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Original Article

Does high achievement in preclinical years predicts similar achievement in clinical year in medical students? A correlational study

Saira Rahim[1]
1 Medical Education Department, Fatima Memorial Hospital College of Medicine and Dentistry (FMHCMD), Lahore, Pakistan.

ABSTRACT

Introduction: There is speculation that early medical school basic science instruction is ultimately of limited utility when students enter clinical rotations. It is worthwhile to establish whether early performance in pre-clinical years correlates with performance in later clinical years so that curricula can be adapted accordingly, and actionable predictors of student performance can be identified.

Objective: The objective of the study is to investigate the predictive role of student academic performance in early (i.e. "pre-clinical") medical school years for performance in later (i.e. "clinical") medical school years.

Methods: We employed a retrospective correlation approach by compiling data from medical students in a major academic center in Lahore, Pakistan. The sample cohort consisted of 413 students taken from three consecutive graduating classes (2018, 2019, 2020). Two separate (but thematically related) statistical analyses were undertaken: 1)we created a multivariate linear regression model to predict performance in later (clinical) years (year 5) based on a student's known demographic factors and academic performance in early (pre-clinical) exams (years 1 and 2) we performed multivariate logistic regression to model the likelihood of attaining "super high achiever" status at the time of graduation (outcome variable) and used demographic data as well as "high achiever" status in early exams (i.e. first three 'prof' exams) as covariates.

Results: The most important predictor of performance in the final summative examination was the performance in early 'prof' exams (Year 2 Prof Score F ratio 91.3, $p<0.0001$). Early attainment of high-achiever status in medical school correlated with the attainment of 'super high achiever' status at the time of graduation ($p<0.0001$).

Conclusion: Performance in early medical school years (i.e., "pre-clinical") correlated with performance in the later medical school years (i.e. "clinical").

KEYWORDS:
Early performance, pre-clinical, high-achiever

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INTRODUCTION

In keeping with constantly evolving perceptions of what makes a "good" doctor and which metrics are most predictive of success in medical school and post-graduate medical practice (Leahy et al., 2003), there is continued evolution in selection criteria for medical schools internationally (McManus et al., 2003; Mercer & Puddey, 2011; Powis, 2015). While there is continued and justifiable interest in defining optimal selection criteria for applicants into medical school, it is also important to study the predictive role of early performance once students begin their medical training. In real-world terms, 'early' and 'late' performance in medical school are often synonymous with performance in 'pre-clinical' and 'clinical' years. While there are ongoing efforts across medical schools to integrate preclinical and clinical components (Abramovitch et al., 2002; Verma, 2016), the general distinction between these two stages of undergraduate medical training persists, especially in Pakistan. The study of early medical student performance is an important undertaking because it allows for the identification of medical student characteristics that may predict superior academic performance in later years (Glaros et al., 2014). If a correlation can be demonstrated between early performance in medical school and performance in the more advanced years, it may be a strong basis for studying characteristics that make early high-achievers different from the rest of their cohort as a means of improving overall class performance. Conversely, if it can be shown that early poor performance in medical school is predictive of continued poor performance in later years, efforts can be made to identify potential 'protective factors' amongst early poor performers (Yates & James, 2007). Some existing research efforts lay a useful groundwork for this field of inquiry. In a cross-sectional study of 71 students, Salem et al have suggested that early medical student performance (in pre-clinical years) correlated significantly with later performance (in clinical years), while pre-admission performance did not correlate with

Correspondence:
Dr. Saira Rahim
Email address: drsairahim@gmail.com, Cell: +92 300 480 2790
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clinical performance (Salem et al., 2016). In a correlational study in 2007, Kozar et al found that while preclinical performance (as measured by pre-clinical block exams and USMLE) seemed to correlate with performance on clinical block exams on univariate analysis, the correlation was not apparent on multivariate analysis (Kozar et al., 2007). The results of these earlier studies, as well as others (EL-Bab et al., 2011), suggest that there remains a significant gap in the existing knowledge base on this topic and there is ample room for continued investigation of the predictive role of early (mostly 'pre-clinical') medical student performance. In the current study, we aim to assess whether a meaningful correlation exists between performance in early medical school years ('pre-clinical and later medical school years ('clinical') as evaluated by summative exam scores at different time-points in the medical curriculum. Key predictor variables for our analyses include summative examination ("prof exam") scores from early medical school years. The key outcome of interest includes performance as judged on summative examination performance in later medical school years.

