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The Association and deterministic role of multiple standard admission tests and second-semester medical students' grades

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ABSTRACT

Admission Test aims to filtrate applicants to get the most suitable applicants. The test must be able to predict candidates' academic performance and to guarantee a fair and transparent selection process. This paper aims to determine the extent and significance of each admission test score associated with students' grade point average (GPA). Herein we conducted a retrospective cohort study conducted between May 2021 to 2022. Study respondents were derived from the 2021 batch of medical students who enrolled at the Faculty of Medicine Universitas Ciputra Surabaya, Indonesia. All students (n=58) underwent an interview session, Graduate Record Examination, science subject test, MMPI-2, and LASSI-3. GPA data were collected at the end of the first semester. Demographics and certain socio-education factors were also collected during admission process. There were weak correlations between UK-ranking system and several LASSI components (SMI, r=0.35; p=0.008; TST, r=0.30; p=0.024) and composite score percentiles (r=0.29, p=0.027). Four LASSI components (CON, INP, TMT, and UAR) demonstrated a weak inverse correlation with UK-ranking system, including the overall LASSI test scores. MMPI-2 test results was negatively correlated with UK-ranking system (r=-0.19, p=0.156). Our model only accounts for 20% for the total variance observed in GPA, with only one TMT garnered a statistically significant result. Surprisingly, other demographic data show better predictive value, being a female medical student (3.08±0.58 vs. 2.66±0.56; p=0.026) and graduating from inner-city high schools (3.23±0.54 vs. 2.88±0.60; p=0.031) demonstrate a significantly higher GPA than those of their counterparts. Interview, potential academic test, science subject test, LASSI, and MMPI-2 did not significantly associate with or determine students' first-semester GPA. Various factors such as students' demographics, habits, well-being, and other seemingly trivial factors should also be able to predict students' future potential and academic success accurately.

Keywords: GPA, interview test, LASSI-3, MMPI-2, potential academic test, science subject test

INTRODUCTION.

Students' academic performance is formally assessed using grade point average (GPA) over the course of their study periods. Students' academic performance and their success can be predicted by using multiple models, including admission tests. It is important that the faculty is able predict candidate students' potential academic performance and success to better gauge and facilitate the most optimal learning methods and knowledge transfer, as well as to guarantee the fair and

transparent admission selection process. Several models have existed, generally relying on past academic records (e.g. high school GPA), present test results (GRE, GMAT), prior high school major or specialization (biology vs. non-biology major, science vs. social major), year of high school graduation, studying methods, duration of reading and learning, types of personalities, or some other factors not directly related to academic measures, including (but not limited to) type and geographical area of high school, degree of physical activity, marriage status, earnings per month, sleeping period near exam time, parents' occupations, transportation used to reach the faculty, and many more (1–5). Debates regarding which model best predicts and represents students' grade is ongoing and each faculty has their own system of predictor.

Our currently active admission criteria emphasize on the present academic performance, including interview test, potential academic test, science subject test, learning outcome and study strategies (LASSI)-3 score, and the result of personality aberrancy as judged by MMPI-2 results interpreted by independent, board-certified, clinical psychologists. However, based on our anecdotal observation, the current model is not sufficient to predict students' academic performance trajectories over time. There are considerable number of cases in which students' initial admission test scores were on the high percentile, yet their grades were below 50th percentile, and vice versa (although the latter tend to occur less frequently). Therefore, we had the urge of devising a model that best represents our students' population, thus able to create ideal admission criteria. As an initial step, first we would like to address our current prediction model regarding its association with students' GPA. Herein we would like to determine the association and deterministic role of admission tests, including interview session, potential academic test, science subject test, and learning outcome and study strategies (LASSI) score, as well as MMPI-2 against medical students' GPA. We would also like to address the role of gender, public vs. private institution, and high school region toward GPA.

MATERIALS AND METHODS.

Study design.

