

RESEARCH ARTICLES

Predictors of Academic Success and Failure in a Pharmacy Professional Program

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Objectives. This study was conducted to determine which admissions criteria are valuable in selecting pharmacy students by determining which criteria are significant predictors of success or failure.

Methods. A statistical analysis was conducted on the retrospective data of 309 students. Academic probation was used as an indication of academic failure. Academic success was measured by first-professional year grade point average (GPA) in pharmacy courses.

Results. Predictors of failure included ACT composite score, average grade in organic chemistry courses, and gender. Predictors of success included ACT score, average grade in organic chemistry courses, grades in math and science prepharmacy courses, and prior attainment of a bachelor's degree.

Conclusion. Academic predictors of success and failure shared common variables, but there were predictors of success that were not predictors of failure. It may be useful for selection committees to consider both sets of predictors as part of the screening processes.

Keywords: academic success, academic failure, pharmacy students, American College Test (ACT), grade point average

INTRODUCTION

Every year schools and colleges of pharmacy face the difficult task of determining which students to admit to their professional programs. The task has become even more difficult in the past few years with the increase in applicants. The number of applications to pharmacy programs increased by 9.1%, 24.6%, and 41.7% in 2001, 2002, and 2003 applicant cycles, respectively.¹⁻³ Similarly at South Dakota State University (SDSU) College of Pharmacy there was a 79% increase in the number of applicants from 2002-2004. With the increased number of applicants for each available position, there are more students with records of high academic performance. Academic performance measures provide useful information for reducing the large pool of applicants to a smaller group. Other characteristics such as communication skills, leadership potential, and motivation to become part of the profession can then be considered as part of the final selection criteria.

The process of selecting students for the professional program is even more critical when the current shortage of pharmacists is considered. This shortage has caused some pharmacy schools to stretch their resources to increase the number of students in their program. These

factors make it increasingly important for pharmacy schools to select students who will complete the program and graduate. Each student who leaves the pharmacy program without completing it contributes to the shortage. Students typically leave pharmacy programs because of a change in career preference, an unexpected personal development, or poor academic performance.

Many studies have investigated the ability of admissions criteria such as Pharmacy College Admission Test (PCAT) scores, cumulative grade point average (GPA), science GPA, and possession of a prior degree to predict success in the professional program.⁴⁻²³ One major intent of each of these studies was to identify criteria that had a positive correlation and to use those criteria as part of the selection process. However, results have varied among studies. For example, some have reported that the composite score or selected subscores of the PCAT are predictors of success in the professional program, whereas other studies have shown the lack of predictive ability of some or all aspects of the PCAT scores on professional program success.^{5-7,10,14,15,17,18,20-23} Results regarding cumulative prepharmacy GPA also have conflicting conclusions.^{10,12,14,15,17,18,20,21,23} Chisholm has reported the benefit of a prior 4-year college degree as a predictor of success, but the results of Thomas did not concur.^{16,17,19,22} On the other hand, more consistent conclusions have been reported concerning the significance of prepharmacy math and science GPAs in achieving success in the professional program.^{8,14,17,22}

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Table 1. Factors Studied as Potential Predictors of Academic Success and Failure*

Demographic Variables
Gender
Prepharmacy Curriculum Status
Prior Degree
P1 Year
Academic Performance Measures
ACT Composite Score
Ave Organic Chem Grade
Cumulative GPA
Science Value

*See text for definitions.

Few studies have looked at predictors of academic failure. Chisholm studied potential predictors of students who will be below the 25th percentile of the first professional pharmacy year class as an indicator of academic difficulty. The factors studied included prior 4-year degree, prepharmacy GPA, math/science prepharmacy GPA, and PCAT scores, but none of the factors were significant predictors of the lower percentile ranking.¹⁷ In another study, Chisholm looked at the necessity of students repeating professional curriculum courses as an indicator of academic difficulty.¹⁹ The study focus was on students with a prior 4-year degree and the study found that these students were less likely to repeat courses and had lower attrition rates than students without a prior degree.

