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Using admissions criteria for predicting student failure outcomes of supplemental instruction and remediation in a Doctor of Pharmacy programme

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Abstract

Objective: To identify potential unique predictors of academic failure or success in a Doctor of Pharmacy programme using curricular experiences with supplemental instruction (SI) and remediation.

Methods: We assessed correlations between admissions variables, including grade point average (GPA) and Pharmacy College Admissions Test (PCAT) scores, with curricular performance measures, including SI and remediation, in 369 students over four years.

Results: Overall entry GPA, pre-requisite/pre-pharmacy GPA, and required maths and science GPA negatively correlated with number of SI enrolments and remediation. Lower PCAT verbal and quantitative ability scores negatively correlated with number of remediation sessions while lower PCAT chemistry and reading comprehension scores negatively correlated with number of SI enrolments and course failures. Overall entry, pre-requisite/pre-pharmacy, and required maths and science GPA; and PCAT composite, quantitative ability, and chemistry scores positively correlated with GPA after the first academic year and at graduation.

Conclusions: Students with higher GPAs and PCAT scores were less likely to need academic support. Lower GPAs and PCAT scores correlated to an increased likelihood of failure and predict need for academic assistance to ensure success.

Keywords: *Admissions, Supplemental Instruction, Remediation, Academic Performance, Success, Failure, Grade Point Average*

Introduction

Many studies have evaluated the ability of specific admissions criteria to predict outcomes of success or failure in the Doctor of Pharmacy curriculum (Allen & Bond, 2001; Thomas & Draugalis, 2002; Kuncel *et al*., 2005; McCall *et al*., 2006; Schauner *et al*., 2013). Several evaluations demonstrate that Pharmacy College Admissions Test (PCAT) scores, including composite and specific subject area scores, cumulative pre-pharmacy grade point average (GPA), and maths and science pre-pharmacy GPAs are predictive of programme academic success (Allen & Bond, 2001; Thomas & Draugalis, 2002; Kuncel *et al*., 2005; McCall *et al*., 2006; Schauner *et al*., 2013). Advanced biology and chemistry coursework and organic chemistry GPA have also been linked to higher academic success in pharmacy programmes (Houglum *et al*., 2005; McCall *et al*., 2007). Additionally, limited data exist that evaluates entering students with advanced degrees and relative age to academic success (McCall *et al*., 2006). Other healthcare professional schools have found similar results predicting success in programmes or on licensure examinations. For example, one study of nursing school graduates from four nursing schools in a large state university system in California found that both pre-nursing and in-programme standardised testing performance correlated with success on the nursing licensure exam, the National Council Licensure Examination for Registered Nurses (NCLEX-RN) (McCarthy *et al*., 2014). Moreover, medical schools have found incoming GPA and Medical College Admission Test (MCAT) results as positive predictors for academic success. In addition, a Canadian study reported that medical school applicants accepted in a school of medicine that used the Multiple Mini-Interview admissions process scored higher on the Medical Council of Canada Qualifying Examination (MCCQE) compared to those students accepted to programmes using more traditional interview techniques (Eva *et al*., 2012).

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Fewer data exist regarding evaluation of admissions variables and their relation to outcomes of academic failure in the pharmacy curriculum. Admissions variables predictive of academic struggle include PCAT, cumulative pre-pharmacy GPA, maths and science GPA, and the American College Testing (ACT) college entrance exam scores (Houglum *et al*., 2005; Schauner *et al*., 2013). In addition, candidates scoring less than the 40th percentile on the PCAT have been shown to have a lower GPA in the pharmacy curriculum (Kelley *et al*., 2001).

