REVIEW

Systematic Review of Predictors of Success for the North American Pharmacist Licensure Examination

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Objective. Studies have examined possible predictors of success on the North American Pharmacist Licensure Examination (NAPLEX). This systematic review investigated the literature on potential predictors of success on the NAPLEX.

Findings. Articles were included in the review if they included student characteristics and academic performance as independent variables and NAPLEX scores and/or pass rate as an outcome. Data were extracted from each article for students’ demographics or variables, sample size, methods of statistical analyses, and results reporting correlation or predictability. From 40 articles retrieved from the initial search and sorting, a total of 20 studies were included in the final review per inclusion criteria. Three studies included all the pharmacy programs, 15 were single-institution studies, 2 multi-institution studies, and 4 published as posters. Among 30 different variables identified as potential predictors of success on the NAPLEX, the most examined variables were student age at matriculation, having a prior degree, Pharmacy College Admission Test (PCAT) scores, cumulative pharmacy school grade point average (GPA), overall Pharmacy Curriculum Outcomes Assessment (PCOA) scores, and PCOA content areas scores. Positively correlated factors included PCAT scores, not having a prior degree, prepharmacy and pharmacy school GPA, institutional characteristics, and PCOA scores. Negatively correlated factors included older age at admission.

Summary. Cumulative pharmacy school GPA and PCOA scores were predictors of NAPLEX success consistently in the studies. The effects of preadmission student characteristics on NAPLEX success varied and were not consistently correlated or predictive.

Keywords: NAPLEX, student characteristics, admissions, predictor variables, accreditation

INTRODUCTION

Passing the North American Pharmacist Licensure Examination (NAPLEX) is required for pharmacists to obtain licensure to practice in the U.S. The NAPLEX measures a doctor of pharmacy (PharmD) candidate's entry-level knowledge and competence to practice as a pharmacist, and serves as one of several programmatic outcomes that the Accreditation Council for Pharmacy Education (ACPE) evaluates for accreditation criteria of a pharmacy program. However, concerns regarding graduates’ suboptimal NAPLEX performances began to surface when a decrease in the overall pass rate for the NAPLEX was reported between 2015 and 2016, from 92.6% to 85.9%, respectively. Since then, the pass rate has remained relatively stable with 88.03% in 2018 (first-time pass rate, 89.46%), 86.74% in 2019 (first-time pass rate, 88.43%) and 87.03% (first-time pass rate, 88.43%) in 2020. The proliferation of new pharmacy programs, the changing applicants’ demographics, and changes to the NAPLEX format in 2016 - including changes in passing standards, extension of the length of examination and more application-based questions - may have contributed to the lower pass rates of NAPLEX in recent years. Additionally, the National Association of Boards of Pharmacy (NABP) published its revised NAPLEX competency statements in January 2021, which have expanded from two main areas to six, each including a range of 4-12 subareas and added expanded contents such as pregnancy or lactation. This change may likely affect the NAPLEX performance of the first cohort of pharmacy graduates in 2021.

While pharmacy programs make efforts to increase the pass rate of their graduates, there are no clear predictors of success for NAPLEX identified to date. Compiled and described in this review, a score of studies has examined possible predictors of NAPLEX first-time pass rates such as student demographic, preadmission criteria, Pharmacy College Admission Test (PCAT) scores, pre-NAPLEX scores, the pre-professional curriculum, Pharmacy Curriculum Outcomes
Assessment (PCOA) scores, and remediation status. These studies have attempted to provide data-driven direction for admissions-related and programmatic decisions, and collectively have shown the challenges of predicting students’ success on NAPLEX outcomes, partly due to the variability in student sample size and characteristics, study design, outcome variables, and period of evaluation. Only one study to date has comprehensively reviewed previous studies for these variables; however, it included only 3rd year pharmacy grade point average (GPA) as a predictor of PCOA scores and a subsequent predictability of PCOA scores on NAPLEX scores. The use of multiple indicators or predictors to identify students at risk of not passing NAPLEX would provide an opportunity for programs to strategize student support prior to taking NAPLEX. Therefore, the purpose of this systematic review is to comprehensively review previously published data regarding predictors of NAPLEX success.

METHODS

Based on the principles from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), a literature search was conducted to retrieve publications regarding student characteristics at admission and NAPLEX pass rate, using PubMed, Embase, American Journal of Pharmaceutical Education, and Currents of Pharmacy Teaching and Learning. Keywords used for the search included a single or combination of the following terms: NAPLEX (both spelled out and in abbreviation), licens* exam, pharmacy, board exam, graduation year, factor, variable, predict*, correlat*, personal characteristic, student demographic, or student profile. An additional search was conducted via the internet search engine (Google, Google Scholar) to capture and retrieve studies that were not yet published in a journal or indexed by databases not found in the search. Citations of each retrieved article were reviewed to find any potential articles missed from the database search.