This was a retrospective cohort study conducted between May 2021 and May 2022. A total of 58 subjects had been admitted into this study. Study respondents were derived from the 2021 batch of medical students who enrolled at the Faculty of Medicine Universitas Ciputra Surabaya, Indonesia. This study had been approved by the Ethical Committee of the Faculty of Medicine Universitas Ciputra prior to its commencement. Prospective students who underwent the whole admission selection processes and finally admitted into the program with a status of being an active medical student up until this study was conducted were eligible to be included as participants. All prospective medical students eligible for the study should have already completed the compulsory admission tests, including interview session, GRE, test for science subjects, LASSI, and MMPI-2. All medical students then underwent formal education as per faculty's curricula comprising innovative design (3 semester credit hours [SCH]), effective communication and health behaviors (2 SCH), biomedic blocks (musculoskeletal, 4 SCH; respiration and cardiovascular, 5 SCH; digestive system, 4 SCH) for the first semester and civics (3 SCH), medical ethics (3 SCH), biomedic 4, 5, 6, and 7 (each with 3 SCH) for second semester. Thus, all students have already been enrolled in a total of 36 SCH for the first two semester prior to being included in this study. Students' grade point average (GPA) was calculated cumulatively, considering all their grade scores from the past two study semesters. Medical students who did not undergo or have a

complete admission test records documentation or did not have their GPA available for any reasons were excluded from this study. Our study's primary outcomes were to determine the extent and significance of each admission test score associated with students' grade point average (GPA), whereas our secondary outcomes were to determine the influence of demographics and certain socio-education factors toward academic success as reflected by the GPA.

Statistical analysis.

All data were initially assessed for normality of distribution. We initially determined the extent of bivariate association of each independent variable with GPA. We broke down LASSI into its ten components and tested each of it against GPA. We also performed an individual correlation test for interview test, GRE, and science subject test results against GPA, as well as its composite score. This was done as per the faculty's policy of using the composite score of the interview test (30%-weighted), GRE (40%-weighted), and science subject (30%-weighted) test results as one of the bases for admission. Whenever there was no significant correlation observed, we transformed independent variables into ordinal data and performed correlation tests using Spearman's rho. LASSI score components were transformed in accordance with LASSI range score classification, i.e. 0-50, 50-75, and 75-100 percent, respectively, whereas interview test, GRE, and science subject test results, including its composite score were divided into five ordinal ranks according to its percentiles (below 25^{th}, 25^{th}, 50^{th}, 75^{th}, and 90^{th} percentile, respectively). GPA was also converted to ordinal data, in accordance to U degree classification system (so-called UK-ranking system onward i.e. unclassified, <2; third class honours, 2 – 2.30; lower second-class honours, 2.31 – 3.0; upper second-class honours, 3.1 – 3.70; and first class honours, 3.71-4) (6). MMPI-2 test results were evaluated by independent, 3^{rd} party, board-certified consultant psychologists and classified into three ordinal categories, namely 'sufficiently recommended', 'recommended', and 'highly recommended'. Students residing in Surabaya city were considered as coming from inner-city, while the rest were categorized as from outer city. Ultimately, all independent variables were tested for its individual determinants toward GPA using multiple regression tests, except interview test, GRE, and science subjects test results composite score due to its multicollinearity with its individual components. In addition, we also tested the role of gender, public vs. private institution, and high school region toward GPA. Since GPA were normally distributed, we conducted the independent t test for all corresponding models. A confidence interval of 95% was used and p value of less than 0.05 was considered statistically significant. All data analyses were conducted using IBM SPSS Statistics 20.

RESULTS.

Subjects' baseline characteristics.

There were 70 prospective medical student candidates who initially undertook the admission test. However, 10 of them did not complete the LASSI-3 test, whereas 2 more subjects did not have a complete record of their admission test scores. A total of 58 subjects, thus, were eligible to be included in this study. Subjects' baseline characteristics were displayed on **Table 1.** Female students predominated the class by four-fold than those of their male counterparts. Three-quarters of students graduated from private high school and a similar percentage of students graduated from high school which reside in Java Island. However, only one-third of the total students graduated from high school in inner-city.

Table 1. Subjects' baseline characteristics.

Parameters (n=58)	N (%) or mean±SD or median [IQR]
Sex	
Male	12 (20.7)
Female	46 (79.3)
High school type	
Public	15 (25.9)
Private	43 (74.1)
High school region (1)	
Inside Java island	44 (75.9)
Outside Java island	14 (24.1)
High school region (2)	
Inside Surabaya city	20 (34.5)
Outside Surabaya city	38 (65.5)
Admission test results	
Interview test	25.31 [2.47]
GRE	26.53 [3.50]
Science subject test	23.10 [3.15]
Composite score	74.61±7.54
LASSI components	
ANX	40.00 [35]
ATT	55.00 [43]
CON	50.00 [45]
INP	50.00 [40]
MOT	60.00 [55]
SMI	45.00 [50]
SFT	65.00 [30]
TST	55.00 [50]
TMT	57.50 [35]
UAR	70.00 [35]
Number of components with score <75%	8 [4]
MMPI-2	
Sufficiently recommended	12 (20.7)
Recommended	40 (69)
Highly recommended	6 (10.3)
GPA	2.99±0.60

SD, standard deviation; IQR, interquartile range

Association of admission test results with the UK-ranking system.

