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The Association and Deterministic Role of Academic Admission Tests toward Medical Students' Academic Success

Florence Pribadi[1], Maria Jessica Rachman[2], Susaniwati[3]
[1]Faculty of Medicine, Ciputra University, Surabaya, Indonesia
[2]Faculty of Medicine, Ciputra University, Surabaya, Indonesia
[3]Pulmunologist at Mohammad Soewandhie Hospital, Surabaya, Indonesia

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***Corresponding Author**
Florence Pribadi
Faculty of Medicine, Ciputra University, Surabaya, Indonesia

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A B S T R A C T

Introduction: Students' academic performance and success can be predicted using various models, including admission tests. Predicting this potential helps faculty optimize learning methods, ensure effective knowledge transfer, and maintain a fair, transparent admission process. **Methods**: This was a retrospective cohort study conducted between May 2021 to 2022. Study respondents were derived from the 2021 batch of medical students. All medical students who have already completed the interview session, potential academic test, science subject test, LASSI, and MMPI-2 and had been actively enrolled as a medical student in the past one year with available interim GPA were included in this study. **Result**: There were significant-but-weak statistical 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, non-significant, inverse correlation with UK-ranking system, including the overall LASSI test scores. MMPI-2 test results negatively correlated with UK-ranking system, despite being statistically non-significant (r=-0.19, p=0.156). Multiple regression analysis demonstrated partial explanation (20%) of our model toward GPA with only one LASSI component (TMT) garnered a statistically significant result (B=-0.013; 95% CI -0.025 – -0.01; p=0.031). **Conclusion**: Interview, potential academic test, science subject test, LASSI, and MMPI-2 did not significantly associated with or determine the academic success as reflected by GPA or UK-ranking system. Factors like demographics, habits, well-being, and other subtle aspects should be considered to accurately predict students' future potential and academic success.

Keywords: GPA, interview test, 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 has the ability to 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. 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.

METHODS

Study design.

This was a retrospective cohort study conducted between May 2021 and May 2022. 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, SAT, 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. They, in turn, underwent nationalism (3 SCH), medical ethics (3 SCH), and biomedic blocks (endocrinology and metabolism, 3 SCH; urogenital system, 3 SCH; special sensing, 3 SCH; neurobehavior, 3 SCH). Thus, all students have already been enrolled in a total of 18 SCH for each semester prior to be included in this study. Students' grade point average (GPA) was calculated cummulatively, taking into account all of 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 determinant factors's association with GPA as a representation of medical students' academic success, whereas our secondary outcomes were to determine the influence of demographics and certain socio-education factors toward academic success as, again, 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 againts GPA. We also performed an individual correlation test for interview test, SAT, 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 interview test (30%-weighted), SAT (40%-weighted), and science subject (30%-weighted) test results as one of the basis for admission. Whenever there was no significant correlation observed, we transformed independent variables into ordinal data and performed correlation test using Spearman's rho. LASSI score components were transformed in accordance to LASSI range score classification, i.e. 0-50, 50-75, and 75-100 percent, respectively, whereas interview test, SAT, 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 UK degree classification system (so-called UK-ranking system onward i.e. unclassified, <2; third class honours, 2 – 2.3; lower second-class honours, 2.7 – 3; upper second-class honours, 3.3 – 3.7; and firstclass honours, 3.7-4). 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'. Ultimately, all independent variables were tested for its individual determinants toward GPA using multiple regression test, except interview test, SAT, and science subjects test results composite score due to its multicolineearity 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 conduted the independent t test for all of the 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 were not admitted for multiple reasons, including having already admitted into other universities or finally refused to be enrolled, 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's 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 Surabaya 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]
SAT	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 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 (SMI, r=0.35; p=0.008; TST, r=0.30; p=0.024) and composite score percentiles (r=0.29, p=0.027) [**Table 2]**. Four LASSI components demonstrated a weak, inverse correlation with UK-ranking system, although statistically insignificant (namely CON, INP, TMT, and UAR), including the overall LASSI test scores, i.e. the number of components with score of less than 75%. Interestingly, MMPI-2 test results negatively correlated with UK-ranking system, despite being statistically non-significant (r=-0.19, p=0.156). 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	0.215	0.105
SAT	0.076	0.568
Science subject test	0.170	0.203
Composite score	0.291	0.027*
LASSI components		
ANX	0.003	0.983
ATT	0.154	0.250

CON	-0.012	0.930
INP	-0.039	0.771
MOT	0.051	0.702
SMI	0.346	0.008*
SFT	0.097	0.471
TST	0.297	0.024*
TMT	-0.157	0.238
UAR	-0.069	0.608
Number of components with score <75%	-0.169	0.196
MMPI-2	-0.189	0.156

*P value is significant at <0.05

Accordingly, multiple regression analysis demonstrated that our model of independent varibles could only explain 20% of the amount of variances seen in GPA (adjusted R^2 0.200), thus yielding a modest ANOVA test result of predicting the GPA (F [15, 42] = 1.953, p=0.045). Among all independent variables, only one LASSI component, i.e. TMT which garnered a statistically significant result (B=-0.013; 95% CI -0.025 – -0.01; p=0.031).

