Is performance in pre-clinical assessment a good predictor of the final Doctor of Medicine grade?

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ABSTRACT

الأهداف: لاستقصاء ما إذا كان هناك ارتباط موجود بين درجه التخرج النهائية MD للطلبة والمعدل التراكمي GPA للأداء العام بمكوناته الجزئية.

الطريقة: تم تحليل بيانات الطلاب من عمادة القبول والتسجيل. تم التوصل إلى معامل ارتباط بيرسون لتقييم درجه العلاقة الخطية بين الأداء في المرحلة قبل السريريه ودرجه التخرج النهائية MD بين 529 طالب وطالبه تخرجوا من كلية الطب والعلوم الصحية في الفترة ما بين يونيو 1998 إلى يونيو 2005. تم عمل تحليلات للتراجع البسيط والمتكرر لتقييم التأثير الحادث فردا وإجمالا لدرجات الدورات في المرحلة قبل السريريه علي درجات التخرج النهائية MD.

النتائج: هناك ارتباط وثيق بين المعدل التراكمي GPA لفترة المرحلة قبل السريريه والمعدل التراكمي لدرجات التخرج النهائيMD r=0.641. وان المكونات العلمية التي درست من قبل في المرحلة ما قبل السريريه كان ارتباطها أوثق(r=0.457) من التي يختارها الطلبة (r=0.246). وهذا الارتباط كان أفضل في مجموعه الطلبة الذين يجيدون اللغة الانجليزية ولكن جوده الأداء كانت أفضل في المواد الإختياريه وكانت أسوأ في الانجليزية ومعظم الطلبة الذين حصلوا علي نتائج أقل في المعدل التراكمي لدرجه التخرج MD GPA- (أقل من 2.0) كانت نتائجهم أيضا قليله في المعدل التراكمي لمواد المرحلة قبل السريريه والعلوم (أقل من أو يساوي 2.5) وقد وجد أن الطلبة ذوي النتائج الأقل في المعدل التراكمي قد قضوا وقت أطول في البرنامج الطبي.

خاتمة: محدودية التقدم في المرحلة الاكلينيكيه السريريه علي هؤلاء الطلبة ذوي المعدل التراكمي في الفترة قبل السريريه (أكبر من أو يساوي 2.5) والحد من رصيد الساعات المطلوبة للمواد الإختياريه بواسطة الكلية له ما يبرره.

Objectives: To investigate if any correlation exists between students' grades on their final doctor of Medicine (MD) assessment and their overall preclinical grade point average (GPA) and its component parts.

Method: Student data available from the Deanship of Admissions and Registration were analyzed. Pearson correlation coefficient was obtained to assess the degree of linear relationship between performance in the preclinical and the MD assessment of 529 students who graduated from the College of Medicine and Health Sciences, Sultan Qaboos University, Al-Khoud, Oman from June 1998 to June 2005. Simple and multiple regression analyses were performed to evaluate individual and combined impact of the preclinical courses' grades on MD grades.

Results: Preclinical GPA correlated highly with MD GPA ($r=0.641$). The science component taught early in the preclinical phase correlated more strongly ($r=0.457$) than student electives ($r=0.246$). This correlation was better in the "good" English group. Students' performance, however, was best in electives, but worst in English. Most students who had low MD GPA (<2.0) had also preclinical and science GPA of <2.5. The students with low GPA were found to spend longer in the medical program.

Conclusion: Restricting progression to the clinical phase to those students whose preclinical GPA is ≥ 2.5, and limiting the credit hour requirement of electives by the College seems to be justified.

