RESEARCH

Pharmacy Residency School-wide Match Rates and Modifiable Predictors in ACPE-accredited Colleges and Schools of Pharmacy

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Objective. To analyze the modifiable predictors of institution-wide residency match rates.

Methods. This was a retrospective analysis of colleges and schools of pharmacy data and school-wide PGY-1 pharmacy residency match rates for 2013 through 2015. Independent variables included NAPLEX passing rates, history of ACPE probation, NIH funding, academic health center affiliation, dual-degree availability, program length, admit-to-applicant ratio, class size, tuition, student-driven research, clinically focused academic tracks, residency affiliation, U.S. News & World Report rankings, and minority enrollment.

Results. In a repeated measures model, predictors of match results were NAPLEX pass rate, class size, academic health center affiliation, admit-to-applicant ratio, U.S. News & World Report rankings, and minority enrollment.

Conclusion. Indicators of student achievement, college/school reputation, affiliations, and class demographics were significant predictors of institution-wide residency match rates. Further research is needed to understand how changes in these factors may influence overall match rates.

Keywords: pharmacy residencies, pharmacy education, pharmacy residency match, school rankings, educational measurement

INTRODUCTION

In 2006, the American College of Clinical Pharmacy (ACCP) published a position statement that outlined a vision for the pharmacy profession, which included a provision for formal residency training prior to an entry-level position in patient care.1 Two years later, student interest in residency positions increased by 50%.2 In the early 2000s, the number of unmatched students rarely exceeded 200. For the past 3 years, that number has exceeded 1300 students,3 thereby increasing the need for students to compete for positions and for pharmacy schools to better prepare their students.4

In 2014, there were 55,000 residency applications submitted with an average of 9.5 applications for every applicant.5 To manage the higher volume, residencies have developed algorithms to evaluate applicants.6 Valued applicant characteristics have traditionally included work experience, involvement in professional associations, rotation experiences, publications, presentations, and research experience. These characteristics align with the educational outcomes recommended by ACCP for pharmacy graduates ready for residency training (direct patient care, professionalism, and research).7 Additional characteristics have been used to evaluate candidates including degrees held, certifications, pharmacy schools attended, honors/awards, and GPA.8,9 These factors used have the potential to impact the residency placement rate of a college or school of pharmacy, which is a commonly used student achievement measure which accredited programs are now required to post online.10,11

Morton and colleagues revealed that new and/or private pharmacy schools have lower match rates when compared to older (>20 years) and/or public schools.12 These factors cannot be modified by a particular institution, which is why the purpose of this study was to analyze the modifiable predictors of first post-graduate year (PGY-1) residency match rates at the institutional level so that colleges and schools and pharmacy and residency programs could better understand factors potentially influencing student match rates.

METHODS

This study was considered exempt by the Roseman University of Health Sciences Institutional Review Board. In this retrospective study, school-specific residency
match data reported for 2013 through 2015 were obtained from the Office of Accreditation Services at the American Society of Health-System Pharmacists (ASHP). Pre-match residency placements or those secured during the scramble were excluded. Branch campus data was combined with main campus data if they were under the same accreditation by the Accreditation Council for Pharmacy Education (ACPE). College or school inclusion criteria consisted of accreditation by the ACPE, reporting of a graduating class for 2015 and earlier, and availability of residency match data. Residency match rates were calculated as a percentage of students registering for the match via the National Matching Service. Modifiable characteristics of pharmacy schools selected for independent variables in the analysis included national licensing examination passing rates, history of ACPE accreditation probation, National Institutes of Health grant funding, academic health center affiliation, availability of a dual degree with the doctor of pharmacy degree, 3- or 4-year program length, ratio of the number of students admitted to the number of applicants, number of students per class, tuition rates, curricular availability of student-driven research, availability of a clinically focused academic track or program, residency program affiliation, U.S. News & World Report rankings, and percentage of ethnic or racial minority enrollment.