METHODS

We employed a retrospective correlation approach by compiling data from medical students in a major academic center in Lahore, Pakistan. To allow for longitudinal analysis, exam scores for each student from all five years of undergraduate medical training were collected and included in the analyses. Variables of interest included student demographics (gender, age, city of origin, pre-medical school system) as well as scores from summative examinations (termed "professional exams" or "profs" in Pakistan.) The study protocol underwent review by the Institutional Review Board (IRB) at Fatima Memorial Hospital College of Medicine and Dentistry, Lahore, Pakistan(IRB#FMH-07-2021-IRB-931-M). The sample cohort consisted of 413 students taken from three consecutive graduating classes (2018, 2019, 2020). Inclusion criteria were deliberately kept broad to allow maximal data acquisition; all students who completed the 5-year MBBS program in these graduating classes were included. Students were excluded from analyses if they failed to complete the MBBS program. We also identified a group of "high achievers" and "super-high achievers" to facilitate analyses. "High achiever" status for a given exam session was achieved by students who were in the top 20th percentile for that exam. "Super high achiever" status was achieved by students at the time of graduation if they had attained "high achiever" status four times during their medical training. Data was compiled and collated in spreadsheet format (Microsoft Excel). Descriptive statistical analysis and tables were prepared in Excel. Inferential statistics were performed using JMP Pro (SAS Institute) (Jones & Sall, 2011; Klimberg & McCullough, 2016). Two separate (but related) statistical analyses were undertaken.

Analysis 1 - We performed multivariable linear regression to model student performance using final year summative exam ("final prof") scores as the outcome variable and included demographic data as well as summative exam scores from early years (i.e., first three "prof" exams) as covariates. We controlled for multiple confounding factors including the pre-medical school system, pre-admission test score, student age, and city of origin. Thus, we created a computational model to predict performance in later (clinical) years based on a student's known demographic factors and academic performance in early (pre-clinical) exams.

Analysis 2 – We performed multivariate logistic regression to model the likelihood of attaining "super high achiever" status at the time of graduation (outcome variable) and used demographic data as well as "high achiever" status in early exams (i.e. first three 'prof' exams) as covariates. Again, we controlled for multiple confounding factors including the pre-medical school system, pre-admission test score, student age, and city of origin. Thus, we created a model that could determine whether achieving high achiever status in early medical school would increase the likelihood of being deemed a 'super-high achiever' at the time of graduation. No student-identifying data elements (name, serial number, address, etc.) were included in the dataset used for analysis.

RESULTS

Table 1 shows descriptive statistics for the study cohort. The sample consists of 413 students with a slight majority of females (65%). All students were of a similar age (i.e., narrow spread around mean age of 26.8 years). Local students are slightly overrepresented (55%), and the majority of students were from the Matric/F. Sc pre-medical school system. Results of 1st Prof (II) exam show the widest spread, followed by Final prof, 1st Prof (I).

Table I: Descriptive Statistics for students included in the study

N	413	
Gender	Male (%)	Female (%)
	35	65
Average Age in Years (Standard Deviation)	26.8 (1.4)	
Residents of Lahore (%)	55	
Pre-medical School System	O/A Level %	Matric/FSC %
	20	80
Average Prof 1, Part I % (Standard Deviation)	67.1 (8.4)	
Average Prof 1, Part II % (Standard Deviation)	71.3 (9.9)	
Average Prof 2 % (Standard Deviation)	70.3 (7.7)	
Average Prof 3 % (Standard Deviation)	68.3 (7.9)	
Average Final Prof % (Standard Deviation)	70.9 (9.2)	

Analysis 1 – Modeling performance in late (clinical) years based on performance in early (pre-clinical) years