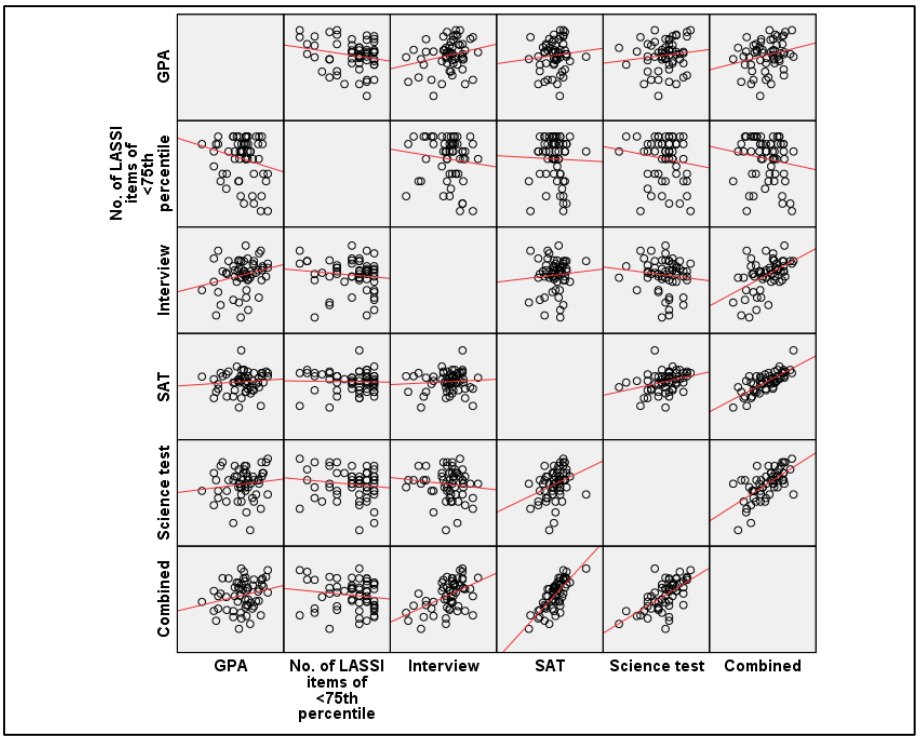

Figure 1. Key associations between various admission test results and GPA. Note the tendency of inverse association between GPA and number of LASSI components with score of <75% (although statistically insignificant).

The role of gender, public vs. private institution, and high school region toward GPA.

We then would like to determine secondary outcomes of this study, i.e. whether or not there is any significant role of gender and high school region as classified by within vs. outside Java Island and within vs. outside Surabaya city toward students' academic success reflected by their GPA. It turned out that female medical student group outperformed their male counterparts by having a significantly higher GPA (3.08±0.58 vs. 2.66±0.56; mean difference -0.43, 95% CI -0.80 – -0.054, p=0.026). 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 (3.00±0.61 vs. 2.98±0.59; mean difference 0.26, 95% CI -0.34 – 0.39, p=0.886). However, further analysis demonstrated that medical students graduating from Surabaya city were able to achieve higher GPA than their peers who graduated from outside Surabaya city (3.23±0.54 vs. 2.88±0.60; mean difference 0.35, 95% CI 0.33 – 0.68, p=0.031). Meanwhile, students who graduated from public high school did not demonstrate any significant difference of GPA than those who graduated from private institution (3.09±0.49 vs. 2.96±0.64, mean difference 0.13, 95% CI -0.23 – 0.49, p=0.47).

DISCUSSION

Composite score grade 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 mean to gauge student's academic performance. There has been an exhaustive discussion with respect to how to accurately measure and predict student's potential success in 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) (Suryawan & Putra, 2016). 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 (Almigbal, 2015).

All in all, we attempted to analyze the admission test model that we have been using to objectively determine potential student candidates for years, with a 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, SAT, and science subject test, did not demonstrate any significantly linear association with UK-ranking system. However, a composite score of these did show a weak, but statistically significant association with 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 (Shawwa et al., 2015). It is arguable as university's admission test often exert adverse impact toward disadvantaged and underrepresented minority students (Geiser & Santelices, 2007).

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 (Cano, 2006). 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 (Cano, 2006; Zhou et al., 2016). Our study demonstrated weak but significant linear correlations between SMI and TST percentile with UK-ranking system, suggesting that our medical students predominantly orient their academic achievements with goal-directed strategies.

MMPI-2 test results was not statistically significant but it indeed was useful as a screening tool to mitigate the enrollment of individuals with potential aberrancy in personality and clinical psychopathology (Butcher et al., 1990; Graham, 2006; Greene, 2000). 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 was commonly considered inappropriate in the general society may be proven to work extremely positive 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 (Doherty & Nugent, 2011).

We also found a significantly different GPA between different student gender and high school in Surabaya city or outside of Surabaya city. This was actually in accordance to 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 (Nawa et al., 2020; Sonnert & Fox, 2012). 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 Surabaya city than those of outside Surabaya 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 (Cano, 2006; Geiser & Santelices, 2007). 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 (Van Maarseveen, 2021). 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 (Ahmed et al., 1988).

We also need to take into account 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 (Andersen et al., 2022; Hammerstein et al., 2021; Tzeng et al., 2022). 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 (Cassidy, 2012; Nawa et al., 2020; Salem et al., 2013; Shawwa et al., 2015; Sitticharoon et al., 2014). 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 (Al-Drees et al., 2016; Salem et al., 2013; Shawwa et al., 2015). 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 (Cassidy, 2012). Indeed, our admission criteria model did not yet incorporate such things into consideration. We proposed that the next study should summarize all of 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 did not significantly associated with or 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 taken into account in order to be able to accurately predict students' future potentials and academic success.

Conflict of Interest

There is no conflict of interest.

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