The North American Pharmacy Licensing Examination (NAPLEX) is the sole national licensing exam for pharmacists in the US; passing rates for first-time test takers for 2011-2015 were obtained from the National Association of Boards of Pharmacy website. The ACPE website was used to obtain schools’ data on occurrences of probation status in the 10 years prior to November 2015. To obtain data about NIH awards and funding, the Research Portfolio Online Reporting Tool was searched by selecting the organization type “Domestic Higher Education” and then selecting the subcategory of “Schools of Pharmacy” for the fiscal years 2012-2015. The number of awards and the funding dollar amounts were added to create a composite sum of each component for every school with data available. In addition, total funding amounts for the time period were ranked according to the following cutoffs: greater than $5 million, between $1 and $5 million, greater than $0 but less than $1 million, and $0.

The American Association of Colleges of Pharmacy (AACP) website for prospective pharmacy students who would be matriculating in the 2016-2017 academic year was used for school characteristics. Dichotomous data regarding affiliation with an academic health center was collected. Program length was initially collected using the designators: 3-, 4-, or 6-year. Later, 4- and 6-year programs were combined to reflect the typical 4-year duration of professional study for 6-year programs. The ratio of the number of students enrolled to the number of applicants as reported for students matriculating in fall 2014 was also obtained. The ratio was converted to a decimal and rounded to the nearest thousandth. The same source and timeframe were used to report class size. To determine tuition, in-state and out-of-state school tuition data for fall 2015 were rounded to the nearest thousandth and averaged.

College/school of pharmacy websites were reviewed to obtain information about the availability of dual degrees, which were defined as a doctoral degree in pharmacy combined with a degree in a related discipline. Under the following circumstances, colleges/schools were not considered to offer dual-degrees: a bachelor’s degree in pharmacy is awarded prior to a doctor of pharmacy degree; a pharmacy degree other than the doctor of pharmacy degree is combined with a degree in a complementary field of study; or a doctor of pharmacy degree is combined with a certificate in a complementary field of study. In January 2016, websites were also used to identify programs offering required or elective student-driven research projects by identifying keywords such as, “research project,” “research paper,” “publishable manuscript,” “presenting a poster,” “thesis,” or “capstone project.” Programs which only described journal club presentations, clinical seminars, grand rounds, research methods courses, or open forums were not counted as providing student-driven research. The same applied to courses which described only literature evaluation or student presentations. Courses fitting keywords were explored further via online catalogs or course descriptions. The same approach and timeframe were used to identify colleges of pharmacy providing clinical or residency training tracks. Keywords included: “clinical,” “pharmaceutical care,” “patient care,” “residency,” “patient care research,” or “clinical research.” Pharmacy schools offering disease-specific or population-specific certificates, tracks, minors, or concentrations were not counted as providing clinical pharmacy tracks, nor were tracks in leadership, education, international pharmacy, or medical Spanish. If a program offered a research track but did not specify that it was for clinical research, that program was not considered to have a “clinical track.” The ASHP website and the college/school of pharmacy websites were reviewed to identify affiliation with one or more pharmacy residency programs.

The U.S. News & World Report website was used to access pharmacy school rankings. Rankings were recorded for each college/school of pharmacy with a score reported; if no ranking was provided, the school was given...
a zero ranking. For the purpose of the analysis, schools with a top 20 ranking were compared to those with a non-top 20 ranking and to those with no ranking.

The Institutional Research section of the AACP website was used to obtain data about enrollment for each pharmacy school with respect to the class matriculating in the fall of 2013 and 2014. Only PharmD students obtaining their first professional degree were included. The percent of students from each college/school identifying with a racial or ethnic minority group was collected and averaged between the two years.21,22

We used the repeated measures analysis by using a mixed model for the match rate as the dependent variable and all other variables as the independent variables. To account for the within-university dependence among the match rates, an unstructured variance-covariance structure was assumed. Once a model was fit from the mixed model, each parameter was tested using a t-test. A backward eliminating method was utilized to select the final model where the p value threshold for a variable to be kept in the model was set at less than .2. All tests were performed at a .05 nominal significance level. Colleges and schools of pharmacy were also divided into quartiles based on their average of 2013, 2014, and 2015 match rates. A logistic regression model was used to determine the relationship between the quartile status (lowest or highest) and all the independent variables considered in the repeated measures model. The backward model selection method was also used here with the critical value of .2.