Many schools implement different mechanisms to enable struggling students to succeed in their coursework (Arendale, 1997; UMKC International Center for Supplemental Instruction Web Site, 2014). Our programme utilises a modified form of supplemental instruction (SI) and remediation as two of these mechanisms. SI with course faculty is mandatory for all students scoring less than 70 percent at pre-defined time points during a required course. The course syllabus informs the date, time, and location of the session. As a guiding principle, SI is scheduled to occur soon after an exam or major course grade is released. The number of sessions is dependent on the course length. Each SI consists of a facilitated discussion with the course faculty to improve understanding of content areas and identify barriers to effective learning. Remediation may be offered to students scoring less than 70 percent on their final course grade; the student will participate in an intensive two-week study of the course during the summer and receive an additional opportunity to pass the course. However, students who require remediation due to course failure have recently been shown to also have lower pass rates on the North American Pharmacist Licensure Examination (NAPLEX) (Madden *et al*., 2012).

The utilisation of SI and remediation as markers of academic performance has not been previously evaluated versus other published admissions variables. The objective of our study was two-fold: 1) to assess known variables of student academic failure and success; and 2) to identify potentially unique predictors of academic failure using curricular experiences with SI and remediation in our Doctor of Pharmacy programme.

Methods

This retrospective cohort analysis was approved by the university's institutional review board (IRB) for the Protection of Human Subjects (IRB Number: 13-06-005). Pharmacy school applications and transcripts were reviewed for students who matriculated in our programme over four academic years. The assessed variables were selected as a result of literature reviews, availability of data, and discussion by faculty on the Admissions committee and the Office of Student Affairs. Independent variables included demographic, prerequisite requirements, and pharmacy school performance measures. Demographic variables collected were: Texas residence, out-of-state residence, foreign student, age, first generation college student, gender, and ethnicity. The prerequisite requirements considered in this study were: overall entry GPA, pre-requisite/pre-pharmacy GPA, required maths and science GPA, previous (Associate or Bachelor) or advanced degree (Master or Doctorate), and PCAT scores (composite, verbal ability, quantitative ability, biology, chemistry, reading comprehension). All attempts in a specific course were included in the overall and pre-requisite/pre-pharmacy GPA. The pharmacy school performance measures collected were: supplemental instruction, first-year GPA, overall professional GPA, course remediation, course failure, rotation failure (introductory or advanced pharmacy practice experiences), on-time pharmacy school graduation, and inability to pass the NAPLEX exam on first attempt.

Student failure was defined as greater than six supplemental instruction enrolments, any course remediation (letter grade of "D"/number grade of 60-69), any course failure (letter grade of "F"/number grade of <60), any introductory pharmacy practice experience (IPPE) or advanced pharmacy practice experience (APPE) failure (number grade <70), and not achieving on-time pharmacy school graduation. Six supplemental instructions were determined by allowance of one supplemental instruction enrolment per semester for the entirety of the didactic programme. Student success was measured as first-year GPA reported following completion of the first academic year, overall professional GPA. The overall professional GPA was calculated at the end of the third professional year upon completion of the didactic portion of the four year programme.

Student data was initially collected in a Microsoft Excel® (Microsoft Office Professional Plus® 2010) spreadsheet. Data analysis was performed using JMP® 10.0 (SAS Corporation, Cary, North Carolina). Correlation between pre-pharmacy variables and measurements of student failure were determined for 369 students admitted to our Doctor of Pharmacy programme over four academic years from 2009 to 2013. Correlations were performed using Spearman's rho correlation coefficient. Descriptive statistics were used to analyse demographic variables and academic performance measures. Comparisons were considered statistically significant if the *p*-value was less than an *a priori* alpha level of 0.05. *Chi*-square and Fisher's exact tests were used for analysis of dichotomous and categorical data. Continuous variables were tested for normality using the Shapiro-Wilk W Goodness of Fit test. Normally distributed variables were reported as mean and standard deviation and compared by the Student's *t*-test. Non-normally distributed variables were reported as median and interquartile range and analysed by the Wilcoxon Rank Sum test. All variables found to be significant ($p<0.05$) on univariate analysis were included in a multivariable nominal logistic regression model. The dependent variable was any outcome of failure, as previously defined. Variables that remained significant in the multivariable model were considered to be independent predictors of any outcome of failure.