Articles were included in the review if they (1) used NAPLEX passing at the first attempt as an outcome, (2) reported results from pharmacy programs in the U.S. and/or U.S. territory, (3) included at least one student characteristic as an independent variable potential for correlating with or predicting the outcome, (4) was published in a peer-reviewed journal or as a poster at a professional conference, and (5) investigated either a correlation or predictability of the student characteristic for NAPLEX passing. Articles were excluded if they (1) were review articles, thesis/dissertations, commentaries, editorial or non-peer reviewed publications, or published only as an abstract with minimal data, (2) did not study NAPLEX passing as an outcome, or (3) reported NAPLEX passing after an instructional intervention or a curriculum revision (eg, incorporation of skills laboratory, modification of an instructional design), or (4) did not report any correlation or predictability of NAPLEX passing.

Three investigators independently searched for relevant articles and discussed their merit for inclusion via consensus-building. Articles were included in the review if all three investigators agreed on their merit for inclusion based on the inclusion criteria. The investigators comprehensively reviewed the retrieved literature and extracted the following data: study year, study institution, student sample size, preadmission variables, first-attempt NAPLEX pass rate, any other assessments reported as independent variables (eg, PCOA scores), and any statistical analyses and results reporting correlation or predictability. Preadmission variables were defined as any independent variable that students possessed without any intervention before they began their pharmacy program such as prepharmacy GPA and PCAT scores. Prior degrees were used for any undergraduate or graduate degrees attained before entering pharmacy program. If it is specifically noted as an undergraduate degree, it was reported as such. NAPLEX success or NAPLEX passing was defined as passing of NAPLEX at the first attempt unless otherwise noted. If the authors reported NAPLEX scores as outcomes instead of NAPLEX success/passing, they were reported here as such. Statistical significance was confirmed by reported p-values or effect estimates with confidence intervals. If any statistical significance was claimed without an inclusion of statistical confirmation, it was noted as ‘not reported.’

RESULTS

The initial search yielded 40 articles, from which 20 articles were included based on the inclusion and exclusion criteria. The details of the included studies and their findings are summarized in Table 1. Of the excluded articles, 3 were duplicate information (ie, a poster which was later published as full-text), 8 articles were commentaries, editorials, or non-peer reviewed publications, 5 articles did not have NAPLEX passing as an outcome, 3 articles correlated NAPLEX passing after a change in the curriculum, and 1 article reported correlation between the student characteristics with pre-NAPLEX scores. The included studies were published over a period of 15 years from 2005 to 2020, investigated NAPLEX passing from pharmacy programs ranging from a single institution to 137 institutions, and collectively covered over 13,000 individual students’ NAPLEX results. Four of the 20 studies were published as posters with extractable data. Two publications by Shaya et al. were of the same student cohort from one institution but had results for different predictor variables. Common predictors investigated in the studies were age, gender, having a prior degree,
prepharmacy GPA, PCAT scores, pharmacy GPA, PCOA scores, pre-NAPLEX scores, and on-time graduation. Other variables included attending different campuses of the same program, type of program or institution, critical-thinking test scores, personality type, and remediation.

**Age:** Six studies evaluated age as a predictor of performance on NAPLEX, of which three found age to be an independent predictor for NAPLEX success. Two of these studies were from one institution but with two separate analyses for the same cohort of students, and found that ages ≥ 25 years were associated with lower scores on both the NAPLEX and the Multistate Pharmacy Jurisprudence Examination (MPJE). A three-institution study found the age ≥ 25 years as a negative predictor of NAPLEX score in all three areas and the total scores (p<.01). This result was also confirmed in another single-institution study in which age at graduation > 28 years was the only significant factor that had a negative correlation to NAPLEX score (p<.014) and predictive of poorer outcomes on the NAPLEX (p<.002). McCall et al. found that, when controlled for composite PCAT and prepharmacy GPA, age at admission was negatively correlated with NAPLEX (r = -.189, p<.001). While age was not significantly associated with NAPLEX success, Spivey et al. found that increased age was predictive of decreased likelihood of on-time graduation (p<.001).

**Gender:** Six studies assessed the correlation between gender and NAPLEX performance. Only one three-institution study found that male students had higher mean NAPLEX scores than females, but only by 1.65 points (p=.017). No other studies reported positive correlation between male gender and NAPLEX scores.

**Prior degree:** Eight studies investigated the correlation between students having a prior or other degree at admission on NAPLEX performance. Five of these studies found that having an undergraduate degree(s) had no association or predictability with NAPLEX performance. However, having a prior degree was negatively correlated with NAPLEX performance in a study with one cohort of students from one institution. Shaya et al. found that not having a prior degree was positively predictive of the score on the pharmacotherapy section of NAPLEX (p<.05). Relatedly, Spivey et al. found that having an undergraduate degree was a negative predictor of on-time graduation.