GPA was normally distributed, while other data were not. Spearman's rho correlation test demonstrated a significant-but-weak statistical correlation between UK-ranking system and several LASSI components (ATT, r=0.302; p=0.021; SMI, r=0.460; p=0.001; TST, r=0.312; p=0.017) [**Table 2**]. One LASSI component (TMT) demonstrated a weak, inverse correlation with the UK-ranking system, although statistically insignificant, along with the overall LASSI test

scores, i.e., the number of components with score of less than 75%. Interestingly, MMPI-2 test results were negatively correlated with the UK-ranking system with statistical significance (r=-0.277, p=0.0.35). A summary of key associations between admission tests and GPA was displayed in **Figure 1.**

Table 2. Spearman's rho association between various admission tests and UK-ranking system.

Parameters	**Correlation coefficient (r)**	**P value**
Interview test	0.241	0.068
GRE	0.066	0.621
Science subject test	0.154	0.248
Composite score	0.192	0.148
LASSI components		
ANX	0.143	0.283
ATT	0.302	0.021*
CON	0.127	0.343
INP	0.071	0.595
MOT	0.106	0.429
SMI	0.460	0.001*
SFT	0.167	0.211
TST	0.312	0.017*
TMT	-0.071	0.595
UAR	0.029	0.827
Number of components with score <75%	-0.208	0.116
MMPI-2	-0.277	0.035*

*P value is significant at <0.05

Accordingly, multiple regression analysis demonstrated that our model of independent variables could only explain 20% of the number of variances seen in GPA (adjusted R^2 0.18), thus yielding a modest ANOVA test result of predicting the GPA (F [13, 44] = 1.965, p=0.048). Among all independent variables, only one LASSI component, i.e., SMI which garnered a statistically significant result (B=-0.010; 95% CI 0.002 – 0.18; p=0.02).

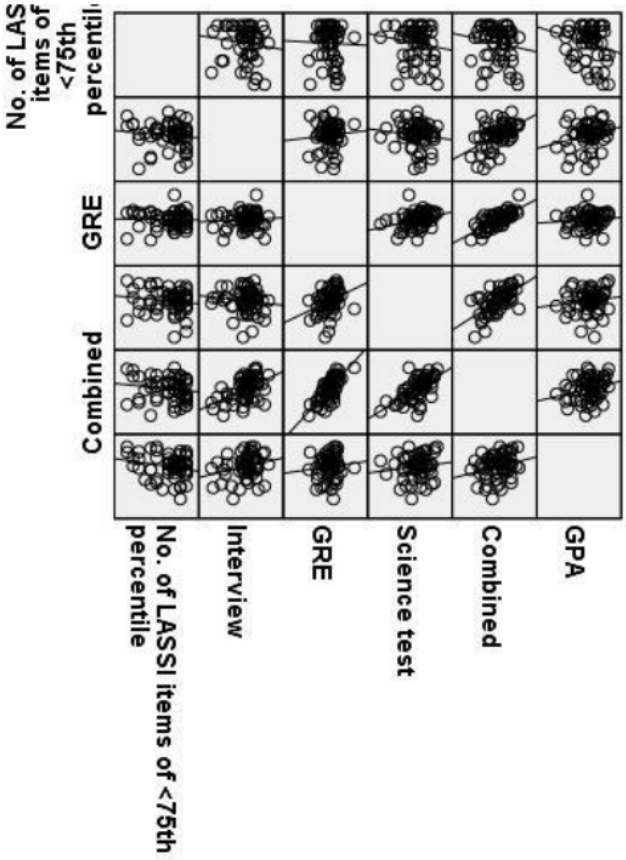

Figure 1. Key associations between various admission test results and GPA. There were no specific associations between GPA and various types of admission test.