The PCAT score is the most frequently used standardized test score as selection criteria among colleges of pharmacy. For nearly 30 years, studies have been conducted regarding the correlation of PCAT scores with academic success.⁴ As discussed above, PCAT scores have been useful predictors of academic success for some pharmacy programs. However, few pharmacy colleges use the American College Test (ACT) score as selection criteria.²⁴ This test is typically taken by college-bound high school students in many states and provides subscores (science, math, reading, English), as well as a composite score. Scores range from 1 to 36. The ACT is used as an entrance test for many colleges and universities, including those in South Dakota and surrounding states. There are no reports with sufficient ACT data from which conclusions can be drawn regarding the use of ACT scores as a potential predictor of success in a pharmacy program.

A few studies have investigated chemistry-specific data as a factor that may predict academic success. The usefulness of the chemistry PCAT subscore as a predictor for success in the pharmacy professional program has not been consistent, ranging from not a predictor to one of the strongest predictors.^{6,7,9,14,20,22} Hardigan also looked at chemistry GPA and found it not to be a significant pre-

dictor.²⁰ Twenty years earlier, Lowenthal found chemistry GPA to be a predictor of academic success for 1 class of students but not for the other 2 classes in the study.⁹

The objectives of this study were to conduct an analysis of retrospective student data (1) to identify significant factors that predict probation in the pharmacy program and (2) to identify significant factors that predict academic success in the first professional year.

METHODS

Prior to beginning this study, approval was obtained from the Human Subjects Committee of SDSU. The study population consisted of 334 students who entered the first professional year (P1) of the PharmD program at SDSU during the 6 years from 1997 to 2002. Only student records were used if data for all study factors were available; the records of 309 (92.5%) students were usable. The factors studied are listed in Table 1 as demographic variables and academic performance measures. The factors were selected as a result of the literature review and the availability of data in the academic records.

Demographic variables included prepharmacy curriculum status, prior degree, gender, and the P1 year. Prepharmacy curriculum status differentiates students who completed any of their prepharmacy courses at SDSU from students who did not complete any courses at SDSU (transfer students). Prior degree designation was given if the student had attained a bachelor's degree prior to beginning the pharmacy professional program. The P1 year indicates the fall semester in which the students began the first year of the professional program.

Academic performance measures included cumulative GPA, science value, ACT score, and average organic chemistry grade. The ACT score was the composite values attained by the student prior to high school graduation. Applicants were not required to take the PCAT; therefore, PCAT scores were only available for a few students. However, the ACT was reported by most students and thus was used as the standardized test score.

Cumulative GPA was calculated based on all the courses the student completed for a grade at the time of application to the program. This included grades in all courses through the fall semester prior to the spring semester application deadline. The prepharmacy curriculum is shown in Table 2, although students with a prior degree or those who transferred from another major had credits beyond those shown. Science value was calculated based on the required science and math courses specified in the prepharmacy curriculum (Table 2). The term "science value" is used rather than GPA because these 10 courses were weighted equally regardless of their credit value. Because the organic chem-

Table 2. Prepharmacy Curriculum at South Dakota State University

Course	Semester Hours
English composition	3
Speech	3
Biology*	3
Microbiology with lab*	4
Survey of calculus*	5
Statistics*	3
Economics	3
General chemistry I & II with labs*	8
Organic chemistry I & II with labs*	8
Anatomy with lab*	4
Physiology with lab*	4
Humanities	8
Social sciences	5
Wellness	2
Electives	4

*Courses included in the calculation of science value
Labs=laboratories

istry sequence is the most advanced chemistry required in our prepharmacy curriculum, grades in these 2 courses were selected among the study factors. The average organic chemistry grade was the numerical average (4 point scale) of the 2-course sequence. If the organic chemistry courses or any other course used to calculate the science value reported the laboratory and lecture grades individually, only the lecture grade was used. Since SDSU does not use “+” or “-” grades, such designations were dropped from the grades of transfer students for the science and math courses (eg, B+ and B- were both calculated as a grade of “B”).

Academic probation, which is a sign of academic difficulty or failure, was based on GPA for the professional pharmacy courses (PHA-prefix). A student was determined to be on academic probation when the GPA for the professional pharmacy courses was below 2.0 for either of the first 2 semesters of the professional curriculum. Academic success was measured by GPA in pharmacy courses in the first professional year (Table 3).