**PCAT:** Eight studies evaluated PCAT performance as a predictor of NAPLEX performance and attempted to investigate both the PCAT composite score as well as PCAT section scores. All of the studies found a positive correlation with NAPLEX scores except one study in which PCAT composite percentile was not associated with NAPLEX passing. McCall et al. found that PCAT composite score had the highest correlation value with NAPLEX score (r=.400, p<.001) and each of the five PCAT subscores showed a positive correlation with NAPLEX score (all p<.001). Shaya et al. found that PCAT chemistry, reading comprehension, and verbal ability correlated with NAPLEX scores. In a sub-analysis that examined the relationship between PCAT scores and specific sections of NAPLEX, Shaya et al. found that scores in the area 1 were explained by PCAT chemistry and verbal ability, scores in the area 2 by quantitative ability and reading comprehension, and area 3 by biology, quantitative ability, and verbal ability (see Table 1). These results were confirmed by another study using a three-institution cohort; both NAPLEX and MPJE pass rates were associated with higher chemistry, reading comprehension, and verbal scores on the PCAT. Chisholm-Burns et al. also found a positive correlation with PCAT section scores and composite scores with NAPLEX total scaled scores (p<.05 for both). Shah et al. found that low PCAT composite scaled score (<74) was a predictor of poor NAPLEX performance (p<.05).

**Prepharmacy GPA:** Seven studies investigated the relationship between prepharmacy GPA and NAPLEX success, from which two studies found a positive correlation. McCall et al. found that prepharmacy GPA was positively correlated with NAPLEX score (p<.001); however, type of institution where organic chemistry was completed (2-year vs. 4-year) or taking advanced chemistry, biology, and math courses was not significantly correlated with NAPLEX score. Additionally, the best predictor of NAPLEX score was a combination of composite PCAT score, prepharmacy GPA, and age. Allen and Diaz found that prepharmacy cumulative GPA, math-science GPA, transfer admission, and having no unsatisfactory grades at admission positively correlated with NAPLEX success (p<.001). No other studies corroborated this correlation or predictability. Two other studies found no significant relationship between NAPLEX scores and prepharmacy major, or prior institution's ranking, size, or location.

**Pharmacy GPA:** Among the nine studies that investigated the relationship between pharmacy GPA and NAPLEX success, seven of them found a positive correlation between the two. Allen and Diaz found that cumulative pharmacy GPA had a positive correlation with NAPLEX success (p<.001), and a total number of unsatisfactory grades, having no unsatisfactory grades, and on-time graduation were also positively correlated with NAPLEX success (p<.001). Cumulative pharmacy GPA was positively correlated with NAPLEX and MPJE success, and with all three areas of NAPLEX scores. Hein et al. found a positive association between P3 pre-APPE GPA with NAPLEX success (p<.05) while Shah et al. found no correlation with P3 cumulative GPA. Nevertheless, having a final course percentage less than 74% in three or more courses was positively correlated with poor NAPLEX scores (p<.05). Chisholm-Burns et al. suggested that cumulative pharmacy GPA was one of the significant predictors of NAPLEX.
success in their predictability equation where NAPLEX total scaled score = 3.514 + 25.479 (pharmacy GPA) + 0.205 (pre-NAPLEX score). Garavalia et al.\textsuperscript{21} found that GPA and PCOA together accounted for 39\% of the variation in the NAPLEX scores ($p<.001$), with GPA (14\%) explaining more than PCOA scores (8\%). While not shown a positive correlation with NAPLEX success, Spivey et al.\textsuperscript{28} found that P1 GPA was a positive predictor of on-time graduation and a negative predictor of dismissal from the program.

**Academic progression:** From five studies investigating academic progression as a predictor of NAPLEX success,\textsuperscript{11,12,20,25,28} Madden et al.\textsuperscript{11} found that the NAPLEX passing rate significantly differed between students who required remediation and those who did not (70\% vs. 97\%, respectively; $p<.001$). Two studies found that on-time graduation was positively correlated with NAPLEX success.\textsuperscript{11,20} However, Shah et al.\textsuperscript{25} found that graduation delay was not one of the predictors of poor NAPLEX performance. Spivey et al.\textsuperscript{28} found that appearing before an academic progression committee was a negative predictor of NAPLEX passing at first attempt ($p<.02$), and age at graduation and having undergraduate degree were negative predictors of on-time graduation ($p<.01$ and $p<.01$, respectively).