At present, there are many studies on the predictive validity of measurements obtained in medical school assessments and of measurements used for entry selection to medical school.[1-4] These studies showed a positive relationship between admission criteria and subsequent performance at the medical school, and between medical school assessment and performance in the internship and residency program. Performance based on similar measuring instruments was better

correlated for example, performance at the Medical College Admission Test (MCAT) strongly correlated with performance at the United States Medical Licensing Exam, both measuring knowledge and application by means of written exams.[5-9] The correlations between non-academic predictors and final grade in medical school were weaker than those between academic predictors and final grades in medical school.[10] Studies on the ability of individual courses to predict performance of students in medical school showed that sciences, basic to medicine, such as A-level Chemistry and A-level Biology were good predictors of performance in basic medical science examinations whereas general A-level studies were a poor predictor of achievement.[11] On similar lines, the biological sciences subset of MCAT correlated the highest with both basic science (preclinical) and clerkship (clinical) years of medical school performance, whereas the writing sample subset correlated the lowest.[5] Progression within medical school is important. The final development into a qualified doctor represents a major investment, financial and personal, by the individual, their family and by society in general. Avoidance of someone pursuing the wrong career or having to drop out of a program due to academic failure or academic unsuitability is important. Any markers then that can predict future disappointments are vital to ensure quality education. At our medical college, we wanted to investigate if any correlation existed between students' grades on the final Doctor of Medicine (MD) exam and their preclinical grade point average (GPA), as well as, any the relationship between the basic science, English, and elective components of this stage of the course. The extent of this correlation could indicate the relevance, or importance of these courses to the medical program and, hence, justify the decisions made by the College that affects student progression criteria from the preclinical to the clinical phase. Up until recently, progression to the clinical phase was conditional on obtaining a minimum cumulative GPA of 2.0 in the preclinical phase, whereas graduation with an MD degree required a minimum GPA of 1.0. However, since around 29% of students graduate with an MD GPA of less than 2.0, there was a concern about the existing selection criteria. In order to allow for better selection of students to the clinical phase, and to increase the standards of graduating students, the GPA requirement for progression to the clinical phase was increased to 2.5 and the graduation GPA (MD GPA) to 2.0. The College has also limited the maximum credit hour requirements from electives. Although this requirement has been set at 6 credit hours in the degree plan of students, no restriction was put on the maximum number of credits coming from these electives. This has led some students, especially those who had extra slots in their timetable due to repeating a semester, to undertake extra credits in

electives. The scores in electives were perceived to affect students' GPA in a way that gave them a better chance to be promoted to the clinical phase. Many of these electives were offered by the College of Arts and Social Sciences and were taught in Arabic - the mother tongue of students. We hope this study will help in answering some important questions related to student retention and progression in the medical program.

Methods. Data available with the deanship of Admissions and Registration were analyzed. Ethical approval for the study was obtained from the local Ethics Committee. Entry to the medical program in the College of Medicine & Health Sciences, Sultan Qaboos University, is based on academic merit only. Selected high school graduates gain entry to a 7-year medical MD program, which is comprised of 2 phases: pre-clinical and clinical. The degree of Medical Doctor at the College of Medicine and Health Sciences, Sultan Qaboos University, is obtained after a successful completion of a 7-year program, which is divided into 2 phases, pre-clinical and clinical. The preclinical phase follows a credit hour system and culminates in a BSc. (Health Sciences) degree. In this phase students are required to complete a minimum of 120 credit hours spread over 4 years before they can commence the clinical phase. These 120 credit hours are made up of basic sciences, basic medical sciences, English, University required courses and student self-selected courses that are called "electives". The language of instruction is English except for the University required courses and most of the electives, which are taught in Arabic. The clinical phase is built around rotations (clerkships) in clinical departments and its duration is 3 years. Obtaining the MD degree is conditional upon passing the final assessment. The maximum time allowed for obtaining the MD degree is 9 years. Around 76% of students complete the MD degree in the normal time of 7 years. Study participants included 529 students (231 males and 298 females) who graduated from the College of Medicine and Health Sciences, Sultan Qaboos University, between 1998 and 2005. Performance measures in individual courses during the preclinical phase included GPA on a 4 point scale (A=4.0, B=3.0, C=2.0, D=1.0, F=0) in sciences basic to medicine such as: Biology (2 courses, 4 credits, and 3 credits), Chemistry (2 courses, 4 credits each), Physics (2 courses, 4 credits, and 3 credits) and in University required courses, such as: English language (2 courses, 3 credits each), Arabic language (1 course, 3 credits), a history course (1 course, 2 credits) and a course in social sciences (1 course, 1 credit). The University required courses, except for the English language, were taken as "electives". To calculate the aggregate "elective" score, numeric grade values for each University required course were added and then averaged.