Table I: Baseline Characteristics of All Students Matriculated in the Doctor of Pharmacy Curriculum (n=369)

Demographic Variables	**n (%)**
University of the Incarnate Word undergraduate student	99 (27%)
Texas resident	351 (95%)
Foreign student	2 (0.5%)
1st generation college student	103 (28%)
Female	265 (72%)
Ethnicity	
Caucasian	101 (27%)
Hispanic	124 (34%)
Black	35 (10%)
Native American	2 (0.5%)
Asian American	98 (27%)
Other	9 (0.5%)
Age, median (years)	24
Previous Coursework	
Overall GPA, median (IQR)	3.30 (3.08-3.57)
Pre-requisite GPA, median (IQR)	3.40 (3.14-3.70)
Maths & Science GPA, median (IQR)	3.21 (2.93-3.54)
Previous degree	96 (53%)
Advanced degree	17 (5%)
Application Variables	**Median (IQR)**
PCAT	
Composite	59 (43-76)
Verbal ability	50 (32-69)
Quantitative ability	48 (29-61)
Biology	59 (41-76)
Chemistry	47 (25-66)
Reading comprehension	40 (25-61)

GPA: grade point average
IQR: interquartile range
PCAT: Pharmacy College Admissions Test

Results

The majority of students (n=351) were Texas residents. Approximately one-quarter of students (n=99) completed pre-requisite courses at our university's undergraduate programme. Another one-fourth were first generation college students (n=103) and nearly half (n=159) self-defined their ethnicity as Hispanic or Black. More than one-half of students had previously earned either an undergraduate (n=196) or advanced (n=17) degree. Table I shows median overall entry GPA, pre-requisite/pre-pharmacy GPA, required maths and science GPA, and PCAT scores. The median PCAT composite and biology score was 59.

Table II illustrates the correlation between pre-requisite/pre-pharmacy variables and outcomes of failure. A negative correlation was noted between the overall entry GPA, pre-requisite/pre-pharmacy GPA, and required maths and science GPA with the number of SI enrolments as well as any course remediation. Students with an overall entry GPA of less than 3.3 were likely to be enrolled in six or more SI sessions throughout their first three professional years as well as in remediation. Students with pre-requisite/pre-pharmacy and required maths and science GPAs of less than 3.4 and 3.21, respectively, were likely to result in similar outcomes of failure. Although not statistically significant, students with higher GPAs were less likely to fail rotations or to require more than four years to graduate.

The median composite PCAT score of less than 59 correlated with the number of SI enrolments, any course remediation, and course failures. Conversely, a median composite PCAT score of greater than 59 showed a positive correlation with on-time graduation. Lower PCAT verbal ability scores and quantitative ability scores were negatively correlated with the number of remediation sessions for this study group. Furthermore, lower PCAT chemistry and reading comprehension scores showed negative correlations with the number of

Table 2: Prerequisite/Prepharmacy Variables and Outcomes of Failure (n=369)[ab]

Prepharmacy Variable	**# SI Enrollments**	**# Remediations**	**# Course Failures**	**Rotation Failure?**	**Graduation in 4 years?**	**NAPLEX Failure on 1st Attempt**
Overall GPA	-0.1747*	-0.1441*	-0.0811	0.0164	0.052	0.091
Pre-requisite GPA	-0.1232*	-0.1770*	-0.0773	-0.013	0.087	-0.112
Maths & Science GPA	-0.1698*	-0.1606*	-0.0623	0.054	0.055	-0.095
PCAT Composite Score	-0.2107*	-0.1443*	-0.1065*	0.023	0.129*	-0.067
PCAT Verbal ability	-0.1139	-0.2433*	-0.1788	0.027	0.10	--
PCAT Quantitative ability	-0.0865	-0.2214*	-0.1898	-0.031	0.086	--
PCAT Biology Score	0.0346	-0.0962	-0.1375	0.127	0.039	--
PCAT Chemistry Score	-0.2294*	-0.1583	-0.1103	-0.078	0.160	--
PCAT Reading Comprehension	-0.1414	-0.1562	-0.2348*	0.057	0.114	--