RESULTS

Data on 133 colleges and schools of pharmacy were collected. Of which, data on 121 colleges and schools were used in the analysis. Average and median composite match rates by year and average match rates within each quartile are presented in Table 1. The lowest average match rate reported over the years 2013-2015 was 17.3% while the highest was 85.5%. Table 2 includes analyzed data associated with all 121 colleges and schools analyzed. The median number of NIH awards per year across all colleges and schools and for just those with funding was 1.25 and 4.13 respectively. Among the colleges and schools receiving funds, the average amount received per year was $3.02 million (range = $15,000 to $29 million).

Dual degree programs were available at the majority of colleges and schools. Examples included PharmD/MBA, PharmD/PhD, PharmD/JD, PharmD/MPH, PharmD/PA and PharmD/MD. The most common dual degree program offered was the PharmD/MBA. While the majority of colleges/schools provided elective research opportunities, a small number required research activities, which were most often final-year seminar or capstone projects. A minority of colleges/schools offered clinical tracks and the scopes varied widely. Clinical tracks included required elective courses, clinical rotations, research projects and/or independent study. Most colleges/schools were affiliated with at least one residency program. The lowest average NAPLEX pass rate between 2011 and 2015 was 77.5% and the highest average pass rate was 99.67%. There were 59 occasions in a single year where a college/school achieved a pass rate of 100%.

There were 11 colleges/schools who admitted 10% or less of their applicants and 10 colleges/schools who admitted 50% or more of their applicants, with one program admitting 85% of their applicants. Class sizes varied widely (range 45 to 310 students per class). Averages of in- and out-of-state tuitions varied from as low as approximately $11,000/year to as high as over $68,000/year. The lowest in-state tuition was just below $5,000/year and seven colleges/schools had in-state tuition rates below $10,000/year. The lowest out-of-state tuition rate was around $15,000/year. Racial and ethnic minority enrollment rates varied significantly with a range of 0.5% to 73.7% (not counting those in U.S. territories or outside the U.S.). Minority rates were highest at historically black colleges and universities (58.3%) and the college of pharmacy located in Puerto Rico (100%). Seventy-four colleges/schools had minority rates below 10%.

In the final fitted model (Table 3) the significant predictors of 2013-2015 match results were average NAPLEX pass rates, class size, academic health center affiliation, admit-to-applicant ratio, U.S. News ranking, and minority enrollment. The positive significant predictors were average NAPLEX pass rates, academic health center affiliation, admit-to-applicant ratio and college/school ranking. The negative significant predictors were class size and minority enrollment. When the upper and lower quartiles of the college/school match rates were compared (Table 4), the final fitted model showed that the significant predictors in the logistical regression model were NIH funding ranking, average tuition, and minority enrollment. While average tuition and minority enrollment were negative predictors for the probability of a university belonging to the highest quartile, NIH funding ranking was a positive predictor.

DISCUSSION

The study identified several modifiable factors that could predict college/school match rates in addition to the other non-modifiable factors previously identified.12 College/school familiarity or reputation is based on a perception of future performance of residency candidates. Reputation can be shaped by many different channels
including reporting of performance measures by licensing boards, reporting of accreditation decisions, and media exposure of everything from research activities to scandalous events. Reputation can also be shaped by perceptions of the strengths or weaknesses of college/school of pharmacy characteristics. ASHP PGY-1 residency standards refer to the use of formal predetermined criteria to evaluate and rank program applicants. The role of subjective and objective data in pharmacy residency candidate pre-interview selections or post-interview rankings is not stipulated by residency accreditation standards. In the medical school literature, the usefulness of school reputation has been periodically questioned, and no study in the pharmacy literature has substantiated a positive correlation between an academic institution’s reputation and resident performance.

