RESEARCH

Relationship of Prepharmacy Repeat Course History to Students' Early Academic Difficulty in a Pharmacy Curriculum

Daniel J. Hansen, PharmD, Jane R. Mort, PharmD, Thomas Brandenburger, PhD, Allison Lempola, BS
South Dakota State University, Brookings, South Dakota

Submitted November 19, 2014; accepted May 6, 2015; published December 25, 2015.

Objective. To examine the relationship between students' prepharmacy repeat course history and their academic difficulties early in a professional pharmacy program in conjunction with other prerequisite success variables known to predict academic difficulty.

Methods. For students admitted to a pharmacy program in 2010 and 2011 (n=160), admission variables [eg, prepharmacy coursework, grade point average (GPA)] and pharmacy program academic difficulty data (ie, academic difficulty defined as a pharmacy GPA in the bottom quartile of the class after 3 semesters of pharmacy course work) were extracted. Regression analysis was employed to examine the relationship between admission variables and academic difficulty.

Results. Twenty-six percent of the students (n=42) repeated a course, and 50% of these students (n=21) repeated more than one course. All of the admissions variables studied were found to individually increase the odds of a student having academic difficulty early in the pharmacy program. Specifically, repeat of a prepharmacy course increased the odds of academic difficulty threefold.

Conclusion. Repeating prepharmacy coursework appears to be a strong indicator of future academic difficulties early in a professional pharmacy program.

Keywords: admissions, academic success, student success, repeat courses, early intervention

INTRODUCTION

Over the past decade, the applicant pool for doctor of pharmacy (PharmD) programs in the United States changed due to a rise in the number of pharmacy schools (82 in 2000 to 130 in 2013), an increase in the number of first-year pharmacy students (8382 in 2000 to 14 008 in 2013), and a decline in the number of applications (106 815 in 2011, 99 821 in 2012, 87 956 in 2013).^{1,2} These changes created challenges in obtaining a qualified applicant pool that may increase with time. Similar to the 2011 Accreditation Council for Pharmacy Education's (ACPE) Standards (Guideline 17.8),³ Standards 2016 states schools must evaluate admission criteria to assure qualified students are selected (Standard 16).⁴ Many studies that examine predictors of student success in professional programs evaluate admission grade point average (GPA) and the Pharmacy College Admission Test (PCAT) scores,⁵⁻³² but colleges and schools of pharmacy consider other factors in the admission process (eg, repeat courses, course load, residency, previous institutions attended, extracurricular involvement,

impromptu writing assessment).³³ However, few published studies examine the relationship between these additional factors and student success.

In addition to selecting the best applicants, early identification of students at risk for academic difficulties helps ensure students graduate. In fact, research highlights the need for schools of pharmacy to devise early detection programs to minimize the need for remediation and improve student success.³⁴ Standards 2016 state that schools must implement systems for early detection of academic difficulty and provide individualized services, such as mentoring, to help students succeed in the professional pharmacy program (Standard 17.2).⁴ By identifying admission data of students more likely to need these services, schools would not have to wait for a student to develop academic difficulties before intervening. The objective of this study was to examine the relationship between students' prepharmacy repeat course history and academic difficulties early in a professional pharmacy program in conjunction with other prerequisite success variables known to predict academic difficulty.

METHODS

The study was undertaken in a public, land-grant university with an enrollment of more than 12 000 students.

Corresponding Author: Daniel J. Hansen, South Dakota State University, Box 2202C, Brookings, SD 57007. Tel: 605-688-6197. Fax: 605-688-6232. E-mail: Dan.Hansen@sdstate.edu

The College of Pharmacy has a traditional 2-year pre-pharmacy and 4-year PharmD curriculum. The prepharmacy curriculum contains 66 credits (Table 1) with an emphasis on math and science courses. Eighty students are admitted annually into the professional program. Admissions variables relevant to this study include students' overall GPA, science GPA, repeat course history (having one course repeated), and number of courses repeated by a student.