Statistical analysis of the data was performed using *Statistical Package for Social Sciences*, 11.0 (SPSS, Inc, Chicago, Ill). Descriptive statistics were used to analyze demographic variables and academic performance measures. Due to the exploratory nature of the analyses and multicollinearity among the variables examined, forward stepwise regression analyses were used to find the best fitting model. The predictor variables included demographic characteristics and academic performance measures. The dependent variables were academic probation (dichotomous variable) and academic success (continu-

Table 3. First Professional Year Pharmacy Curriculum at South Dakota State University

Course	Fall Semester	Spring Semester
Introduction to Pharmaceutical Care	3	
Pharmaceutical Calculations	1	
Pathophysiology	3	
Pharmaceutical Biochemistry*	4	
Pharmaceutics I	3	
Medicinal Chemistry I with lab*	4	
Professional Communication Skills		3
Biomedical Science*		4
Pharmaceutics II with lab		4
Medicinal Chemistry II with lab*		4
General Elective†		3

*Chemistry intensive pharmacy courses in the P1 year.

†Not included in the pharmacy GPA to determine success or failure.

Table 4. Demographic Characteristics of Study Sample

Characteristic	Frequency (%)
Gender	
Female	210 (68.0)
Male	99 (32.0)
Prepharmacy Curriculum Status	
SDSU	254 (82.2)
Transfer	55 (17.8)
Prior Degree	41 (13.3)
P1 Year	
1997	45 (14.6)
1998	51 (16.5)
1999	49 (15.9)
2000	52 (16.8)
2001	57 (18.4)
2002	55 (17.8)

ous variable). Logistic regression was used to examine predictors of academic probation, whereas linear regression was used to model academic success. Statistical significance was based on an alpha of 0.05.

RESULTS

Of the 309 student records included in this study, 5.5% of the students were placed on academic probation during the first professional year. The demographic characteristics of the study sample are presented in Table 4. Data for the academic performance measures are shown in Table 5.

As shown in Table 6, factors significantly associated with academic probation were: ACT score, average organic chemistry grade, female gender, and being in the

Table 5. Academic Performance Measures of Study Sample

Variable	Mean (SD)	Range
ACT composite score	25.5 (3.3)	17 – 33
Cumulative GPA	3.6 (0.3)	2.6 – 4.0
Science value	3.5 (0.3)	2.6 – 4.0
Average organic chemistry grade	3.3 (0.5)	2.0 – 4.0

Table 6. Factors Significantly Associated with Academic Probation

Variable	Beta	Wald Statistics	Odds Ratio	P
Female Gender*	-1.36	5.06	0.26	0.02
ACT [†]	-0.30	7.11	0.74	0.01
Average Organic Chemistry Grade [†]	-2.47	14.36	0.08	<0.01
P1 Year 1997 [‡]	2.67	4.09	14.49	0.04
P1 Year 1998 [‡]	1.30	0.95	3.68	0.33
P1 Year 1999 [‡]	2.85	5.53	17.24	0.02
P1 Year 2000 [‡]	1.20	0.99	3.32	0.32
P1 Year 2001 [‡]	-0.21	0.02	0.81	0.89

*Male gender used as reference group (odds ratio 1.0)

[†]Analyzed as continuous variables

[‡]P1 Year 2002 used as reference group (odds ratio 1.0)

P value significant if <0.05

1997 or 1999 P1 years. The odds of academic probation were decreased with female gender, higher organic chemistry grades, and higher ACT score. Students in the 1997 and 1999 P1 years had increased odds of being placed on academic probation compared to students in the 2002 P1 year. A forward stepwise logistic regression analyses correctly classified 94.8% of the student sample using these 5 factors that were significantly associated with academic probation ($p < 0.05$).

Forward stepwise linear regression analyses explained 46% of the variation in the academic success using predictor variables. As shown in Table 7, factors significantly associated with academic success were: science value, ACT score, prior degree, average chemistry grade, academic year, and being a transfer student. The first professional years 1997 and 1998 were associated with lower GPA in pharmacy courses compared to the 2002 P1 year. Factors associated with a higher GPA in first professional year pharmacy courses were a higher ACT score, a higher chemistry grade, being a transfer student, and having a prior degree.