The NAPLEX is designed to measure knowledge of the practice of pharmacy and is used by boards of pharmacy after degree program completion to assess competence to practice. It therefore is not surprising that colleges/schools

Table 1. Residency Match Percentages by Year and Average Match Rate Percentages Within Quartiles

|          | 2013       | 2014       | 2015       | Total      |
|----------|------------|------------|------------|------------|
|          | N=115      | N=121      | N=121      | Total      |
| Mean (SD)| 61.6 (14.8)| 62.1 (16.4)| 61.1 (15.6)| 61.4 (12.7)|
| Median (IQR)| 64.1 (8.6)| 63.2 (10.2)| 62.8 (8.4)| 63.4 (8.3)|
| Mean (SD)|            |            |            |            |
| First quartile| 41.6 (10.1)| 40.3 (10.4)| 40.5 (11.8)| 43.9 (8.6)|
| Second quartile| 58.7 (3.3)| 59.5 (2.8)| 58.9 (2.3)| 58.6 (2.5)|
| Third quartile| 68.0 (2.3)| 68.3 (2.9)| 67.3 (2.6)| 67.4 (2.1)|
| Fourth quartile| 78.1 (5.2)| 81.5 (6.1)| 78.6 (6.1)| 75.8 (3.0)|

Abbreviations: SD=standard deviation; IQR=interquartile range

Table 2. School-wide Modifiable Predictors Analyzed

| Characteristics (N=121) | Number (%) |
|-------------------------|------------|
| ACPE accreditation probation within the past 10 years | 10 (8.3) |
| NIH funding            |            |
| >5 million             | 41 (33.9)  |
| 1-5 million            | 24 (19.8)  |
| <1 million             | 17 (14.1)  |
| No funding             | 39 (32.2)  |
| Part of an academic health center | 53 (43.8) |
| Dual degree programs offered | 87 (71.9) |
| Three-year program     | 12 (9.9)   |
| Research               |            |
| Required or elective   | 116 (95.9) |
| Required               | 9 (7.4)    |
| Clinical track availability | 16 (13.2) |
| Residency affiliation  | 102 (84.3) |
| U.S. News rankings (2012) |         |
| Top 20 ranking         | 20 (16.5)  |
| Total ranked           | 86 (71.1)  |
| Not ranked             | 35 (28.9)  |

| Characteristics | Mean (SD) | Median (IQR) |
|-----------------|-----------|--------------|
| NAPLEX percentage pass rate\textsuperscript{a} | 94.7 (4.2) | 95.8 (4.8) |
| Admit-to-applicant ratio | 0.3 (0.1) | 0.2 (0.2) |
| Class size      | 122 (56)  | 108 (73)     |
| Average tuition in thousands\textsuperscript{b} | 33 (9)    | 33 (9)       |
| Percentage minority enrollment\textsuperscript{c} | 13.4 (0.2) | 7.9 (7.9) |

Abbreviations: SD=standard deviation; IQR=interquartile range
\textsuperscript{a}Average of 2011 through 2015 for each school
\textsuperscript{b}In-state and out-of-state tuition as averaged for each school
\textsuperscript{c}Average of 2013 and 2014 for each school
with lower NAPLEX pass rates would have lower residency match rates. Routine publication of school-wide passing rates on the National Association of Boards of Pharmacy website makes the information readily retrievable by pharmacy residency programs. A student’s individual NAPLEX scores, however, are not available for use in the residency application process since the majority of residency candidates are students who have not yet finished the doctor of pharmacy program. Alternatively, in medical residency programs, objective examination scores are routinely used to assess cognitive performance of medical students. As many as 82% of medical residency programs use US Medical Licensing Examination (USMLE) Step 1 scores in decisions regarding interview offers. The Federation of State Medical Boards (FSMB) does not officially publish USMLE scoring or passing data by school, however, so only individual student scores can be used. The Pharmacy Curriculum Outcomes Assessment (PCOA) is in the process of being adopted by most schools to address accreditation requirements regarding the ability to perform national comparisons between programs. The exam is designed to be given during the early years of the curriculum.27 The possibility of using PCOA as one component of a process similar to what is used in medical schools has been suggested by several authors.28,29 A letter from AACP, ACPE and the National Association of Boards of Pharmacy was issued to residency programs and colleges/schools of pharmacy in early 2017 strongly advising against the use of PCOA scores for post-graduate placement including resident selection. However, postgraduate training programs recognize the limitations associated with measures such as grade point average and are hard pressed to identify similar numerical data which can be used to evaluate residency candidates.29 The temptation for residency programs to use PCOA may be high, especially as researchers attempt to understand correlations between PCOA and NAPLEX scores.