**PCOA or other pre-APPE exams:** All six studies\textsuperscript{14,17,21,23-25} found a positive correlation between NAPLEX and PCOA scores. Naughton and Friesner\textsuperscript{14} found significantly positive correlation between PCOA scaled score and four subtopic domain scores with NAPLEX total and the areas 1, 2, and 3 scores (range: $r=.167$ to $.590$; $p<.05$). However, the PCOA Social, Behavioral, and Administrative Science subtopic score did not significantly correlate with NAPLEX scores by Pearson ($p=.084$) and Spearman ($p=.033$) analyses. Hutchinson et al.\textsuperscript{17} found that combined scores of the Pharmaceutical Sciences and Clinical Sciences content areas explained 32.8\% of the variation in the NAPLEX scores ($r=.572$; $p<.0005$) and those areas were predictive of NAPLEX scores by 51.4 (Pharmaceutical Sciences) + 0.70 (Clinical Science). This association was also corroborated in two other studies in which PCOA score explained 26\% of the variance in NAPLEX scores,\textsuperscript{21} and PCOA total and contents scores explained 30-33\% of variance in total NAPLEX scores.\textsuperscript{23} Basic Biological Sciences, and Social, Behavioral, and Administrative subtopic score were not predictors of NAPLEX scores\textsuperscript{23} and did not correlate with NAPLEX Competency area 2 scores.\textsuperscript{14} While not shown any association with NAPLEX success, Hein et al.\textsuperscript{24} found that PCOA scores were positively associated with P3 pre-APPE GPA.

**Pre-NAPLEX:** The results were split between the two studies that investigated the association between pre-NAPLEX test scores with NAPLEX scores;\textsuperscript{20,28} Chisholm-Burns et al.\textsuperscript{20} found that pre-NAPLEX was a significant predictor of NAPLEX score and explained 44\% of the variance in NAPLEX total scaled scores ($p<.05$). Spivey et al.\textsuperscript{28} found no correlation or predictability with pre-NAPLEX score.

**Critical-thinking skill or personality tests:** McCall et al.\textsuperscript{10} found a positive correlation between NAPLEX scores and the California Critical Thinking Skills Test which was taken during the admissions interview ($p<.001$). Interestingly, Ware\textsuperscript{22} found that Myers-Briggs Type Indicators were predictive of first-attempt NAPLEX scores with 17\% of the variation explained by the types (adjusted $R^2=12.4\%$); Introversion personality types scored 9.5 points higher than Extroversion types ($p<.01$), and Feeling types scored 6.0 points higher than Thinking types ($p=.03$).

**Internationally trained pharmacists:** Based on one study by Prabhu et al.,\textsuperscript{18} NAPLEX pass rates did not differ between graduating students from a traditional PharmD program versus those who were internationally trained pharmacists graduating from an international postbaccalaureate PharmD program (IPBP). The IPBP group performed better compared with the traditional group in average total scaled score (115.1 vs 107.6; $p<.05$). Spivey et al.\textsuperscript{28} found a positive correlation between NAPLEX scores and pre-1992 vs. post-1992 groups ($p<.001$) and testing year ($p<.05$). Approximately 14 years later, Jimenez et al.\textsuperscript{26} conducted a comprehensive review of 128 accredited programs with PharmD graduates as of May 2018 and compared their NAPLEX pass rates over a three-year period with the programs’ nonmodifiable factors (eg, graduating class size <100, public vs. private, 4- vs. 3-year curriculum, GPA vs. pass/fail grading system). Positive correlations were found between public institution vs. private and graduating class size ≥100 in the years 2015 and 2017. No correlation was found for 4- vs. 3-year curriculum, graduating class size ≥100 in 2016, or GPA vs. pass/fail grading system. However, Williams et al.\textsuperscript{27} evaluated 137 programs accredited as of July 2017 and found a positive correlation between NAPLEX total scaled scores and public institution, location of the program in an academic health center, establishment before year 2000, and traditional 4-year curriculum. For institutions having more than one campus, the location of the campus (eg, main vs. satellite) had no
correlation with NAPLEX scores or pass rates in one study\textsuperscript{13} whereas another study found a 5.7 point higher score in one campus vs. the other.\textsuperscript{22}

Other factors: Williams et al.\textsuperscript{27} also found a positive correlation between NAPLEX total scaled score and the percentage of P4 students who matched for a first PGY-1 residency. However, the NAPLEX scores were negatively correlated with the percentage of out-of-state students. Shaya et al. found a similar result where the students from the West region of the country was negatively predictive of NAPLEX scores \textup{(p<.05)}\textsuperscript{15} and that the students were negatively predictive of the NAPLEX area 1 result \textup{(p<.05)}.\textsuperscript{16}

**DISCUSSION**

This is the first comprehensive review of potential student-related factors correlated with or predictive of NAPLEX success. Given the number of publications on this topic and the breadth of data collection and evaluation, NAPLEX passing rate is a critically important measure of programs’ success and an area of ongoing interest.\textsuperscript{29}\textsuperscript{30} This review elucidates the efforts and curiosity of pharmacy programs to define potential variables of NAPLEX success amidst the vague and subjective nature of those variables in answering the question. McCall et al.\textsuperscript{10} demonstrated that while composite PCAT, prepharmacy GPA, and age had the strongest correlation with NAPLEX success, they explained only 21\% of the variance in NAPLEX performance and the other 79\% of the variance was explained by other variables. While the results of this review may not provide a precise answer to the question of student-related variables that would increase their NAPLEX success, they provide an overview of the factors and congruency among different studies investigating similar variables. For example, cumulative pharmacy GPA and PCOA scores were one of the most frequently studied variables and were also consistently correlated or predictive of NAPLEX scores. Interestingly, these results corroborated a recent report by NABP, which reported a comprehensive analysis on the relationship between PCOA scores of 49,510 students and their NAPLEX outcomes over a three-year data period.\textsuperscript{32} While the analysis was considered preliminary, the report concluded that PCOA was a strong predictor of NAPLEX performance.