Repeated prepharmacy coursework and other admissions data were retrospectively compiled for all students admitted to the pharmacy program in 2010 and 2011 (n=160). For this study, a repeated course was defined as a course in which the student had earned a grade and subsequently the student took that same course again for a grade. If a student repeated the same course multiple times, each successive attempt was considered a repeat and added to the total number of courses repeated by the student. According to university policy, the most recent grade for the course was used in the calculation of the student's overall GPA. If a student withdrew from a course, the student received a "W" and the subsequent course completion was not considered a repeat of the course. The exclusion of the withdrawal was based on the fact that a student receiving a "W" would have been exposed to only a portion of the course and a withdrawal may represent a different event than a repeat course.

In this study, student success was evaluated at the end of the third semester in the professional pharmacy program. This point in the curriculum was chosen

because it allowed for early detection yet provided a reasonable analysis of students' performance based on completion of 51 pharmacy credits. In addition, courses in the first 3 semesters of the curriculum rely on preparation provided by the prepharmacy curriculum. Since no student had failed a course at that point in the curriculum, student success was measured by class rank of the cohort. The bottom quartile included the 25% of students with the lowest cumulative third-semester pharmacy GPA (PHA-GPA), and, for this sample, was made up of students with a PHA-GPA between 2.18 and 2.98.

Students in the bottom quartile were defined as having academic difficulties, and they were assigned a value of 1. Students not in the bottom quartile were defined as successful and were assigned a value of 0. By using this definition of student success, the outcome for the measure was binary and logistic regression analysis was employed. The 4 admission variables (students' overall GPA, science GPA, repeat course history, and number of courses repeated by a student) were first evaluated individually for significance using logistic regression, then stepwise regression was used as a variable selection method. The data was analyzed using SAS, v9.4 (SAS Institute Inc., Cary, NC). The study was determined to be exempt from review by the Institutional Review Board at South Dakota State University.

RESULTS

Of the 160 students admitted to the pharmacy program, 42 (26.3%) repeated a prepharmacy course. Twenty-one students only repeated one (50.0% of students who repeated a course), and thirteen repeated 2 courses (30.9%) (Table 2). Repeated courses included General Chemistry I (32.4% of repeated courses), General Chemistry II (22.9%), anatomy (14.9%), and Calculus (9.5%) (Table 1). Of the 74 courses repeated, 64 courses (86.5% of all repeats) replaced a grade of "C" or "B," and 10 courses (13.5%) replaced a grade of "D" or "F."

Four admissions variables were evaluated in this study (Table 3) and were shown to be individually

Table 1. Prepharmacy Curriculum and Number of Times Repeated (n=74)

	Repeat Courses no. (%)
First Year	
General Chemistry I with Lab	24 (32.4)
General Chemistry II with Lab	17 (22.9)
General Biology I with Lab	3 (4.0)
Survey of Calculus	7 (9.5)
English Composition I	0
Fundamentals of Speech	0
Introduction to Pharmacy	0
Second Year	
Organic Chemistry I with Lab	4 (5.4)
Organic Chemistry II with Lab	3 (4.0)
General Microbiology with Lab	1 (1.4)
Human Anatomy with Lab	11 (14.9)
Human Physiology with Lab	4 (5.4)
Macroeconomics	0
English Composition II	0

Table 2. No. Courses Repeated/Student

No. Courses Repeated	Students Who Repeated a Course, no. (%)
1	21 (50)
2	13 (30.9)
3	6 (14.3)
4	1 (2.3)
5	1 (2.3)

Table 3. Distribution of Predictive Variable Values Among the Sample

	Median	Mean (SD)	Minimum	Maximum
Repeat Course History ^a	0	0.26 (0.44)	0	1
No. Repeats/Student	0	0.47 (0.95)	0	5
Science GPA	3.71	3.66 (0.29)	3.00	4.00
Overall GPA	3.78	3.74 (0.24)	2.56	4.00