The grade point average is based on written, practical, and oral continuous examinations of various formats. A cumulative GPA at the end of the fourth preclinical years was used as the dependent variable. The GPA was based on 120 credit hours of courses. For the final MD examination an average GPA (MD GPA) was calculated based on the final MD examination grades in 5 main clerkships (medicine, surgery, child health, obstetrics & gynecology, and family medicine). The final MD examination grades were based on written, clinical, and oral examinations of various formats. A master data file (spread sheet) was made in SPSS software version 16, and grades of students in all courses were converted to their respective numeric values. Friedman test for related samples was used to test the significance of differences between the scores in the 5 courses of the preclinical phase under study. Pearson coefficient of correlation was obtained to see the degree of linear relationship between the 2 variables and student's t-test was applied to test the significance of the linear relationship. A *p*-value of 0.05 or less was considered as significant. Simple and multiple regression analysis were performed to evaluate the individual and combined impact of preclinical courses' grades on MD grades.

Results. Among the 5 courses of the preclinical phase, the maximum score was observed in the electives component, which also showed the least variability as compared to other courses. This was followed by Biology, Chemistry, Physics, and English language (**Table 1**). These differences in scores were highly significant (*p*<0.001). All 5 courses were significantly related to the preclinical cumulative and MD GPA. The strongest relationship was observed with Biology followed by Physics, Chemistry, and then English. electives showed the weakest relationship among the 5 courses (**Table 2**). These courses have almost equal contribution to the final BSc (Health Sciences / Preclinical) grades. The average GPA of the basic science courses (Biology, Chemistry, and Physics) correlated highly with the cumulative preclinical GPA (r=0.841, **Figure 1**) which means that 70% variation in cumulative preclinical GPA is explained by the performance in science subjects. The relationship of basic science courses with preclinical and MD GPA was stronger among those students whose language GPA was >2.80 (**Table 3**). The average GPA in the MD final exam was 2.24 ± 0.57.

Simple regression analysis showed that, independently, every BSc course has a significant impact on MD GPA, Biology being the most significant one. Moreover, multiple regression analysis also confirmed that Biology grades had the maximum impact on MD GPA but the impact of Physics was insignificant (**Table 4**). A significant positive linear relationship was observed between preclinical GPA and final MD GPA (r=.642,

p<0.001). Out of the total 529 participants, MD final GPA of 155 (29.3%) was <2.0 and among these 155, the preclinical cumulative GPA of 99 (63.9%) was <2.5. Also average science GPA of 67 (43.2%) of these 155 participants was found to be ≤2.5 (**Figure 1**).

The preclinical GPA of students who spend normal time in the preclinical phase (with no delay due to failure) is higher than those who spend longer time (**Figure 2**). The same is true for the average Science and MD GPA.

Discussion. Promotion to the clinical phase of the MD program in our medical college is dependent on performance in the preclinical phase, which is articulated by a cumulative GPA that results from scores on different courses in this phase. The preclinical GPA was found to be highly correlated with the MD GPA. This is in agreement with previous studies that showed a strong relationship between undergraduate GPA and performance in licensing examinations,[9] The basic science components of the preclinical phase, when taken individually or in combination, were found to
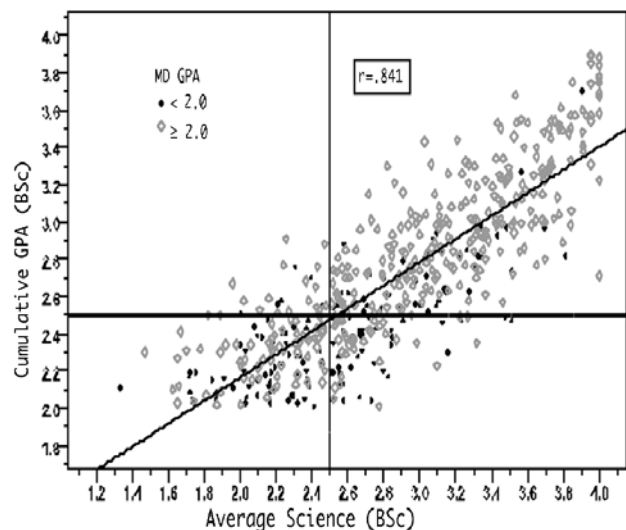