The results of this review should be carefully and critically interpreted given their limitations. The most significant limitation is that the data do not represent the entirety of pharmacy programs and their student population; thus, some of the positive or negative correlation data may not be generalizable to all programs. The three nation-wide, multi-institution studies evaluated only the characteristics of the programs and not the student variables.\textsuperscript{9}\textsuperscript{26}\textsuperscript{27} To comprehensively determine the predictability of student-dependent characteristics for NAPLEX success, a large-scale study of all pharmacy programs would be warranted.

Moreover, several changes have occurred in pharmacy academia recently that may affect the generalizability of this result. First, many programs have decided to eliminate the PCAT requirements for pharmacy school admission due to competition and ease of admission application process for the candidates. Thus, the correlation of PCAT data to NAPLEX success may not be relevant to some programs. Given that several studies did demonstrate PCAT scores as being correlated with NAPLEX scores, the PCAT requirement may be reconsidered as part of the admission criteria. Second, NABP has revised its NAPLEX competency statements in January 2021.\textsuperscript{5} Thus, this change evokes curiosity and concern for NAPLEX pass rate for the class of 2021. Using the previous NAPLEX change in 2016 as an example, four studies from our review included NAPLEX performance data from both pre- and post-2016 NAPLEX blueprint.\textsuperscript{25}\textsuperscript{26}\textsuperscript{28} All four studies reported a decrease in the NAPLEX pass rate in the class of 2016 compared with other years - the graduating class of 2016 from 128 programs performed significantly worse compared with those of 2015 and 2017 \textup{(p<.05)}\textsuperscript{26} Additionally, the NAPLEX pass rate of 2016 was significantly lower than from 2014 and 2015 \textup{(p<.001)}, and 29\% of schools experienced more than 10\% drop in NAPLEX pass rates between 2015 and 2016.\textsuperscript{27} Given these results, it is presumable that any changes to the NAPLEX blueprint may negatively affect NAPLEX performance, especially during the first year after the change. Moreover, students’ preparedness and familiarity of the test or lack thereof may potentially affect the first-year performance. Given that NAPLEX score reporting is also changing from scaled scores to pass/fail system in 2021,\textsuperscript{33} the correlation or predictability of the variables with NAPLEX scores may not be relevant or helpful moving forward.

Nevertheless, there is a need for a more consistent and systematic approach to studying the effectiveness of student demographic and performance variables to inform academic support decisions, especially for NAPLEX preparation. Given the uncertainty of some of these variables in predicting NAPLEX outcome, more judicious and cautious use of these results is recommended than otherwise assumed; overtly accepting or dismissing these variables as the NAPLEX predictors for all students would be precarious and unreliable. While there are inherent challenge and limitations to considering a singular predictor variable for this purpose, the use of multiple variables or predictors may assist in identifying students at risk for not passing NAPLEX. The results of this review may serve pharmacy programs as
a tool to supplement or support their own assessment data in an effort to prepare for early intervention programs to change the trajectory of “at-risk” students in the program.

**CONCLUSION**

Cumulative pharmacy school GPA and PCOA scores were predictors of NAPLEX success consistently in the studies. Older age, having a prior degree, PCAT scores, and graduation delay negatively affected NAPLEX scores. The effects of other preadmission characteristics, pre-NAPLEX scores, and institutional characteristics on NAPLEX success varied due to student population and sample size. These predictive variables may help identify at-risk students for early intervention, supplemented with each institution’s data to prepare for the changing NAPLEX landscape.

**REFERENCES**


Table 1. Summary of Literature Investigating Student-related Factors Correlated with or Predictive of NAPLEX Success