^aHaving repeated at least one course (0=No Repeat, 1=Yes)

GPA=grade point average (0-4 grade scale)

significant ($p<0.01$) in predicting the risk of a student ranking in the bottom quartile of the class (Table 4). Because the predictor variables were individually significant, correlation among the variables was examined to determine if they contained common information about the subject (eg, science GPA contained courses also in the overall GPA, so a grade in a science class would affect both GPAs). Correlation among variables may cause variability in the odds ratio and give potentially false relationships. Table 5 presents the correlation matrix for the variables considered in this study. Analysis via stepwise regression was chosen in order to select variables that both captured information about the subject and contained independent information. Variables with redundant information were then excluded.

Using stepwise logistic regression, the 2 variables retained in the model were repeat course history and science GPA (each significant with $p<0.05$). This was based on analysis showing that the other variables, although individually significant, did not add significant information to the model independent of the information already contained in repeat course history and science GPA. Moreover, the number of courses repeated by the student, although individually significant, did not add more information to the model than knowing whether a student repeated just one course (repeat course history). Similarly, a student's overall GPA did not add more information than could be found in the student's science GPA. Table 4 shows the significance of each of these variables, and Table 5 shows the high degree of correlation between them.

Table 4. Odds Ratio for Student Ranking in the Bottom Quartile Based on Univariate Analysis

Variable	Odds Ratio (95% CI)	<i>p</i>
Repeat Course History ^a	5.2 (2.4, 11.4)	<0.0001
No. Repeats/Student	2.2 (1.4, 3.2)	0.0002
Science GPA	0.050 (0.013, 0.19)	<0.0001
Overall GPA	0.024 (0.004, 0.14)	<0.0001

^aHaving repeated at least one course

GPA=grade point average

The odds ratio of a student who repeated a prepharmacy course being in the bottom quartile of the class after the fall semester of their second (P2) year was 3.0 ($p=0.012$) (Table 6). Science GPA also proved to be a significant predictor ($p=0.0015$) of academic performance, having an odds ratio of 0.094. This means that for every 1.0 unit increase in a student's science GPA, that student was 0.094 times less likely to be in the bottom quartile of the class after the fall semester of the P2 year.

DISCUSSION

While science GPA was a good predictor of poor performance by students (ie, odds ratio 0.094 of being in the bottom quartile for every 1.0 unit increase in GPA), knowing whether students had repeated at least one course would shed significant light on a student's future academic success (ie, threefold greater odds of academic difficulty). The greater odds ratio for academic difficulties associated with repeat course history compared to science GPA was intuitive because the study institution's policy for calculating GPA discards the previous grade earned for a repeated course, thereby losing that information.

Many schools participate in the Pharmacy College Application Service (PharmCAS), which calculates overall GPA from all initial and repeated course work.^{35,36} However, PharmCAS indicates that some pharmacy programs may recalculate a student's overall GPA and exclude repeated coursework.³⁶ Our study suggests that, regardless of PharmCAS participation, pharmacy programs may benefit from reviewing their respective admissions policies regarding repeat course history to better identify students most likely to succeed in pharmacy school. Future research examining programs' utilization of repeat course information in their admissions process will provide insight into current practices.

Interestingly, the number of courses a student repeated did not carry nearly as much importance as whether the student repeated even a single course. These results suggest programs should not overemphasize

Table 5. Relationship Among the Predictor Variables (Pearson Correlation Coefficients)

	Repeat Course History ^a	No. Repeats/ Student	Science GPA	Overall GPA	Chemistry Value
Repeat Course History	1	0.83	-0.45	-0.23	-0.53
Number of Repeats/Student	0.83	1	-0.41	-0.21	-0.42
Science GPA	-0.45	-0.41	1	0.76	0.74
Overall GPA	-0.23	-0.21	0.76	1	0.53

^aHaving repeated at least one course

GPA=grade point average

multiple repeats. The results also highlight the fact that students typically repeated a course to improve a grade, not simply correct a failing grade and, therefore, the repeat did not represent a failure of the student to achieve a minimum level of understanding on first attempt, which alone would bode poorly for success in the program.