Figure 1 - Relationship of average science grades and BSc grade and performance in MD (GPA < 2.0 and GPA ≥ 2.0). GPA - grade point average, BSc - Bachelor of Science, MD - degree of Medical Doctor.

Table 1 - GPA in different BSc preclinical courses.

Course	Mean	95% confidence interval
Electives	3.24	3.20 - 3.28
Biology	2.97	2.92 - 3.02
Chemistry	2.90	2.84 - 2.96
Physics	2.74	2.67 - 2.81
English language	2.38	2.32 - 2.44

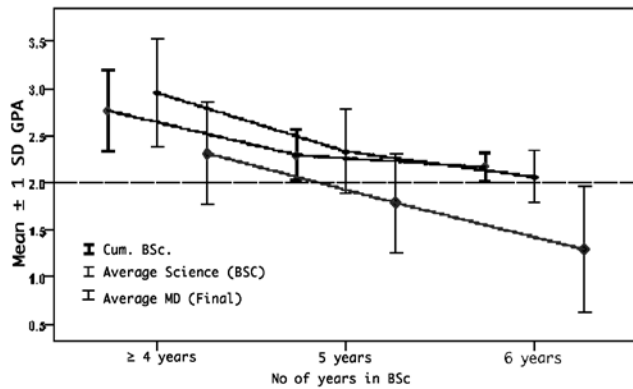GPA - grade point average, BSc - Bachelor of Science.

Figure 2 - Bachelor of Science (BSc) and degree of Medical doctor (MD) performance in relation to the number of years spent in BSc program. GPA - grade point average, Cum - cumulative GPA

Table 2 - Degree of relationship of BSc cumulative GPA and MD GPA with different components of the BSc program.

BSc subjects	BSc cumulative GPA r	MD GPA r
Biology	0.748	0.459
Physics	0.715	0.373
Chemistry	0.707	0.359
Average Biology, Physics & Chemistry	0.841	0.457
English Language	0.545	0.335
Electives	0.333	0.246

r - coefficient of correlation. All correlations are significant at $p < 0.001$. BSc - Bachelor of Science, GPA - grade point average, MD - degree of Medical doctor.

Table 3 - Relationship of MD GPA with BSc GPA and preclinical courses in 3 groups of language GPA and regression coefficients of MD GPA (simple = linear regression) on these grades.

Groups of language		Coeff.	BSc GPA	Biology	Chemistry	Physics	Elective	English
	< 2.0	r	0.531‡	0.393‡	0.101	0.256†	0.217*	0.130
		B	0.919‡	0.383‡	0.083	0.197†	0.291*	0.276
Language GPA	2.0 - 2.8	r	0.593‡	0.324‡	0.247‡	0.243†	0.178†	0.115
		B	0.830‡	0.315	0.204‡	0.172‡	0.219†	0.248
	> 2.8	r	0.658‡	0.487‡	0.505‡	0.454‡	0.305‡	0.337‡
		B	0.861‡	0.557‡	0.417‡	0.386‡	0.413‡	0.614‡

r - coefficient of correlation, B - Regression coefficient, *$p < .05$, †$p < .01$, ‡$p < .001$, GPA - grade point average, BSc- health sciences. MD - degree of Medical Doctor

Table 4 - Regression coefficients of MD GPA on BSc courses and their significance for simple and multiple regression analysis and respective R^2 values.