DISCUSSION

Selecting the students who will become the best pharmacists from among many applicants is a challenge for pharmacy admissions committees. Many studies have

Table 7. Factors Significantly Associated With Academic Success

Variable	Beta	Standard Error	t	P
Science Value*	0.69	0.10	6.87	<0.01
Transfer [†]	0.20	0.08	2.59	0.01
ACT*	0.03	0.01	3.98	<0.01
Prior Degree [‡]	0.20	0.09	2.27	0.02
Average Organic Chemistry Grade*	0.23	0.06	3.68	<0.01
P1 Year 1997 [§]	-0.32	0.09	-3.62	<0.01
P1 Year 1998 [§]	-0.20	0.09	-2.30	0.02
P1 Year 1999 [§]	-0.09	0.09	-1.08	0.28
P1 Year 2000 [§]	0.14	0.08	1.62	0.11
P1 Year 2001 [§]	0.08	0.08	1.01	0.31

*Analyzed as continuous variables

[†]SDSU students used as reference group

[‡]Students with prior degree used as reference group

[§]P1 Year 2002 used as reference group

P value significant if <0.05

focused on whether selected measures of academic performance are good predictors of success in the pharmacy program.⁴⁻²² The results of these studies have varied, possibly because of the differences among prepharmacy course requirements, P1 year curricula, sample size, or rigor of prepharmacy courses. In this study, in addition to the common variables studied by others, the predictive value of the ACT score and average organic chemistry grade were studied to determine whether there were predictors of academic failure or success that the selection committee at SDSU should use in making decisions.

Academic difficulty occurs more often during the first and second years of the curriculum and the greatest attrition occurs during the first year.¹⁹ A similar trend has been observed at SDSU. Pharmacy students at SDSU are placed on academic probation if the pharmacy GPA drops below 2.0 for any semester. While on probation, if the student's pharmacy GPA falls below 2.0 for another semester, the student is not allowed to continue in the program. In this study, 5.5% of the students were on academic probation after the first year of the pharmacy program.

The ACT score, average grade in organic chemistry courses, female gender, and being in the 1997 or 1999 P1 year were significant predictors of academic failure (being on probation). Predictors of academic success were ACT score, average grade in organic chemistry courses, science value, prior bachelor's degree, being a transfer student, and being in the 1997 or 1998 P1 year.

The standardized test score most often evaluated for ability to predict pharmacy student success is the PCAT

score, but in this study the predictive value of the ACT score was investigated. The ACT test assesses knowledge in English, math, reading, and science and is a standardized test taken by high school students in many states. In this study, higher ACT scores decreased the odds of academic probation and increased the chances of academic success. Because the ACT is administered prior to college, it provides a relative measure of aptitude among students at approximately the same time in their academic careers.

Lower grades in organic chemistry courses increased the odds of academic probation; higher grades increased the level of success. The attrition is greatest in our program during the first professional year. Since 16 credits (48%) of our first-year curriculum (Table 3) are chemistry-intensive courses, students with a poor understanding of chemistry are more likely to struggle academically in the professional curriculum. Some students did not complete the organic chemistry at SDSU and therefore the predictor value of the organic chemistry grades obtained at SDSU was compared with the predictor value for the grades obtained at other colleges or universities. There was no significant difference between these subsets of data. Although data on whether the transfer institution was a 2-year or 4-year school were not collected, most students (approximately 90%) who transfer to our program previously attended a 4-year school. Allen and Bond reported no difference in the predictor value of academic success between students who completed organic chemistry at a 2-year vs 4-year institution.¹⁸ However, other reports indicate the quality of the transfer school has a significant impact on academic performance.^{7,25}

Even though the results of several studies have demonstrated the predictive value of science and math grades, the criteria for calculating the science GPA is not always clear and may differ somewhat among studies. In this study the calculation is not weighted by credits per course and only the required prepharmacy science and math courses are used. Regarding the science value, we wanted to consider competency in each course equally important, avoiding any science or math course having a larger impact on the science value than any other course. Also, weighting these courses equally avoided credit disparity in transfer courses compared to SDSU courses. A higher science value increased the chances of success but a lower science value was not a predictor for failure. The professional curriculum is heavily science and math; 27 credits (82%) of the P1 pharmacy courses are science and math based. We might expect, therefore, that the science value, like the organic chemistry, would also be a predictor of both failure and success. However, it appears that there is no additional sig-

nificant contribution of other courses in the science value to predict academic probation once the organic chemistry is included in the regression model.