<table>
<thead>
<tr>
<th>Author, year</th>
<th>Study design, sample location and size</th>
<th>Variables/predictors studied</th>
<th>Outcomes</th>
<th>Implications</th>
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<tbody>
<tr>
<td>Zarembski et al, 2005</td>
<td>Retrospective review of 74 SOPs accredited before 1992 vs. 8 SOPs accredited in or after 1992</td>
<td>Schools accredited pre-or post-1992 NAPLEX testing year</td>
<td>Small but significant difference found between the two groups: 19,124 (96.4%) passed from pre-1992 vs. 1,070 (94.9%) passed from post-1992 (p&lt;.05)</td>
<td>Accreditation year of SOP may not be a strong predictor of NAPLEX success or failure. The schools accredited post-1992 addressed the curriculum adequately to prepare students.</td>
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<tr>
<td>McCall et al, 2007</td>
<td>Retrospective review of single SOP at Texas Tech U HSC; review of transcripts from fall 1996-August 2005 with NAPLEX scores (n=373)</td>
<td>- Academic degree attained</td>
<td>Positive correlation with NAPLEX score (each p&lt;.001)</td>
<td>Best predictor: composite PCAT + Prepharmacy GPA + Age</td>
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<td></td>
<td>- Advanced courses taken in chemistry, biology, or math</td>
<td>- Composite PCAT score (r=.400, highest correlation)</td>
<td>Composite PCAT score was the strongest predictor of success and failure on the NAPLEX.</td>
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<td>- Age at admission</td>
<td>- Each of the five PCAT subscores</td>
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<td>- CCTST</td>
<td>- Prepharmacy GPA</td>
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<td>- PCAT subscores</td>
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<td></td>
<td>- Prepharmacy GPA</td>
<td>No correlation:</td>
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<td>- Type of institution where organic chemistry was completed (2-year or 4-year)</td>
<td>- Age (negative correlation when controlled for composite PCAT and prepharmacy GPA)</td>
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<td>- Advanced courses in chemistry, biology, or math</td>
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<td>- Attainment of BA, BS, or MS degree</td>
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<td>- Organic chemistry taken at 2-year or 4-year institution</td>
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<td>Madden et al, 2012</td>
<td>Retrospective review of single SOP at Lake Erie College of Osteopathic Medicine</td>
<td>Students who required remediation vs. who did not</td>
<td>20 students required remediation</td>
<td>Students who are remediated may need additional support to pass NAPLEX.</td>
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<td></td>
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<td>Significant difference in NAPLEX passing rate between those who were remediated vs. who were not (70% vs. 97%, respectively; p&lt;.001)</td>
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<tr>
<td>Allen and Diaz, 2013</td>
<td>Retrospective review of single institution at Xavier U of Louisiana COP with 6-year program</td>
<td>Preadmission variables:</td>
<td>Positive correlation: Prepharmacy (p&lt;.001)</td>
<td>High cumulative GPA in either prepharmacy or pharmacy program was a significant predictor of NAPLEX.</td>
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<td>- Previous degree</td>
<td>- Cumulative GPA (strongest correlation)</td>
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<td>- Number of unsatisfactory grades (D or F)</td>
<td>- Math and science GPA</td>
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<td>- Transfer admission</td>
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Students graduating between 2008 and 2011 (n=432)

- Prepharmacy cumulative and math-science GPA
- Admission type (internal or transfer)

Pharmacy program variables:
- Number of unsatisfactory grades
- On-time graduation
- Cumulative GPA for didactic courses

- No unsatisfactory grades
- Positive correlation: PharmD program (p<.001)
  - Cumulative GPA (strongest correlation)
  - Total unsatisfactory grades
  - On-time graduation
  - No unsatisfactory grades

No correlation:
- Having previous degrees

Congdon et al, 2014
Retrospective review and annual student survey, single institution at U of Maryland SOP for main (Baltimore) and distance (Rockville) campuses

Graduating class of 2011 and 2012 (n=306; main=235, distance=71)

Campus comparison for
- Gender
- Race
- Prepharmacy GPA
- PCAT score – biology, chemistry, and composite
- APPE grades
- NAPLEX scores and pass rates
- Students’ time allocation for attending class, listening to lectures, studying, school activities, and work

- No statistical difference between two campuses in
  - APPE grades
  - NAPLEX scores
  - NAPLEX pass rates

- No statistical difference between time allocation and NAPLEX outcomes

Student survey response rate for time allocation: Main=50%, distance=51%

Naughton and Friesner, 2014
Retrospective review of single institution at North Dakota State U COP

P3 students who took PCOA in 2009 and 2010 (n=108)

P3 PCOA scores:
- 2009 (n=53) and 2010 (n=55)

- Significantly positive correlation between PCOA scaled score and four subtopic domain scores with NAPLEX total and Areas 1, 2, and 3 scores (range: r=.167 to .590; p<.05)

- PCOA SBA subtopic score did not significantly correlate with NAPLEX Area 2 scores with mixed results between Pearson (p=.084) and Spearman (p=.033) analyses.

- Positive predictor of NAPLEX and MPJE:
  - Cumulative pharmacy GPA (p<.05)

- Positive predictor of NAPLEX alone:
  - PCAT chemistry (p<.05)
  - PCAT reading comprehension (p<.10)
  - PCAT verbal ability (p<.05)

- Negative predictor of NAPLEX and MPJE:
  - Age≥25 years (p<.10)

Shaya et al, 2014
Retrospective review of single institution at U of Maryland with two campuses

Graduating class of 2011 – 2013 (n=383) with NAPLEX (n=361) and MPJE (n=319) scores

- Age at admission
- Gender
- Race/ethnicity
- Geographic location
- Prior degree and concentration
- Previous institution’s location, size, ranking
- Prepharmacy cumulative GPA
- PCAT composite and subscores
- Legacy

- Student’s overall academic performance may predict NAPLEX and MPJE success.

