



STUDENT SELECTION/ADMISSIONS

## Can Selection Assessments Predict Students' Achievements in the Premedical Year?: A Study at Arabian Gulf University

FAISAL A. LATIF AL-NASIR, FRCGP, MICGP, PhD<sup>1</sup> & ANNETTE SACHS ROBERTSON, DSM, MPH, ScD<sup>2</sup>

<sup>1</sup>Department of Family and Community Medicine, Student Affairs and Premedical Program and <sup>2</sup>Department of Family and Community Medicine, College of Medicine and Medical sciences, Arabian Gulf University, Bahrain

**ABSTRACT Background:** In a problem-based learning (PBL) program, students are encouraged to develop self-motivation, self-confidence, communication skills and problem-solving skills. Measuring these attributes when selecting students into medical schools is a formidable task. Admission to medical school typically depends upon students' academic achievement in their prior education. In the past 3 years the College of Medicine and Medical Science (CMMS) at the Arabian Gulf University, which has a PBL curriculum, adopted an admission policy that utilizes final high school scores, a written admission examination in English and science, as well as a structured interview. **Objective:** To determine the extent to which the admissions measures predict academic achievement in the first year of studies at CMMS.

**Design:** Prediction study of prospectively collected data. Final cumulative score for all subjects at the end of the first year was the main dependent variable analyzed.

**Subjects:** All students admitted to the college during the academic year 1998–1999.

**Results:** The written admission science examination scores had the highest correlation ( $r=0.663$ ,  $p<0.05$ ) with the Year 1 final cumulative score. Although the admission interview focused on non-cognitive student attributes, which may or may not affect the students' academic performance, its score had a statistically significant, if low, correlation with the Year 1 final cumulative score ( $r=0.275$ ,  $p<0.012$ ). Approximately 59% of the total variability of the Year 1 final cumulative scores could be explained by the admission examination scores in science and English and the high school scores.

Address for correspondence: Dr. Faisal A. Latif Al-Nasir, Vice Dean, Student Affairs and Premedical Program, College of Medicine and Medical Sciences, Arabian Gulf University, PO Box 22979, Manama, Bahrain. Tel: (973) 239707/239653. Fax: (973) 271090. E-mail: faisal@agu.edu.bh

**Conclusion:** *Procedures for selecting students who are most likely to succeed academically in the initial year at an innovative medical school deserve further study and probably should include both academic performance and non-academic attributes.*

**KEYWORDS** *Admission, performance, score.*

## **Introduction**

The medical curriculum of the College of Medicine and Medical Science (CMMS) of the Arabian Gulf University (AGU), with the exception of the premedical year, is problem-based (Abouna, 1999). Located in Bahrain, it belongs to the six Gulf Cooperation Council countries (GCC). It was established in 1982 and has graduated eight groups of students. Until recently, the only requirement for admission was a grade of 80–90% in high school (Alnasir & Abouna, 1997; Alnasir & Grant, 1999). However, since the practice of medicine requires affective (attitudinal), and psychomotor (physical) skills in addition to cognitive knowledge (Bloom, 1956) and in view of the school's problem-based curriculum requiring self-directed learning, we determined that high school grades alone would not be adequate for selecting suitable candidates. Besides good academic performance in high school, candidates should possess special characteristics and attitudes toward learning. During the past four years CMMS adopted a different admission procedure which, though unique in this part of the world, is in accordance with what has been recommended internationally (Hoschl & Kozeny, 1997; David, 1998).

The revised admission procedure includes the following factors:

1. a minimum average score of 90% in the high school final examination;
2. a written admission test that includes English, biology, chemistry, physics and mathematics; and
3. a structured interview done by trained faculty members.

This admission assessment approach was thought to be important because students enrolling in AGU come from diverse backgrounds and because, for the first time, many will be studying an entire curriculum in English, rather than in their mother tongue (Arabic).

Studies have found that combining cognitive and non-cognitive variables can improve the prediction of success during basic science years in medical school (Roessler *et al.*, 1978). We decided to incorporate an assessment of non-cognitive elements that are relevant to student performance in medical school in the interview portion of our selection process.

Any student who passed the written admission examination at the required level was invited to a 35–40-minute interview, conducted by two faculty

members. Each interviewer completed a semi-structured interview questionnaire, which covered areas related to the student's personal characteristics and attitudes, such as respect, confidentiality, maturity, responsibility, self-confidence, tolerance, sensitivity and compassion. Similar methods of assessing non-cognitive attributes have been reported by other institutions (Robbins *et al.*, 1983; Miller *et al.*, 1989).