The role of gender, public vs. private institution, and high school regions toward GPA. We then would like to determine secondary outcomes of this study, i.e., whether there is any significant role of gender and high school region as classified by within vs. outside Java Island and inner- vs. outer-city toward students' academic success reflected by their GPA. It turned out that the female medical student group outperformed their male counterparts by having a significantly higher GPA (3.23±0.49 vs. 2.85±0.58; mean difference 0.39, 95% CI -0.71 – -0.058, p=0.022). Furthermore, students who graduated from high school in Java were able to achieve a relatively higher GPA than those who graduated from high school outside Java, albeit statistically insignificant (3.14±0.57 vs. 3.20±0.38; mean difference 0.06, 95% CI -0.386 – 0.265, p=0.71). However, further analysis demonstrated that medical students graduating from inner-city were able to achieve higher GPA than their peers who graduated from outer-city (3.35±0.45 vs. 3.05±0.54; mean difference 0.30, 95% CI 0.017 – 0.58, p=0.038). Meanwhile, students who graduated from public high school did not demonstrate any significant difference of GPA than those who graduated from private institutions (3.19±0.12 vs. 3.14±0.55, mean difference 0.47, 95% CI -0.27 – 0.36, p=0.77).

DISCUSSION.

Admission criteria for medical institutions has been a debate for long. North American countries use the MCAT (Medical College Admission Test), which stresses on logical reasoning and problem solving and previous CGPA (Cumulative Grade Point Average) scores. The UK in 2005 established the UK Clinical Aptitude Test (UCAT), which consists of verbal reasoning, decision making, quantitative reasoning, abstract reasoning, and situational judgment. In Malaysia, performance during high school, and pre-university programs determines eligibility. South Africa uses a combination of National School Certificate and National Benchmark Test scores. Many studies evaluated predictive validity of the selection process and personal qualities are also critical to successful medical practice.

Composite score grades such as GPA or UK-ranking system has long been used as the primary objective measurement and classification of students' academic success. Despite the long-hauled debates regarding its accuracy to reflect academic success, it remains to be used as the formal certification method to justify students' academic performance and to be incorporated as an important factor in making critical decisions, such as admission criteria for higher education, scholarship eligibility and priority, as well as career admission. We, therefore, in this study, still use the GPA and its transformed UK-ranking system method as a primary means to gauge a student's academic performance. There have been exhaustive discussions with respect to how to accurately measure and predict a student's potential success in an academic environment. One study, for example, points the dynamic contribution of student's previous academic performance as reflected by their national examination scores and academic potential test results, high school specialization (science vs. social class), as well as factors which determine the learning process (e.g. class attendance during university study period and lecturer quality).(7) Another study determined the potential role of specific learning styles (aural, visual, kinesthetic, read and write, or its combination) among students and their academic achievements but did not find any significant association.(8)

Prior academic performance and cognitive ability is needed to pass medical school, but personal qualities, and interpersonal skills are needed to care for the patients and cope with medical profession challenges. School of Medicine Universitas Ciputra new students' criterion comprises cognitive test (GRE, Science subject test), interpersonal skills (interview), personality assessment (MMPI-2), and learning and study strategies (LASSI-3). We attempted to analyze the admission test model that we have been using to objectively determine potential student candidates for years, with respect to their future academic performance. Our model incorporates current intellectual performance as reflected by academic potential test and science subject scores, emotional, social, and adversity intelligence as reflected by interview test scores, students' learning strategy and adaptation as gauged by LASSI, and any associated aberrancy in personality as reflected by MMPI-2 results.

We did not find any robust results that would otherwise support the routine use of our current admission test model for yielding an accurate trajectory of students' academic performance over time. For example, among the individual assessment of associations between interview, GRE, and science subject test, did not demonstrate any significantly linear association with the UK-ranking system. However, a composite score of these did show a weak, but statistically significant

association with the UK-ranking system. The results seem to be counter intuitive as several studies have pointed out the important contributions of past academic success toward the future endeavors. This could bring at least two notions, firstly that our model is not sensitive enough to capture the students' inner academic potentials, by which more test items and questions should be added into the current model. Secondly, that our model is limited in a way that other significant contributing factors such as high school GPA should be incorporated into the admission criteria.(1) It is arguable as university's admission test often exert adverse impact toward disadvantaged and underrepresented minority students.(9)

Similar findings were also found with LASSI evaluation and MMPI-2 recommendation. LASSI is a self-report instrument to assess student's learning strategies according to a general model of learning and cognition and a model of strategic learning. Its focus is to address students' ability to orient themselves processing information and constructing knowledge by adapting to their skill, will, and self-regulation.[6] LASSI has been shown to be correlated with students' academic performance, particularly those of CON, MOT, TMT, and TST, whereas other studies classified LASSI components into two groups, i.e. affective strategies (TMT, MOT, CON, ATT) and goal strategies (ANX-, TST, and SMI) to be significantly correlated with academic performance.[6,7] Our study demonstrated a weak but significant linear correlation between TMT percentile with UK-ranking system, suggesting that our high-achiever medical students predominantly orient their academic achievements by optimizing their time management.

