 (9.7%)	
Admission track [a]			0.128
Regular and *Bidik Misi* beneficiaries	832 (88.9%)	104 (11.1%)	
Naval and Nala Foundation families	201 (91.8%)	18 (8.2%)	
Invitation	37 (97.4%)	1 (2.6%)	
Psychology test [b]			0.002
Less recommended	272 (85.0%)	48 (15.0%)	
Considered and can be suggested	572 (90.8%)	58 (9.2%)	
Recommended and moderately recommended	226 (93.0%)	17 (7.0%)	
Academic test [b]			<0.001
Higher than the median	490 (85.2%)	85 (14.8%)	
Less than or equal to the median	543 (93.6%)	37 (6.4%)	

[a]Contingency test, [b]Kendall's tau b test

females (n=813, 68.1%) and from the regular track (n=936, 78.5%). Based on the psychology test, the majority were from the considered and can be suggested group (n=630, 52.8%). Most students had an academic admission test of less than or equal to the median (n=615, 51.6%). Most students (n=1070, 89.7%) met all the academic requirements to pass the end-year evaluation.

The results of bivariate analyses in Table 2 shows significant correlations between academic success and cohort (P<0.001), psychology test (P=0.005), and academic test (P<0.001). The analyses showed no significant correlation between academic success and sex (P=0.324), and admission track (P=0.128).

Discussion

One of the most sought-after professions in the world is medicine, and getting into medical school is competitive. As a result, medical schools encounter significant challenges in impartially choosing the most qualified candidates, and the admission procedure they employ may influence how well students do academically, which refers to a student's mastery of knowledge and skills (2). Selection strategies of new undergraduate medical students vary depending on the context, meaning that the goals of an institution, the needs of the communities it claims to serve, and the system in which it operates must all be taken into account. Further, issues related to diversity and globalization are still important and should be considered (21).

In 2012, the Indonesian Medical Council (*Konsil Kedokteran Indonesia*, KKI) emphasized that medical education institutions must have student admission policies following the principles of relevance, transparency, accountability, and academic and social responsibilities. Relevance means that the entrance selection can only be taken by high school graduates or equivalent majoring in natural sciences who are not color blind, physically and mentally healthy, and drug-free. The admission process consists of academic, interest, and talent selection carried out institutionally and nationally. The ratio of student to lecturer in the preclinical stage of the undergraduate medical education program is 10:1 (22). In 2019, KKI added several requirements that medical education institutions should have a potential student selection consideration according to gender, ethnicity, and other social requirements (sociocultural and linguistic population characteristics), including the potential need for special recruitment, admission, and induction policies for underprivileged and minority students. Moreover, KKI also stressed

that medical education institutions have policies regarding student transfer from national or international programs, and have regulations for accepting foreign students following the applicable statutory provisions (23).

Of the various admission strategies, high school performance appears to be a strong predictor of academic standing in medical education programs (24). Therefore, many medical schools place a lot of weight on student's high school scores during the admission process, particularly for those who are accepted straight out of high school. However, it is unclear which high school degrees are a stronger indicator of a student's success in medical school because there is a large range of degrees offered globally (2).

Our study showed no significant correlation between student academic success in the preclinical stage of undergraduate medical education programs with sex. A study conducted on three cohorts of 1,254 medical students in a medical school in Sudan that used a six-year curriculum of preclinical and clinical stages showed there was no noteworthy contrast in academic performance between male and female students. Few differences might be observed, but they could not be attributed merely to gender (25). A study on eight years of data conducted at a medical school in the US that used a four-year integrated hybrid curriculum showed that male students performed better in the first year of the medical education program, but the gap was not observed in the second, third, and fourth years of the program (26).

Our study also showed no significant correlation between student academic success in the preclinical stage of undergraduate medical education programs with admission tracks. The results indicated a good admission process in terms of admission track. Thus, potential students from invitation, regular, or naval families had the same chances of a successful academic performance in the preclinical stage of undergraduate medical education. A responsible medical school was expected to recruit potential students from various backgrounds, especially by recruiting students from underserved communities so that the graduates would return to their communities to address the health problems in their communities (27).

In addition, our study showed significant correlations between academic success and cohort, psychology, and academic tests. The 2014 cohort had the highest number of students who failed in the first, second, third, and fourth years of the preclinical stage. Conversely, the 2019 cohort had the lowest number of students

who failed and the highest number of students who succeeded, meaning that the 2019 cohort had the highest number of students who could graduate on time. While the 2014 student cohort showed the highest academic admission test score average, the 2019 student cohort had the second highest proportion of students with upper-level psychology test results (recommended and moderately recommended group) of 22%, after the 2018 student cohort with 22.6% of upper-level psychological test results. Furthermore, the academic success of the 2019 and 2018 cohorts could be influenced by various factors, including motivation, time spent on learning, mental health, and commitment (28, 29).