Figure 1 shows an 'actual by predicted' plot of our multivariate linear regression model. Correlation between the actual final year 'prof' scores and the predicted final year 'prof' scores (based on the model) is evidenced by the narrow scatter along with a line with a trend-line. R2 for the model is 0.65 ($p<0.001$). Table 2 shows the F values for each variable in the model (providing a comparative quantitative measure of the impact of each variable on model prediction.) These data show that the most important predictors of performance in the final prof are: score in Prof 2, score in Prof 1 (II), and score in Prof 1 (I). (Note: we refer to the first two professional exams taken by medical students as 'Prof 1 Part I' and 'Prof 1 Part II' as was the standard nomenclature in Pakistani medical schools until recently. The nomenclature has recently been revised so that the first two professional examinations are now referred to as 'Prof 1' and 'Prof 2'.)

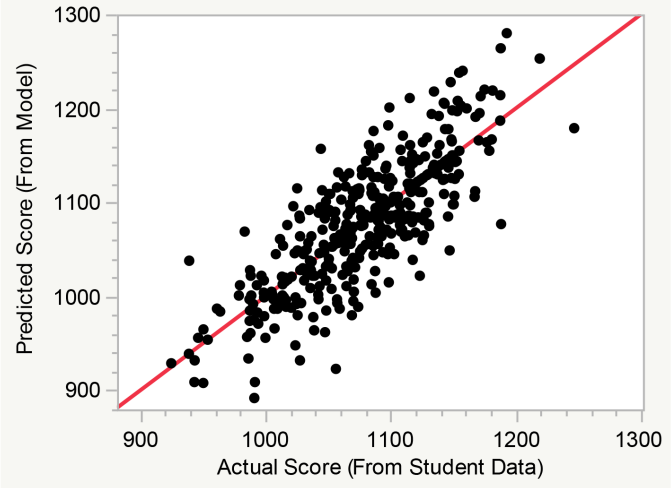

Fig I: Predicted by Actual' Scatter Plot for Multivariate Regression Model of Final Year Prof Scores

Table II: Result s of the multivariate linear regression model of final prof scores.

Variable	F Ratio	P-Value
Prof 2	91.3	<0.0001
Prof 1 (II)	14.8	0.0001
Prof 1 (I)	13.6	0.0003
Age	4.3	<0.0001
Gender, City, Pre-med school system, Resident of Lahore		>0.5

Analysis 2 – Modeling likelihood of achieving 'super high achiever' status at graduation based on early 'high achiever' status

Figure II shows that many students achieve 'high achiever' status multiple times during medical school. Only about 10% of students can achieve 'high achiever' status four or more times during medical school (Table III); these students are designated "super-high achievers".

Table IV shows results from our logistic regression model to predict the likelihood of achieving 'super high achiever' status. The model has strong predictive power ($R2= 0.89$, $p<0.0001$). Achievement of 'high achiever' status in any of the first three prof exams was an important predictor of attaining 'super high achiever' status. It is important to note that 'high achiever' status refers only to a student's performance in a single exam and can be achieved multiple times in a student's medical school career, whereas 'super high achiever status' is a designation attained only once as the end of a student's career.

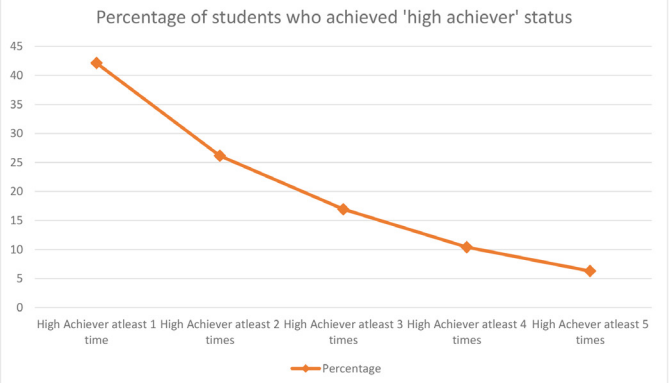

Fig II. Percentage of high achiever students

Table III: The proportion of medical students meeting different thresholds of high achiever status throughout medical school

	N	Percentage
High Achiever at least 1 time	174	42.1
High Achiever at least 2 times	108	26.2
High Achiever at least 3 times	70	16.9
High Achiever at least 4 times	43	10.4
High Achiever at least 5 times	26	6.3