Only students who performed well in all three components of the admission process were invited to enroll in the CMMS.

The objective of this study was to determine the extent to which the admission factors we use predict academic achievement in the first year of medical studies at CMMS, AGU.

Because it is a GCC College, students from multiple Gulf countries should have equal opportunities for being selected. However, there are differences in the applicants' educational backgrounds, especially since some applicants attend private schools and may be highly proficient in the English language, while others attend government schools, which use only Arabic. We sought an admissions procedure that would provide relatively uniform criteria for all applicants.

Studies have shown that the results of a medical college's selection procedures that include interviews incorporating the students' personal characteristics and cognitive abilities (Aldrich, 1987; Hojat *et al.*, 1993), a written test (Shen & Comrey, 1997), undergraduate grade point average (Leonardson *et al.*, 1987; Mitchell *et al.*, 1994; Wiley & Koenig, 1996) and institutional selectivity (El-Mouzan *et al.*, 1991) were significant predictors of grades obtained in basic science courses.

In 1995, prior to incorporating a structured interview in our selection process, Shazali *et al.* (1997) reported that variability in performance in the final year examination by medical students could be partially explained by their high school certificate examination scores. Our study was conducted subsequently to determine the extent to which these high school scores and the newly instituted admission procedure components predict academic success in the first year at AGU, CMMS.

## **Methods**

### *Subjects*

We included all 68 students (54 (79%) female and 14 (21%) male) who were admitted to the college for the academic year 1998–1999.

### *Measures*

The following measures were obtained for each student:

1. high school grade from regional GCC standardized final examination (HSG);

2. high school science grade (HSSG);
3. score on the admission English test (AET);
4. admission science grade (ASG);
5. admission interview score (AIS); and
6. total admission score (TAS).

### *Prediction Factors*

The AGU-MCAT (Arabian Gulf University Medical College Admission Test) is a locally designed evaluation program, used for assessing students to be selected for CMMS. The CMMS takes into consideration the AGU-MCAT scores along with the (HSG) and the (HSSG) for selecting students. The (TAS) is calculated numerically on the basis of (1) a passing score on the (AET) and (2) a score comprising 25% of each of the following: HSG, HSSG, ASG and AIS. The overall total admission score and its components were analyzed as potential predictors of students' academic performance in the Year 1 program.

### *Criterion Measures*

The performance data used for this study were the final cumulative scores of each student in the various subjects in the first and second semester of the first year.

During the premedical year the students are expected to satisfactorily complete the following courses, which are medically oriented, for a total of 32 credit hours (each credit hour is equal to sixteen lectures in a semester): English, physics, two courses in biology, chemistry, biostatistics, library science, computer, two courses in Islamic studies, psychosocial science and two courses in the English language. Students sit an MCQ-based (multiple choice question) written examination in each of those subjects at mid-term and at the end of each semester. The final cumulative score is calculated as an average mark of the scores obtained from those exams.

### *Statistical Analysis*

In this analysis, the primary outcome of interest was the final cumulative score of each student in semesters one and two in Year 1. Preliminary data inspection and analysis were undertaken using SPSS-PC version 9. Before building the multivariate linear regression model, the distributions, measures of central tendency and dispersion of the variables were analyzed. Skewness and kurtosis of the distribution of variables were examined. To determine whether differences in mean scores between gender and sponsorship were statistically significant, *t*-tests were undertaken. Analysis of variance was used to compare mean scores between students of different countries. Examination of the linear relationships between variables included in the analysis was undertaken using Pearson's correlation coefficients.

A candidate list of variables was developed from the univariate analysis results. Stepwise multiple linear regression was used to assess the extent to

which the high school performance scores, admission test scores and interview scores predicted academic performance during Year 1 at medical school. Criteria used were probability  $p=0.05$  to select a predictor and probability and  $p>0.10$  to remove a predictor from the model. Similar studies have reported predicting medical school performance, by either cognitive ability or personality trait or both, using the linear multiple regression analysis technique (El-Mouzan *et al.*, 1991; Shen & Comrey, 1997).

Outlier and influential points were assessed by analyzing residuals. Residuals were also checked for collinearity, and influence diagnostics were performed on all regression equations to rule out problems with multi-collinearity and extreme influence.