- PCAT score may serve as a helpful indicator for NAPLEX success.
Shaya et al. 2014\cite{Shaya2014}

Retrospective review of single institution at U of Maryland with two campuses

Graduating class of 2011 – 2013 (n=383) with NAPLEX scores (n=361)

- Early decision
- Final cumulative pharmacy GPA
- Grade in pharmacy law course
- SOP campus location

Negative predictor of NAPLEX:
- Having prior graduate degree (p<.10)
- From the West region (p<.05)
- Graduating class of 2012 (p<.05)

Students who are ≥25 years at admission may need additional support to prepare for the tests.

Hutchinson et al. 2015\cite{Hutchinson2015}

Retrospective review of single institution at St. John Fisher College SOP

Graduating class of 2013 and 2014 (n=105) who took PCOA in 2012 and 2013

PCOA scores

Positive correlation with NAPLEX:
- Combined PS and CS scores (r=.572, p<.0005)
- Explains 32.8% of the variation in NAPLEX scores (r²=.328)
- Predicted NAPLEX = 51.4 + 0.70 (PS + CS)

PCOA scores are important variables in predicting NAPLEX success.

Prabhu et al. 2015\cite{Prabhu2015}

Retrospective review of single institution at Western U. Health Sciences

Graduating students from IPBP program from class of 2010 to 2013 (n=71)

Pharmacy program between traditional PharmD and IPBP

No difference in NAPLEX pass rate.
- IPBP group performed significantly better than the traditional group in
  - Average total scaled score, 115.1 vs 107.6 (p<.001)
  - Area 1 scores, 13.6 vs 13.1 (p=.013)
  - Area 2 scores, 13.5 vs 12.5 (p<.001)

Students in IPBP program pass NAPLEX at a similar rate as those in traditional PharmD program.
compared with traditional PharmD (n=414)

- No significant difference in Area 3 scores.

Positive predictor of NAPLEX and MPJE:
- Final pharmacy GPA (p<.001)
- PCAT reading comprehension (p<.05)

Positive predictor of NAPLEX:
- PCAT chemistry (p<.001)
- PCAT verbal ability (p<.001)
- Male gender (p=.017)

Positive predictor of MPJE:
- PCAT reading comprehension (p=.0025)

Negative predictor of NAPLEX:
- Age ≥25 years for the total NAPLEX and its three areas (p<.01)
- Non-Hispanic whites vs. black/AA (p<.01)
- Pre-NAPLEX score (p<.05)
- PCAT section scores (p<.05)
- PCAT composite score (p<.05)
- Undergraduate science GPA (p<.05)
- Cumulative pharmacy GPA (p<.05)
- On-time graduation (p=.01)

No correlation to NAPLEX total scaled score:
- Gender
- Having an undergraduate degree
- Having at least one unsatisfactory grade

Pre-NAPLEX score and pharmacy GPA were significant predictors of NAPLEX score:
NAPLEX total scaled score=3.514 + 25.479 (pharmacy GPA) + 0.205 (Pre-NAPLEX score).

Both GPA and PCOA scores are predictors of NAPLEX success but GPA weighs more than PCOA scores.

Cumulative pharmacy GPA was positively predictive NAPLEX and MPJE scores.

PCAT score may serve as a helpful variable for NAPLEX success.

Students who are older than 25 years may need additional support to prepare for the exams.

Academic performance and pre-NAPLEX scores may serve as predictors of NAPLEX success. Pre-NAPLEX may guide in assisting students to pass NAPLEX.
Graduating classes of 2012 and 2013 who took PCOA as P3 (n=215)

GPA and PCOA accounted for 39% of the variance in NAPLEX scores (p<.001), with GPA (14%) explaining more than PCOA scores (8%).

Two MBTI types positively predictive of 17% of variation in NAPLEX scores (adjusted $R^2=12.4\%$):
- Introversion had 9.5 points higher than Extraversion (p<.01)
- Feeling scored 6.0 points higher than Thinking (p=.03)

Positive correlation with campus location
- GA campus scored 5.7 points higher than the SC (p=.03)

No correlation: gender

PCOA scores, especially the PS and CS scores, are important variables in predicting NAPLEX success.

Studies with a larger sample size with diverse demographics may be necessary to use MBTI as a predictor for NAPLEX success.