In our study, psychological tests were correlated with academic success at the preclinical stage of the undergraduate medical education program. Students in the highest group of psychology test scores demonstrated better academic success in the first to the fourth year of the preclinical stage program compared to other groups in psychology test scores. The psychological tests used to select prospective medical students measured cognitive abilities and personality tendencies. Cognitive ability is an individual's ability to store, process, and integrate various information when facing problems. Some experts consider cognitive abilities as the main mental quality used in individual learning activities. Individuals who have strong cognitive abilities are more likely to be able to extract, encode, and store information more quickly and accurately in their memory, thereby enabling the brain to produce more effective memories (30). This will support individuals to be able to complete exams well so that they will obtain better academic achievement than their counterparts. Various research reported that cognitive ability is a strong predictor of academic achievements (30, 31). Personality also has an important role in predicting individual success in learning. The aspect of personality is assessed from the behavioral tendencies shown by individuals, which can influence individual habits related to achievement, such as persistence and motivation. Prior studies reported that academic motivation, interest in tasks, persistence, and competitive nature were positively correlated with academic achievement (32, 33).

Undergraduate medical education is a long learning journey. Aside from intellectual capacity, personality qualities are regarded as a major determinant affecting academic success, psychological adaptation, and motivation in medical education programs (9-12). As of 2017, our institution added the Minnesota Multiphasic

Personality Inventory (MMPI) as one of the admission tests into the undergraduate medical education program, due to some cases of students with psychological distress and psychopathology symptoms that needed counseling and therapy. MMPI consists of 567 true or false items. It is a commonly used psychometric test to assess personality traits and psychopathology. Many medical schools worldwide use MMPI during the medical school admission process. A prospective study conducted on 203 applicants who took the MMPI as part of the medical school admission process reported that MMPI predicted anxiety and depressive symptoms, perceived stress, and interpersonal difficulties. However, the MMPI scale did not predict self-esteem (34).

Earlier studies reported significant correlations between medical students' academic performance and the admission tests, especially knowledge tests (2, 35). In our institution, the academic admission tests consist of high school mathematics, biology, chemistry, physics, and English, which are less correlated with their application to medical problems or the material of courses in our undergraduate medical education program. Accordingly, our study showed no correlation between academic admission tests with student academic success in the undergraduate medical program. In addition, various factors might affect the students' academic performance, including extracurricular activities (36), mental health, financial situation, interpersonal relationships with peers and others (29), parental concern, time spent on social media, peer influence, and teaching style (28).

In contrast, preceding studies confirmed that academic admission tests could predict medical students' success in undergraduate medical education, meaning that students with high academic tests during the admission process would have a higher chance of having a successful academic performance (6). It was reported that the Medical College Admission Test (MCAT) consisted of multiple-choice questions, which could predict medical students' success in the first and second years of the undergraduate medical education program. MCAT covered problem-solving skills, critical thinking, general knowledge, and social concepts that were the US medical school requirements (37). A study in Bahrain revealed that science tests during the admission process were the only predictor of medical students' success, whereas other factors including high school GPA and interviews were not significant predictors. The research also suggested that the admission process should be re-evaluated to contribute more to the student's

academic success (6). Research conducted in Jordan reported that high school GPA and the admission track could predict medical students' academic performance, whereas the academic test during the admission process could not foresee the academic success of medical students (2).

Currently, the quest for more gender, ethnic, and racial variety in medical education is more compelling than ever. However, the socioeconomic status gap still exists and may be expanding. Approximately 48% of medical students are from the highest quintile, with less than 6% from the lowest (38). Socioeconomic status, a measure of an individual's standing in terms of education, occupation, and income, has an impact on educational attainment. Globally, students from low socioeconomic backgrounds have been underrepresented in medical schools, due to emotional and financial barriers, or other causes (39). In Indonesia, new medical students from the regular track have to pay much more expensive development contribution charges, compared to those from invitation or other tracks, especially in private medical schools, public medical schools with local admission tracks, or international medical education programs. To address this issue, the Indonesian government provides *Bidik Misi* scholarship, aiming at high school graduates or equivalent who have good academic potential but have limitations for studying at tertiary institutions. Moreover, many medical schools in Indonesia offer merit scholarships for students who have excellent academic performance, and some offer limited bursaries for students who have financial needs that are usually without undue emphasis on academic standing. Previous studies reported that candidates from lower socioeconomic backgrounds might score lower on the academic admission tests, but they may outperform their peers in undergraduate academic performances (39). Our study reported that different tracks did not correlate with undergraduate academic success.

The six-year student cohorts and big sample size are the strengths of our study, whereas the limited number of variables was the limitation of our study. Future research should address this limitation by having various variables that could be analyzed to predict the students' academic performance in undergraduate medical education.

Conclusion

This study indicated that psychological tests could estimate the students' academic success at the preclinical stage of undergraduate medical education. Undergraduate medical education is a long learning journey that needs both intellectual capacity and personality qualities. Therefore, the admission criteria must be considered thoroughly to select the best students among the applicants. The medical education institution should also provide a good support system to help students achieve their goals of becoming competent healthcare professionals.

Acknowledgement

Authors' Contribution

All authors contributed to the discussion, read and approved the manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated resolved.

Conflict of Interest

The authors declare no conflicts of interest.

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