The finding that higher class size was correlated with a lower college/school match rate was surprising. While larger programs may be able to offer more resources in terms of student organizations, availability of elective courses, and a wider variety of faculty as research and professional resources, the same programs may also experience challenges associated with access to high-quality experiential rotations and faculty mentorship. Affiliation with an academic medical center would be an advantage to

Table 3. Significant Predictors of Match Rates between 2013 and 2015 Using the Final Factors Retained in the Repeated Measures Model

| Independent Variable                      | Estimate | Standard Error | t value | p value |
|------------------------------------------|----------|----------------|---------|---------|
| Match year                               | 0.00086  | 0.0070         | 0.12    | .90     |
| NAPLEX percentage pass rate              | 0.71     | 0.25           | 2.9     | .01     |
| Class size                               | -0.00041 | 0.00017        | -2.4    | .02     |
| Part of an academic health center        | 0.046    | 0.019          | 2.5     | .01     |
| Admit-to-applicant ratio                 | 0.12     | 0.058          | 2.2     | .03     |
| U.S. News rankings                       | 0.033    | 0.016          | 2.1     | .04     |
| Percentage minority enrollment           | -0.25    | 0.073          | -3.4    | <.001   |

*aAverage of 2011 through 2015 for each school  
*bAverage of 2013 and 2014 for each school

Table 4. Significant Predictors of First vs Fourth Quartile Match Rates Between 2013-2015 Using the Final Factors Retained in the Repeated Measures Model

| NIH funding, number (%) | First quartile match N = 30 | Fourth quartile match N = 30 | OR | 95% CI | p value |
|-------------------------|-----------------------------|-----------------------------|----|--------|---------|
| >5 million              | 1 (3.3)                     | 19 (63.3)                   | 7.35 | (1.47, 36.86) | .02 |
| 1-5 million             | 3 (10.0)                    | 3 (10.0)                    |    |        |         |
| <1 million              | 7 (23.3)                    | 3 (10.0)                    |    |        |         |
| No funding              | 19 (63.3)                   | 5 (16.7)                    |    |        |         |
| Average tuition in thousands (SD)* | 37 (11)                     | 29 (1)                      | 0.79 | (0.64, 0.97) | .02 |
| Lowest to highest       | 12 (68)                     | (11-39)                     |    |        |         |
| Percentage minority enrollment (SD)* | 21.7 (21.7)                | 8.6 (8.6)                   | <0.001 | (<0.001, 0.003) | .01 |

Abbreviations: OR=odds ratio; CI=confidence interval; SD=standard deviation  
*aIn-state and out-of-state tuition as averaged for each school  
*bAverage of 2013 and 2014
colleges/schools hoping to provide students with interdisciplinary experiential rotations in a high-acuity setting. Several studies on the evaluation of residency candidates included student rotations in the selection criteria.\textsuperscript{6,8,30} Quality, however, cannot be assumed by association with an academic medical center. Of concern is the recent editorial which suggested that quality in pharmacy education can only be assured through relationships between colleges/schools of pharmacy and doctoral institutions or academic health centers.\textsuperscript{31} Only a speculative relationship exists between these relationships and a college or school’s ability to adequately prepare students for post-graduate training.