PCOA scores, especially the PS and CS scores, are important variables in predicting NAPLEX success.
Texas Tech U Health Sciences Center SOP

Graduates from the class of 2012 to 2016 (n=433) and performed poorly on NAPLEX (score ≤ 82), n=70 (16.2%)

- Grades<74 in> 3 courses
- PCAT composite
- PCAT reading comprehension
- P3 core rotation
- P4 core rotation
- P3 cumulative GPA
- PCOA scores
- Rho Chi membership
- HRDKA
- Age at graduation
- Graduation delay

Grades<74 in> 3 courses
PCAT composite
PCAT reading comprehension
P3 core rotation
P4 core rotation
P3 cumulative GPA
PCOA scores
Rho Chi membership
HRDKA
Age>28 year at graduation
PCAT composite scaled score<74
HRDKA score<90
Grades<74 in>3 courses
PCOA scaled score at P3<349

Above predictors were used to stratify into risk groups:
- Low=106.4
- Intermediate 1=97.4
- Intermediate 2=87.1
- High=75.1

scores and HRDKS are predictors for NAPLEX success.
Stratifying students based on the risk level may help institutions to focus efforts and resources.

Jimenez, et al, 2019

Retrospective review of accredited schools as of May 2018

Schools with graduating classes of 2015 (n=124), 2016 (n=128), and 2017 (n=127) and having NAPLEX scores from NABP

- Graduating year
- 4-year vs. 3-year programs
- Public vs. private
- Graduating class size< 100 vs. ≥ 100
- GPA vs. pass/fail system

Positive correlation:
- Graduating year 2015 (92.3%) vs. 2016 (86.0%) vs. 2017 (87.7%); p<.0001
- Graduating class between 2015 and 2016, and between 2016 and 2017 (both, p<.05)
- Public vs. private (p<.05)
- Graduating class size ≥100 for 2015 and 2017 (p<.05)

No correlation with NAPLEX pass rates:
- 4-year vs. 3-year program
- Graduating class size in 2016
- GPA vs. pass-fail system

The new NAPLEX in 2016 may have affected the differences in passing rate among the three classes.
Private or smaller institutions may need to provide more resources to students to pass NAPLEX.

Williams et al, 2019

Retrospective review of characteristics of all accredited SOPs in U.S. as of July 2017 (n=137)

- Location in an academic health center
- Establishment before or after year 2000
- Traditional vs. accelerated curriculum
- Public vs. private program
- Student-to-faculty ratio
- Percentage of out-of-state students

Positive correlated with NAPLEX total scaled score (p<.05) for all three years:
- Location in an academic health center (p≤.001)
- Establishment before year 2000 (p≤.02)
- Traditional curriculum (2016 only, p=.01)
- Public program (p≤.003)
- Percentage of total graduating class matched for a first PGY-1 residency (p<.001)

Percentage of total graduating class matched for a first PGY-1 residency in 2015 (p<.01) and 2016 was predictor of NAPLEX passing (p<.01) with the 2014 NAPLEX pass rate

Negative correlation with NAPLEX:
- Percentage of out-of-state students (p<.007)
NAPLEX pass rate significantly lower in 2016 than 2014 and 2015 (p<.001)

- ASPR appearance was a negative predictor of NAPLEX passing at first attempt (OR 0.22, 95% CI 0.06 – 0.77; p<.02).
- No other variables were associated with NAPLEX passing.
- P1 GPA predictive of on-time graduation (p<.001) and being dismissed from program (p<.001).
- Age at graduation (OR 0.82, 95% CI 0.74 – 0.91; p<.001) and having undergraduate degree (OR 0.16, 95% CI 0.04 – 0.65; p<.06) were negative predictor of on-time graduation.

P1 performance should be monitored for successful progression in the program and NAPLEX success.

Spivey et al, 2019

Retrospective review of single institution at U Tennessee Health Center COP

Graduating class 2015 through 2018 (n=657)

- Age at graduation
- Race/ethnicity
- Gender
- Undergraduate degree
- Financial need designation
- PCAT composite percentile
- Science GPA at admission
- P1 GPA
- P2 GPA
- P3 fall GPA
- Pre-NAPLEX
- Appearance before ASPR committee

AA=African American; APPE=advanced pharmacy practice experience; ASPR=Academic Standing and Promotion Review; BBS=basic biomedical sciences; CCTST=California Critical Thinking Skills Test; CI=confidence interval; COP=college of pharmacy; CS=clinical sciences; GA=Georgia; GPA=grade point average; HRDKA=High risk drug knowledge assessment score; IPBP=international postbaccalaureate PharmD; MBTI=Myers-Briggs personality type indicator; NABP=National Association of Boards of Pharmacy; NAPLEX=North American Pharmacist Licensure Examination; NR = nor reported; OR=odds ratio; PCAT=Pharmacy College Admission Test; PCOA=Pharmacy Curriculum Outcomes Assessment; PS=pharmaceutical sciences; SC=South Carolina; SOP=school of pharmacy; SBA=social, behavioral, and administrative sciences; U=university

* Statistical significance (p value or 95% confidence interval) was provided if reported in the study.