Students who have difficulties in the PharmD program have a lower pass rate on the North American Pharmacist Licensure Examination (NAPLEX). For example, Allen and Diaz found that students who had at least one unsatisfactory grade (“D” or “F”) in prepharmacy coursework were less likely to pass the NAPLEX.³⁷ In addition, Madden et al showed students requiring remediation as a result of deficient course grades in the PharmD curriculum had a significantly lower pass rate on the NAPLEX compared to those who did not go through remediation.³⁸

Thus, identifying the student who received an unsatisfactory grade in prepharmacy coursework (ie, whether that student repeated the course or not) may reduce the number of students who have an unsatisfactory grade in the PharmD curriculum and thus increase NAPLEX success. By knowing student characteristics associated with academic difficulties when entering the program, students could receive academic support before they begin to struggle. Ideally, this approach would prevent the need for remediation and potentially improve a student’s chances of passing the NAPLEX. Further research is needed to determine if this is a modifiable factor or reflective of some other characteristic.

Prepharmacy coursework varies among pharmacy schools,^{39,40} and may impact the applicability of the study

results to other schools. According to American Association of Colleges of Pharmacy, total prepharmacy semester-hour requirements range from 48 to 120, with 10 schools requiring a BS or BA.⁴⁰ Despite this variation in requirements, the 2 courses most commonly repeated by students in this study (General Chemistry I and II) are required pharmacy prerequisites at 96.8% of pharmacy schools.⁴⁰ As a result, findings from this study should be relevant to other pharmacy programs.

Variations in academic rigor among institutions educating prepharmacy students should be considered when evaluating the implications of repeat coursework. In this study, 88.8% (142 of 160) of the study sample took their prerequisites at the admitting institution, which has practices in place to assure consistent rigor across prerequisites. Variations in rigor may influence the probability of a student repeating a course. However, the majority of students in this study were remediating a “C” grade or better, which suggests that a high level of course rigor (eg, high rigor leading to unsatisfactory grades of “D” or “F”) was not the impetus for repeating courses.

A potential limitation is that this study did not take into account the cause of a student’s need to repeat a course. Factors impacting a decision to repeat a course may vary from prepharmacy course load (ie, credit hours per semester) to personal matters. Future research evaluating the cause of the repeat will provide additional insight into the relevance of repeat coursework in predicting difficulties.

CONCLUSION

Repeating prepharmacy coursework was identified as a frequent occurrence for students applying to a pharmacy program and was associated with a high odds ratio for academic difficulties early in a professional pharmacy program. If admitted, students who repeated prepharmacy coursework may be candidates for early intervention and academic support programs. Future research examining the impact of early intervention programs on students who

Table 6. Odds Ratio for Student Ranking in the Bottom Quartile Based on Stepwise Logistic Model

Variable	Odds Ratio (95% CI)	p
Repeat Course History ^a	3.0 (1.3, 7.0)	0.012
Science GPA	0.094 (0.022, 0.41)	0.0015

^aHaving repeated at least one course

GPA=grade point average

have repeated prepharmacy coursework and examining the admissions practices related to repeat coursework will provide additional insight.