## Results

In the academic year 1998–1999, 68 students were admitted to CMMS. The sociodemographic and academic profile of this group of students is summarized in Table 1. The students were predominantly female (79.4%) since parents from the GCC prefer that their daughters study medicine in Bahrain rather than overseas. The effect of gender on the outcome of the study was examined

**Table 1.** Sociodemographic characteristics in relation to the high school scores of the incoming Year 1 students at Arabian Gulf University, 1998

	<i>n</i>	Mean	Total high school scores Std deviation	<i>p</i> value
<i>Gender</i>				
Male	14 (20.6%)	82.59	6.93	0.86 <sup>b</sup>
Female	54 (79.4%)	82.97	7.02	
<i>Country of origin</i>				
Bahrain	18 (26.5%)	90.8	5.62	<0.001 <sup>c</sup>
Kuwait	11 (16.2%)	80.08	4.63	
Oman	7 (10.3%)	76.79	1.34	
Qatar	11 (16.2%)	79.29	6.51	
Saudi Arabia	11 (16.2%)	79.75	4.54	
UAE	7 (10.3%)	83.77	4.80	
Other Arab countries <sup>a</sup>	3 (4.4%)	85.81	6.99	
<i>Sponsorship</i>				
Government	48 (70.6%)	82.77	6.81	0.93 <sup>b</sup>
Private	20 (29.4%)	82.95	7.08	

<sup>a</sup>Includes Palestine, Sudan.

<sup>b</sup>*t*-test.

<sup>c</sup>Analysis of Variance.

but it did not show any significant linkage. The students admitted were from Bahrain (26.5%), Kuwait (16.2%), Saudi Arabia (16.2%), Qatar (16.2%), Oman (10.3%), UAE (10.3%) and other Arab countries (4.4%). Most students (70.6%) were government sponsored (their tuition fees are paid by their governments). There were no significant differences in the high school scores between males and females or between government and privately sponsored students. However, there were statistically significant differences in the high school scores between students from different countries. Bahraini students had the overall highest mean scores in their high school examination.

Analysis using Pearson’s correlation coefficient revealed statistically significant positive linear relations between selected predictor scores and academic achievement at the end of Year 1 (Table 2). As expected, the total admission score, which included the admission science grade and the admission interview scores had the highest overall statistically significant correlation with the academic score at the end of Year 1 ( $r=0.698, p < 0.001$ ). When the total admission score was analyzed by its components, the admission science grade had the highest correlation with Year 1 performance ( $r=0.663, p < 0.05$ ), followed by the admission English test score ( $r=0.456, p < 0.05$ ). The admission interview score had a significant low correlation ( $r=0.275, p < 0.012$ ). The high school test grade was statistically significant with moderate correlation ( $r=0.446, p < 0.001$ ).

When the correlation matrix of the components of the predictor variables was examined, there was a statistically significant correlation between the

**Table 2.** Correlation between academic performance in Year 1 and variables considered for admission of students at the Arabian Gulf University

Variable	Semesters 1 & 2						
	total result	TAS	AIS	AET	ASG	HSG	HSSG
I. Semesters 1 & 2 total results							
II. Admission total (TAS) <sup>a</sup>	0.698*						
III. Admission interview (AIS) <sup>b</sup>	0.275*	0.656*					
IV. Admission English (AET) <sup>c</sup>	0.456*	0.734*	0.288*				
V. Admission science (ASG) <sup>d</sup>	0.663*	0.593*	0.100	0.199			
VI. High school total (HSG) <sup>e</sup>	0.446*	0.389*	0.024	0.004	0.456*		
VII. High school science (HSSG) <sup>f</sup>	0.392*	0.490*	0.141	0.127	0.334*	0.666*	

\* $p < 0.05$ .

<sup>a</sup>TAS: total mark in admission science, English and interview score.

<sup>b</sup>AIS: scores obtained in the admission interview test.

<sup>c</sup>AET: scores obtained in the science English admission test.

<sup>d</sup>ASG: scores obtained in the science admission test.

<sup>e</sup>HSG: total high school grades including English, science and other subjects.

<sup>f</sup>HSSG: scores for only the science subjects in high school.

admission interview and admission English test scores, and a statistically significant and moderate correlation between high school grade and admission science grade. The correlation between the admission interview and the admission science grades was not statistically significant. Neither were there significant correlations between high school grade and admission interview or admission English test scores. Also no significant correlations were observed between high school science grade and these latter admission factors.

Because we were primarily interested in which components of the admission process were the best predictors, we did not include the admission total score as a separate predictor variable in the model building process. The  $R^2$  is interpreted as the proportion of variability in the dependent variable that can be explained by the predictors used in the model building process. The predictors in the multiple regression model, which included admission science, English and high school total accounted for 58.7% of the variability in the total final first year grades (Table 3). From this model, the most important predictors were admission science grade and admission English test scores. Together, these two variables accounted for 54.9% of the total explanatory power of the equation (Table 3). The high school grade also emerged as a statistically significant predictor of Year 1 academic scores. When the other three variables were in the model the admission interview scores did not appreciably change the predictive power of the model, hence did not emerge as important predictors of academic performance in Year 1.