**Statistically significant difference (p<0.05)*
[a] Positive correlations (determined by Spearman's Rho Correlation Coefficient) are displayed as positive numbers and negative correlations are displayed as negative numbers.
GPA: grade point average
NAPLEX: North American Pharmacist Licensure Examination
PCAT: Pharmacy College Admissions Test

SI enrolments and course failures, respectively. There was a positive correlation among overall entry, pre-requisite/ pre-pharmacy, and required maths and science GPAs with GPAs reported following completion of the first academic year and at graduation (Table III). Additionally, there was a positive correlation among the PCAT composite, quantitative ability, and chemistry scores with outcomes of success.

Table III: Prerequisite/Pre-pharmacy Variables and Outcomes of Success (n=369)[a] pharmacy

Pre-pharmacy Variable	Professional Year One GPA	Overall Professional GPA
Previous Coursework		
Overall GPA	0.2377*	0.2672*
Prerequisite GPA	0.2394*	0.2520*
Maths & Science GPA	0.2342*	0.2519*
Application Variables		
PCAT Composite Score	0.3718*	0.2364*
PCAT Verbal Ability	0.2039	0.1657
PCAT Quantitative Ability	0.2550*	0.2275*
PCAT Biology Score	0.1025	0.0046
PCAT Chemistry Score	0.3491*	0.2913*
PCAT Reading Comprehension	0.1786	0.1286

**Statistically significant difference (*p*<0.05)*
aPositive correlations (determined by Spearman's Rho Correlation Coefficient) are displayed as positive numbers and negative correlations are displayed as negative numbers
GPA: grade point average
PCAT: Pharmacy College Admissions Test

Of the 369 students, 136 had at least one failure outcome (Table IV). There were no significant differences among first generation college students or age; however, there were significant findings among pre-requisite/pre-pharmacy coursework variables. These include overall entry GPA of ≤3.2, pre-requisite GPA of ≤3.34 and median maths and science GPA of ≤3.12, which correlated to an increased likelihood of a failure outcome. Additionally, there were significant findings among PCAT parameters. Composite median score of ≤54 and quantitative ability median score of ≤41 correlate to an increased likelihood of a failure outcome in the curriculum. It is interesting to note that previous and advanced degrees did not show a correlation with decreased likelihood of failure outcomes.

Lastly, we also conducted a multivariable nominal logistic regression model to evaluate the effect of the different significant admissions variables on each other and any outcome of failure. Admissions variables that were significant on univariate analysis (Table IV) included overall entry GPA, pre-requisite/pre-pharmacy GPA, maths and science GPA, composite PCAT score, and PCAT quantitative ability. When entered into the nominal logistic regression model, none of the variables remained significant; therefore, no individual variable was an independent predictor of any outcome of failure.

Table IV: Summary of Predictive Outcomes of Failure in Curriculum

Admissions Variable	No Outcomes of Failure in Curriculum	Any Outcome of Failure in Curriculum
Demographic Variables		
Total student	233	136
1st generation college student	66	37
Age, median (years)	24	24
Previous Coursework		
Overall Entry GPA, median*	3.35	3.20
Prerequisite/Pre-pharmacy GPA, median*	3.43	3.34
Maths & Science GPA, median*	3.25	3.12
Previous degree	129	67
Advanced degree	12	5
Application Variables		
PCAT, median		
Composite*	61	54
Verbal ability	52	48
Quantitative ability*	52	41
Biology	61	56
Chemistry	52	37
Reading comprehension	45	40

**Statistically significant difference (*p*<0.05)*
GPA: grade point average
PCAT: Pharmacy College Admissions Test

Discussion

The pharmacy profession has seen many changes occur over the last ten years, including an increase in graduates competing for a declining job market. Currently, the nation has 129 Doctor of Pharmacy programmes anticipated for 2013 – 2014 (American Association of Colleges of Pharmacy, 2015). The number of degrees conferred has doubled since 2002, from 6,158 in 2002 to 12,719 degrees conferred in 2012 (American Association of Colleges of Pharmacy, 2013). In this competitive climate, pharmacy schools are focusing on strategies to help identify highly qualified candidates with the intent of producing competitive graduates in the ever-evolving healthcare environment.