U.S. News rankings of graduate health programs are based on peer assessment surveys of subjective 5-point scale ratings of “academic quality.”\textsuperscript{32} These methods could create a bias against newer schools since survey participants were asked to select “don’t know” if lacking sufficient knowledge about a program. In turn, a bias in favor of more established schools or schools with high publicity could be a factor. A higher published admit-to-applicant ratio could create a perception that a superior pharmacy education is being provided. Alternatively, colleges/schools receiving more competitive applications may also have an easier time nurturing students with the propensity to achieve superior pharmacy grades and to match during the residency application process.

The association between higher minority enrollment and lower residency match rates is an unsettling finding. In graduate medical education, the disparity between minority populations in U.S. census figures and under-represented minorities in medical education and the physician workforce has been known for many years.\textsuperscript{33} What has not always been well-understood is whether students from under-represented minority groups are at a disadvantage in the residency application process. Our results reveal correlation but not causation with respect to colleges/schools with higher minority enrollment, so interpretations should be made with caution. Because of the proposed link between reducing barrier to health care access and increasing diversity in the health care workforce, pharmacy residencies may wish to consider the advantages of a more diverse pharmacy workforce on minimizing health disparities.\textsuperscript{33}

Research opportunities beyond methodology or components of research have been suggested by ACCP as a way to prepare doctor of pharmacy students for the research activities expected during residency training.\textsuperscript{7} Although these recommendations are fairly new, it was surprising that the availability of student-driven research opportunities in the form of required or elective courses did not correlate with the school-wide match rates. The fact that most colleges/schools of pharmacy have elective courses in research or the fact that there may be variable enrollment levels in these courses among residency-bound students could have contributed to the lack of correlation. Poor correlation could also be explained by the required research courses being offered primarily during the final professional year or in a timeframe not facilitating manuscript or poster presentation before residency application deadlines, which could mean that residency programs were not aware of or didn’t count the research experience. It was surprising to learn that clinical tracks did not confer an advantage to colleges/schools providing the opportunity. It is possible that the colleges/schools that provide those tracks have other factors associated with success, making the influence of clinical tracks difficult to analyze. Schools may also not widely publicize the availability of or the success with these opportunities. In addition, depending on how the information was presented on transcripts or in residency applications, programs may or may not have been aware of the additional residency preparation students may have received. A recent survey of colleges/schools of pharmacy revealed that 22\% of schools offer research tracks and 19\% offer clinical tracks or tracks designed to help students compete for residency positions.\textsuperscript{4} An additional 33\% of schools surveyed were considering the possibility of or in the process of developing electives/curricular tracks to help prepare students for residency. Research on the benefit of curricular tracks across multiple schools and colleges would be beneficial as preliminary data is promising.\textsuperscript{34}

Our study has several limitations. We relied on AACP website for certain details about each school such as academic health center affiliation, and tuition rates. Erroneous information could have been obtained but also factors not yet affecting match rates could have been used. The AACP data was likely updated on the website just prior to the 2015-2016 admissions cycle, which means changes would not have affected match rates from the years 2013-2015. This same issue was potentially present when we obtained information about clinical tracks and student-driven research from college of pharmacy websites. Again, it is possible that a school started or ceased an activity which could have affected the school-wide match rate.

There are additional factors which could have influenced a school’s match rate which would have been more difficult to study. For example, news releases of faculty or student activities regarding major publications, presentations, grants, or awards could have played a role. Negative publicity also could have been a significant factor.

CONCLUSION

There are several characteristics of colleges/schools of pharmacy which have the potential to impact residency
match rates, but further research is needed to understand how changes in these factors may influence overall match rates. Colleges/schools of pharmacy, under pressure to report high rates of student success in obtaining residency positions, should systematically analyze these factors as well as others which best fit their program, student body, and types of residencies frequently pursued. An analysis of predictors of fellowship and graduate program placement could also be helpful. With the use of centralized application services for pharmacy residencies, student-level data is being collected and should be used for additional research, especially for the purpose of understanding how minority status affects student residency placement.

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