REFERENCES

1. Taylor DA, Taylor JN. The pharmacy student population: applications received 2011-12, degrees conferred 2011-12, fall 2012 enrollments. *Am J Pharm Educ.* 2013;77(6):Article S3.
2. Taylor DA, Taylor JN. The pharmacy student population: applications received 2012-13, degrees conferred 2012-13, fall 2013 enrollments. *Am J Pharm Educ.* 2014;78(7):Article S2.
3. Accreditation Council for Pharmacy Education. Accreditation standards and guidelines for the professional program in pharmacy leading to the doctor of pharmacy degree. Chicago, Ill; 2006. <https://www.acpe-accredit.org/pdf/FinalS2007Guidelines2.0.pdf>. Accessed August 1, 2014.
4. Accreditation Council for Pharmacy Education. Accreditation standards and key elements for the professional program in pharmacy leading to the doctor of pharmacy degree. Chicago, Ill; 2014. <https://www.acpe-accredit.org/pdf/Standards2016DRAFTv60FIRSTRELEASEVERSION.pdf>. Accessed February 5, 2015.
5. Munson JW, Bourne DW. Pharmacy College Admission Test (PCAT) as a predictor of academic success. *Am J Pharm Educ.* 1976;40(3):237-239.
6. Kotzan JA, Entekin DN. Validity comparison of PCAT and SAT in the prediction of first-year GPA. *Am J Pharm Educ.* 1977;41(1):4-7.
7. Liao WC, Adams JP. Methodology for the prediction of pharmacy student academic success. I: preliminary aspects. *Am J Pharm Educ.* 1977;41(2):124-127.
8. Jacoby KE, Plaxco WB, Kjerulff K, Weinert AB. The use of demographic and background variables as predictors of success in pharmacy school. *Am J Pharm Educ.* 1978;42(1):4-7.
9. Torosian G, Marks RG, Hanna DW, Lepore RH. An analysis of admission criteria. *Am J Pharm Educ.* 1978;42(1):7-10.
10. Lowenthal W. Relationships among student admission characteristics, licensing examinations and academic performance: a comparison of three graduating classes. *Am J Pharm Educ.* 1981;45(2):132-139.
11. Kimberlin CL, Hadsall RS, Gourley DR, Benedict LK. Predicting success of pharmacy students in basic science and clinical clerkship courses. *Drug Intell Clin Pharm.* 1983;17(4):297-301.
12. Friedman CB, Lage G, Norwood GJ, Stewart J. Predictive validity of the Pharmacy College Admission Test. *Am J Pharm Educ.* 1987;51(3):288-291.
13. Cunney KA, Perri M. Historical perspective on undergraduate pharmacy student admissions: the PCAT. *Am J Pharm Educ.* 1990;54(1):1-6.
14. Charupatanapong N, McCormick WC, Rascati KL. Predicting academic performance of pharmacy students: demographic comparisons. *Am J Pharm Educ.* 1994;58(3):262-268.
15. Chisholm MA, Cobb HH, Kotzan JA. Significant factors for predicting academic success of first-year pharmacy students. *Am J Pharm Educ.* 1995;59(4):364-370.
16. Duncan-Hewitt WC. Designing admissions criteria: a framework. *Am J Pharm Educ.* 1996;60(2):109-121.
17. Chisholm MA, Cobb HH, Kotzan JA. Prior four year college degree and academic performance of first year pharmacy students: a three year study. *Am J Pharm Educ.* 1997;61(3):278-281.
18. Chisholm MA, Cobb HH, DiPiro JT, Lauthenschlager GJ. Development and validation of a model that predicts the academic ranking of first-year pharmacy students. *Am J Pharm Educ.* 1999;63(4):388-394.
19. Allen DD, Bond CA. Prepharmacy predictors of success in pharmacy school: grade point averages, pharmacy college admissions test, communication abilities, and critical thinking skills. *Pharmacotherapy.* 2001;21(7):842-849.
20. Chisholm MA. Students performance throughout the professional curriculum and the influence of achieving a prior degree. *Am J Pharm Educ.* 2001;65(4):350-354.
21. Hardigan PC, Lai LL, Arneson D, Robeson A. Significance of academic merit, test scores, interviews, and the admissions process: a case study. *Am J Pharm Educ.* 2001;65(1):40-44.