Because of the small sample size, country of origin was not added to the final model despite significant differences in high school scores. Thus, the lack of analysis of the influence of country of origin may need to be further addressed in this group of medical students after accumulating a larger number of students over several years, assuming a fairly uniform admission procedures.

## Discussion

The nature of the medical profession requires that future doctors have certain basic skills and abilities. A system for measuring those attributes is needed

**Table 3.** Stepwise multiple linear regression for predicting Year 1 performance

Step	Stepwise multiple linear regression		df	p value
	$R^2$	$R^2$ change		
Admission science ( ASG )	0.439	51.658	1,66	<0.001
Admission English ( AET )	0.549	15.779	1,65	<0.001
High school total (HSG)	0.587	5.938	1,64	<0.018

when selecting students. Given the diversity of educational and cultural backgrounds among applicants to CMMS, AGU we considered it important to develop our own approach to student selection. Undoubtedly many other schools face analogous challenges.

In this study we explored the relationship between our AGU-MCAT results with overall student performance of one class during their premedical year. The AGU admission science and English tests emerged as good predictors of performance during the first year of medicine. However, as recommended elsewhere, multiple factors ought to be incorporated when considering an applicant (El-Mouzan *et al.*, 1991). High school grades, which included science subjects, had a high correlation with end of Year 1 performance. Such a finding was also reported by Huff *et al.* (1999). Those authors suggested considering multiple factors in admission and noted that the pre-admission variables, such as high school science grades, tended to improve the prediction of academic success. The overall AGU-MCAT score (overall admission scores) had a high correlation with the students' cognitive performance in the first year of studying basic sciences. Similar findings have been reported elsewhere (Shen & Comrey, 1997).

The overall AGU-MCAT score, followed by the admission science grade, had the highest correlation with end of Year 1 scores. This finding is similar to the findings of a study conducted in Saudi Arabia in which the MCAT overall score was a better predictor than the MCAT science score alone (El-Mouzan *et al.*, 1991). Since the premedical courses are mostly science subjects, it is expected that those who perform well in the AGU-MCAT science test would do well in all the first year subjects, particularly science. Although the interview part of the AGU-MCAT in our study had a low correlation with the outcome in Year 1, other studies have shown that there is a strong correlation between personality traits and other non-cognitive variables with overall evaluation and performance in medical school (Richards *et al.*, 1988; Shen & Comrey, 1997).

Since the interview can be an important method for assessing non-cognitive factors and since such factors are important components of physician functioning, it seems appropriate to incorporate interview data in any application selection process. However, the manner in which the interview is conducted is critical and may need to be improved at CMMS, AGU, if we are to enhance its predictive power. Furthermore, the method by which these results are integrated into the overall selection process may also need to be addressed further.

The decision to accept a student to a medical institution is not an easy task. Three major factors ought to be considered: those related to the students, those related to the institution, and those related to the role of these future doctors in the community. It is well accepted that non-cognitive characteristics are important in determining the effectiveness of doctors when serving communities. These characteristics are difficult to assess by any procedure, even face-to-face interviews. Nevertheless, other researchers also support the idea that

incorporating both cognitive and non-cognitive variables tends to improve the prediction of success during basic science preclinical and clerkship years in medical school (Hall & Stocks, 1995; Huff *et al.*, 1999).

## Conclusion

The admission selection process is important and each medical school should probably develop a system that suits its unique situation, including the type of students it wishes to admit, The characteristics of the community from which applicants originate, and the needs of the communities where the graduates will likely practice. The admission selection criteria should predict the performance of students during the premedical year and its predictive power depends on the variables that are incorporated in this assessment process. Selection procedures should also include the assessment of non-cognitive attributes in order to improve the selection of medical students who are most likely to perform well in medical school and beyond. The AGU is a regional medical institute, serving students from different sociocultural and educational backgrounds. We have developed a standardized admission procedure (AGU-MCAT) encompassing a high level of academic achievement as well as an assessment of personal attributes that are perceived positively in this cultural setting. We regard all elements as necessary for selecting students who are most likely to succeed in school and in practice. The real value of AGU-MCAT will be determined by future investigations of its predictive value in relation to the students' final year examination results, or even better with their early performance as medical professionals.

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