A prior bachelor's degree was a significant predictor of academic success but not academic failure. It seems reasonable that the additional courses beyond the required prepharmacy curriculum would facilitate competency in professional courses, especially during the first year or 2 of the professional curriculum when many credits are based on natural science concepts.

Being a transfer student was a predictor of academic success. In this study, nearly 53% of the transfer students had a bachelor's degree compared with less than 5% of the students who attended SDSU. Nonetheless, the transfer student variable was significant even after controlling for attainment of a bachelor's degree. This may be due to nonacademic characteristics of transfer students, such as maturity, motivation, social stability, and communication skills, that were not specifically measured in this study. These factors may be more prominent among transfer students because few P1 positions are filled (18%) with these students, resulting in greater competition within a highly selective group of students.

Female students were less likely to be placed on academic probation. There have been some studies regarding gender and success among pharmacy students, but there is no data to explain the results of this study pertaining to academic probation.^{12,13,26} Differences between male and female students in the number of hours used for studying as well as differences in the distracters from academic responsibilities are possible explanations that could be studied.

Membership in the 1997 and 1999 P1 year was a significant predictor of academic probation. These 2 years accounted for 53% of the study sample of students on probation. The reason for an increase in percent of the students on academic probation in these 2 years is unclear, but changes in the curriculum and/or faculty, financial pressures, or excessive involvement in nonacademic activities are possible contributing factors. The 1998 and 1999 P1 years were negative predictors of success, and the same reasons may explain these results.

The cumulative GPA was also studied but was not a significant predictor of probation or success. Considering that over 40% of the prepharmacy curriculum is not math and science, but the P1 year curriculum is heavily math and science, it is not surprising that the cumulative GPA is not a predictor whereas science value is a predictor. In addition, some students have additional academic coursework in nonscience areas and thus have

completed many more credits of nonscience courses that contribute to the cumulative GPA.

In summary, predictors of failure and predictors of success were not the same sets of variables. The ACT score and average organic chemistry grade were common between these sets of variables. Science value and prior degree were additional predictors of success, whereas gender was the only additional predictor of failure after accounting for variation due to years. Therefore, it may be advantageous for pharmacy selection committees to consider both sets of predictors as part of the screening processes. Even though academic and demographic data provide a means to narrow the applicant pool, other factors also affect the students' likelihood to graduate and the quality of pharmacy they practice; thus, other criteria should also be used to select students.²⁷⁻²⁹ At SDSU, the use of writing exercises, an interview, and pharmacy practice shadowing experiences are additional components of the application process. These components assist the selection committee in evaluating the applicant's communication skills, knowledge of the profession, professionalism, critical thinking skills, potential leadership, and motivation to be a pharmacist. These additional components of the application process may also reduce the number of students selected who may change majors for nonacademic reasons.

Limitations

Although data from 92.5% of the students who entered the P1 classes were complete, this study excluded students with incomplete data. Furthermore, the variables selected for analysis were limited to the data available in the academic records. Nevertheless, the significant predictors for academic success or failure among this group of students may not be predictors for students at or applicants to other schools. Since the regression model used was able to explain <50% of the variation in the dependent measure, other variables such as communication skills, motivation, and critical thinking skills could be included in future research to determine their impact on the remaining variation. Even though this research explores the association of independent variables with academic probation and P1 year GPA, no cause and effect relationships were studied.

CONCLUSIONS

In this study, predictors of academic success and failure shared common variables, but there were also significant predictors of success that were not predictors of failure. The average organic chemistry grade and ACT score were common variables; science value and bache-

lor's degree were unique as predictors of success but not as predictors of failure. Therefore, it may be advisable for selection committees to consider both sets of predictors as part of the screening process when selecting students for a pharmacy professional program. Besides the academic performance predictors, other information should be used to facilitate the final selection, such as the student's communication skills, leadership potential, and motivation to become part of the profession.

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