MMPI-2 test results demonstrated a statistically significant inverse correlation with GPA percentiles, and indeed was useful as a screening tool to mitigate the enrollment of individuals with potential aberrancy in personality and clinical psychopathology.(10–12) Interestingly, there is a tendency of inverse association between MMPI-2 test results and GPA, which merits further studies with more data to be analyzed. One plausible explanation was that certain personality traits or behaviors that were commonly considered inappropriate in general society may be proven to work extremely positively in the field of medicine. For example, one study determined the importance of not only positive attitudes and traits such as conscientiousness, extraversion, openness, and high self-esteem, but also a certain degree of neuroticism, in the survival and academic success of, both, during pre-clinical and clinical years among medical students.(13)

We also found a significantly different GPA between different student gender and high school in inner-city or outer city. This was actually in accordance with the previous studies which found that females tended to outperform males by means of GPA, particularly within the science, technology, engineering, and medicine (STEM) fields.(4, 14) However, our findings should be interpreted with caution as the number of female medical students overwhelmingly outbalanced their male counterparts. In addition, the significantly higher GPA attained by students graduating from high schools in inner-city than those of outer-city was virtually predictable, since there has been plenty of evidence demonstrating the comparative advantage of superiority of human capitals derived from inner-city graduated students.(9, 15) Of note, one of the reasons why there was no significant difference between GPA attained by students graduating from Java versus those of outside Java island high schools was perhaps due to the inequality of education in urban and rural areas, even in the most populated island itself. This phenomenon highlights the currently existing urban-rural education gap in Indonesia. The urban-rural education gap may have pervasive effects toward students' well-being, motivation, learning methods, and therefore, knowledge and skills

acquisition. Take for instance that a significant number of medical students in Kuwait had difficulty in English proficiency, whereas almost (if not all) medical textbooks are written in English.(1)

We also need to address the impact of Covid-19 pandemic as one of the factors that contribute to insignificant association between the admission tests and GPA. Given the dramatic and unpredictable nature of Covid-19 pandemic surge and decline had forced medical students to attend online lectures and assessments most of the time. This phenomenon had been studied to affect negatively toward students' academic performance in various settings and that it dramatically reduced the quality of their mental health and relationships which could be responsible for their academic decline, pertaining to their low study motivation and the absence of studying with peers.(16–18) The corresponding 2021 batch students included in our study had been studying online for the past two semesters, therefore further exacerbating their grade in cumulative fashion.

All in all, these study findings reflect the inadequacy of our current admission model to accurately predict students' potential and future academic success as reflected by their GPA. This is reasonable since academic performance is a function of students' inner academic potentials and their dynamic interaction with learning environments, including peer interactions and student support group, lecturers' and study materials' quality, percentage of expected readings, reading after class and near exam time, as well as other intermediate factors such as students' mental health, diet, sleep patterns, demographics, socio-economic and marital status, and residency area as have been previously described by multiple studies.(1, 3–5, 19) Trivial factors such as the extent of physical activity, duration spent on social media, or transportation used to reach the faculty could draw a dramatic difference in academic success among medical students.(1, 2, 5) In fact, taking into account only some of these factors while omitting the others (e.g. prior academic achievement, age and academic self- efficacy) may only partially explain its contribution toward overall academic success.(3) Indeed, our admission criteria model did not yet incorporate such things into consideration. We proposed that the next study should summarize all these significant findings into several categories, that some of it may be classified as mandatory or absolute criteria, while others labeled as "red flags" or to be used as warning signs against poor future academic performance and then followed the subjects prospectively to better gain insights into the most accurate prediction model.

CONCLUSION.

Several academic admission tests, including interview, potential academic test, science subject test, and the composite score thereof, as well as LASSI, and MMPI-2 were neither significantly associated with nor determine the academic success as reflected by GPA or UK-ranking system. Various factors such as students' demographics, habits, well-being, and other seemingly trivial factors should also be considered to accurately predict students' future potentials and academic success.

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CONFLICT OF INTEREST.

All authors had no other conflict of interests to declare.

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