Table IV: Results of multivariate logistic regression model for likelihood of attaining "super high achiever" status at the time of graduation

Model R Square (P Value)	0.89 (<0.0001)	
Variable	**Likelihood Ratio (Chi-Square)**	**P-Value**
Top Achiever Status in Prof 1, Part 1	6.3	0.01
Top Achiever Status in Prof 1, Part 2	11.3	0.0008
Top Achiever Status in Prof 2	5.85	0.02
Gender, Age, City		p>0.1

DISCUSSION

Medical students are initially introduced to the basic sciences which lay the foundations for their studies coming up in later years. The findings of the present study reveal that students' performance in the early years of medical college correlates with their performance in later years of medical college. In real-world situations, this finding implies that students' performance

in pre-clinical years of medical college correlates with their performance in clinical years. There is ongoing interest in understanding whether early medical school performance has any implications for medical students throughout their medical training extending into their early clinical practice (Spurlock et al., 2010). It is often speculated that performance in basic science courses may be entirely uninformative in predicting a physician's future clinical capabilities. The existing literature on this question has provided mixed results, as discussed earlier. While some authors have found a meaningful correlation between pre-clinical performance and clinical performance in medical students (Salem et al 2006), others have failed to replicate these results (Daly et al., 2006; Kozar et al., 2007). Our study provides evidence to support the notion that a correlation does indeed exist between pre-clinical and clinical performance, at least in the context of Pakistani medical students at a major academic center within an urban context.

It is worth considering why our results demonstrate such a correlation which was not apparent in some earlier work. One possible explanation is that there are factors unique to the Pakistani medical student selection process which cause a 'pre-selection' effect. Admission into Pakistani medical schools are based primarily on scores from secondary school examinations and admission tests. Thus, students who are good test-takers have a natural advantage. Within this group, those who are exceptionally good test-takers are likely to remain that way throughout their medical school career. Our study utilizes summative exam scores as the primary outcome of interest and does not take into account other possible outcome measures (patient satisfaction scores, interpersonal communication skills, etc.). Studies from other countries where both admissions to medical school as well as medical student assessments are more diverse (i.e., relying on more domains than just summative exam scores) may have been unable to find the same correlation that we have demonstrated because of differences in the outcome measures being analyzed.

While we believe that our results provide important insight into a little-examined area of medical student performance in Pakistan, we recognize that our study has limitations. The study is retrospective and employs existing data elements. Important demographic variables (such as family income, parents' level of education, the caliber of secondary school, etc.) were not captured. Additionally, our study relies on the notion that summative examinations in later years of medical school are representative of clinical performance. This is a reasonable assumption given the role of clinical rotations in later years which are a factor in the summative evaluations conducted in later years of medical school. However, it would not be correct to state that summative exams in the later years of medical school are a pure assessment of clinical acumen entirely divorced from the basic science curriculum.

We believe that our work provides an important basis for future investigation. Future studies would be well placed to use a similar methodology as applied in our study to identify a subset of "at-risk" students who are unable to demonstrate strong academic performance in later years of medical school and to identify 'protective factors' which may be targeted in early medical school years to improve performance. Furthermore, future studies may benefit from including a more diverse set of outcome measures (such as performance in clinical rotations) as part of their modeling (Makoul & Altman, 2002). It would be beneficial for future studies to include data from multiple academic centers in both rural and urban settings to identify the effect-modifying factors that might exist in different community contexts. Finally, it would be worthwhile to investigate the role of early medical student performance in not only later medical school, but also in post-graduate clinical performance.

CONCLUSION

Student performance in early medical school years (i.e. "preclinical") is a significant independent predictor of performance in later (i.e. "clinical") years. Early attainment of "high achiever" status in medical students was a significant predictor of attainment of "super high achiever" at the time of graduation.

DECLARATION OF INTEREST

The author has no conflicts of interest to declare.

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AUTHOR'S CONTRIBUTION

1. Dr. Saira Rahim. The author has independently conceived the study, performed data analysis, and composed the manuscript..