In addition to these market changes, the Accreditation Council on Pharmaceutical Education (ACPE) requires pharmacy programmes to annually report admissions (ACPE Standard 17) and progressions (ACPE Standard 19) data. Programmes are expected to continually assess admissions and progressions criteria, policies, and procedures, specifically developing and refining criteria to ensure successful students in the curriculum and in practice (Accreditation Council for Pharmaceutical Education, 2015). Ultimately, pharmacy programmes must be strategic and evidence-based when designing admissions criteria and student progression policies and procedures as a means for supporting their graduates in finding employment and being effective professionals.

Our programme utilises SI to help students who score less than a required, pre-defined grade within a course. The overall goal is to prevent course failure and promote student success in the pharmacy programme. In the current study, we identified admissions variables that may be predictive of student failure as being enrolled in six or more supplemental instruction sessions or any course remediation. Other specific predictive admissions variables include entry GPAs and PCAT scores. To our knowledge, this is the first published study showing that curricular assistance programmes could possibly be linked to specific admissions variables.

The objective of this study was to evaluate existing variables of student academic success and failure, including variables with limited published data, and identify potentially unique predictors of academic failure or success using curricular experiences with SI and remediation in our Doctor of Pharmacy programme. Our findings are similar to previously reported literature showing that composite PCAT and sub-category scores, pre-pharmacy cumulative GPA, and maths and science GPA are predictive of academic performance in the pharmacy curriculum (Allen & Bond, 2001; Thomas & Draugalis, 2002; Kuncel *et al*., 2005; McCall *et al*., 2006; Schauner *et al*., 2013). We utilised these same parameters to identify admissions variables to predict those students less likely to succeed. Our data show that lower entry GPAs and composite, quantitative ability, and chemistry PCAT scores correlate to an increased likelihood of failure. While the univariate analysis identified several factors as being predictors of programme failure, none of them were identified as independent predictive factors in the multivariate analysis. This highlights the continued struggle many programmes face when designing admissions criteria to select optimal students.

Interestingly, two variables that did not decrease the likelihood of a failure outcome were any type of degree prior to pharmacy school and age. We anticipated that students with any type of previous degree were more likely to succeed given their prior exposure to advanced coursework. Further studies are warranted to evaluate the rigour of the courses taken along with the degrees conferred. Regarding the maturity variable, our data suggest that age was not a predictor of failure.

Potential limitations of this data include the retrospective nature of the study. The sample size was small; however, we included all data available for students who completed the programme at the time of data analysis. Moreover, a small sample size can affect the correlation coefficient making it difficult to evaluate. In addition, the Spearman's rho correlation coefficients were relatively weak when identifying an association even though they reached statistical significance. Therefore, a larger sample size over a longer period of time would help to increase robustness of conclusions. Because the study outcomes included overall professional GPA and NAPLEX failure on first attempt, we only included students who had the opportunity to matriculate through the entire programme. Lastly, use of remediation and supplemental instruction programmes may vary between schools, making it difficult to generalize these results to all schools of pharmacy.

Conclusions

Students with higher GPAs and PCAT scores at admission are less likely to need academic assistance in the pharmacy curriculum. Schools of pharmacy can use this information to strengthen their admissions programme by creating admissions models for predicting failure, with the intent to increase the likelihood of all matriculating students completing the Doctor of Pharmacy programme. If students are admitted with criteria below these limits, tailored early intervention programmes need to be instituted to promote their success. To better develop a complete model, additional admissions variables, including subjective measures such as but not limited to interviews, personal statements, and letters of recommendation, as well as objective measures such as the multiple mini-interview process should be evaluated. However, future studies are warranted to determine the success of these models and programmes.

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