22. Kelley KA, Secnik K, Boye ME. An evaluation of the Pharmacy College Admissions Test as a tool for pharmacy college admissions committees. *Am J Pharm Educ.* 2001;65(3):225-230.
23. Thomas MC, Draugalis JR. Utility of the Pharmacy College Admission Test (PCAT): implications for admissions committees. *Am J Pharm Educ.* 2002;66(1):47-51.
24. Kidd RS, Latif, DA. Traditional and novel predictors of classroom and clerkship success of pharmacy students. *Am J Pharm Educ.* 2003;67(4):Article 109.
25. Houghlum JE, Aparasu RR, Delfinis TM. Predictors of academic success and failure in a pharmacy professional program. *Am J Pharm Educ.* 2005;69(3):Article 43.
26. Kuncel NR, Credé M, Thomas LL, et al. A meta-analysis of the validity of the Pharmacy College Admission Test (PCAT) and grade predictors of pharmacy student performance. *Am J Pharm Educ.* 2005;69(3):Article 51.
27. Meagher DG, Lin A, Stellato CP. A predictive validity study of the Pharmacy College Admission Test. *Am J Pharm Educ.* 2006;70(3):Article 53.
28. McCall KL, Allen DD, Fike DS. Predictors of academic success in a doctor of pharmacy program. *Am J Pharm Educ.* 2006;70(5):Article 106.
29. Lobb WB, Wilkin NE, McCaffrey DJ, Wilson MC, Bentley JP. The predictive utility of nontraditional test scores for first-year pharmacy student academic performance. *Am J Pharm Educ.* 2006;70(6):Article 128.
30. Renzi SE, Krzeminski MA, Sauberman MM, Brazeau DA, Brazeau GA. Prepharmacy years in college and academic performance in a professional program. *Am J Pharm Educ.* 2007;71(4):Article 69.
31. Meagher D, Pan T, Perez C. Predicting performance in the first year of pharmacy school. *Am J Pharm Educ.* 2011;75(5):Article 81.
32. Schauner S, Harding KL, Graham MR, Garavalia L. Admission variables predictive of academic struggle in a PharmD program. *Am J Pharm Educ.* 2013;77(1):Article 8.
33. American Association of Colleges of Pharmacy. Pharmacy school admission requirements. <http://www.aacp.org/resources/student/pharmacyforyou/admissions/admissionrequirements/Documents/School%20Admission%20Requirements.pdf>. Accessed August 15, 2014.
34. Maize DF, Fuller SH, Hritcko PM, et al. A review of remediation programs in pharmacy and other health professions. *Am J Pharm Educ.* 2010;74(2):Article 25.
35. PharmD School Directory, Pharmacy College Application Service. <http://www.pharmcas.org/school-directory/#/pharmd/general-information>. Accessed December 29, 2015.

36. Verification Process and GPAs, Pharmacy College Application Service. <http://www.pharmcas.org/preparing-to-apply/application-process/verification-process-and-gpas/>. Accessed February 11, 2015.
37. Allen RE and Diaz C. Use of preadmission criteria and performance in the doctor of pharmacy program to predict success on the North American pharmacists licensure examination. *Am J Pharm Educ.* 2013;77(9):Article 193.
38. Madden MM, Etzler FM, Schweiger T, Bell HS. The impact of pharmacy students' remediation status on NAPLEX first-time pass rates. *Am J Pharm Educ.* 2012;76(10):Article 191.
39. Speedie MK, Baldwin JN, Carter RA, Raehl CL, Yanchick VA, Maine LL. Cultivating 'habits of mind' in the scholarly pharmacy clinician: report of the 2011-12 argus commission. *Am J Pharm Educ.* 2012;76(6):Article S3.
40. American Association of Colleges of Pharmacy. 2014-2015 Summary of Pre-Professional Course Requirements by Pharmacy Degree Institution. <http://www.aacp.org/resources/student/pharmacyforyou/admissions/admissionrequirements/Documents/2014-15%20PharmacyPre-RequisiteInformation%20xlsx.pdf>. Accessed August 15, 2014.