BSc courses	Simple linear regression			Multiple linear regression		
	R^2	B	*P*-value significance	R^2	B	*P*-value significance
Biology	0.211	0.436	<0.001		0.253	<0.001
Elective	0.061	0.331	<0.001		0.172	0.001
Language	0.112	0.291	<0.001	0.261	0.117	0.002
Chemistry	0.129	0.283	<0.001		0.088	0.028
Physics	0.139	0.278	<0.001		0.042	0.302

MD - degree of Medical Doctor, GPA - grade point average, BSc - Bachelor of Science, R^2 - regression coefficient, B - coefficient of determination

highly correlate with both preclinical and MD GPAs. The correlation of the basic science courses was stronger with the preclinical GPA than with the MD GPA. This confirms the findings from previous studies that showed sciences, basic to medicine, were good predictors of performance in basic medical science examinations,[11] and that they were better predictors for the basic science/ preclinical than for the clerkship/clinical years.[2] The extent of correlation of other courses taught early in the preclinical phase such as English and electives were not

as high as that of science courses and the performance of students varied from being highest in electives to lowest in English. This variation in correlation could have been due to the language of instruction - elective courses are taught in Arabic whereas the science courses are taught in English. In a study from Kuwait that involved students in a similar setting, it was shown that students' performance in the whole medical program correlated strongly with proficiency in English.[12] Indeed, in this study, the GPA of students who scored higher in English correlated better with basic science courses, preclinical and MD GPAs. Conversely, the variation could have simply been due to the content of science courses and their relevance to Medicine. Indeed, McManus et al,[3] suggested that the importance of the substantive content of basic sciences and its relevance to the study of Medicine made them better predictors of MD GPA than non-science courses.

Our study raises an important question: are we justified in taking students into the clinical phase whom we know will struggle later? The results have shown that around 64% of students who score low (<2.0) on MD GPA have preclinical GPA of <2.50, while 43.2% have basic science GPA of <2.50. Students who have low GPAs also spend longer in the medical program. The ability of basic science courses to predict students' performance in the preclinical phase and later in the final MD exams could be taken as an important selection and progression measure. Students can be allowed to progress in the preclinical phase based on their performance in the basic science courses. This will also eliminate the bias that can come from the GPA of electives. Since elective subjects were not as good predictors of students' performance in the medical program as science subjects, their grades should perhaps be eliminated from GPA calculations so that the cumulative GPA at the end of the preclinical phase reflects only that of sciences, basic to medicine. This should allow better filtration of students since any extra credit hours registered in elective subjects will not be counted in the overall GPA. In the United Kingdom where grades in A levels decide selection for medical school, Chemistry and Biology are 2 of the required subjects for selection criteria,[11] and in North America there are suggestions for limiting the use of only the biological sciences and verbal reasoning subsets of MCAT as the 2 best measures for predicting future medical student success.[2] In order to eliminate the perceived bias that elective subjects create for promotion to the clinical phase, the College has limited the number of credit hours allowed from elective subjects to be included in the preclinical GPA. Furthermore, the overall GPA requirement to progress from the preclinical to the clinical phase has changed from 2.00 to 2.50 and in the new curriculum that has recently been implemented in the College, a basic science GPA

of 2.50 is required to progress from phase I to phase II. This move is supported by the ability of the preclinical GPA to predict students' performance in the final MD exams. The attrition rate based on the basic science GPA is approximately 29%, and the new preclinical GPA would be approximately 37%, if a comparison is made with the present situation. However, it is hoped that this would not materialize based on the assumption that if standards were raised, students would perform better. Future research will show the validity of this point.

The major limitation of our study is that it is a single institute study, the results of which are difficult to generalize. Nevertheless, the specific aspect of the institute that it tackles is important in justifying the decisions taken by the college, which affects student progression criteria from the preclinical to the clinical phase.

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