Review

A Systematic Review of Interventions Implemented by Pharmacy Programs to Improve Postgraduate Residency Placement

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ABSTRACT

Objective: This systematic review aims to identify the impact of interventions implemented by pharmacy programs to support students pursuing postgraduate residency training.

Methods: We conducted a literature search through March 8, 2022 to identify articles that studied an intervention made by a pharmacy program aiming to prepare students to qualify for a postgraduate residency position. Data were collected to describe each study’s methods, the included population, and outcomes and to evaluate study risk of bias.

Findings: Twelve studies met our inclusion criteria. The evidence base is limited to observational data with significant risk of bias. Pharmacy programs use various strategies to deliver training to students opting for the residency application process: elective courses, multiyear curricular tracks, introductory pharmacy practice experiences (IPPEs), and organized professional development events. Participation in these interventions was found to be associated with higher residency match rates, with exception of IPPE where match rates were not evaluated as an outcome. Curricular tracks and multicomponent professional development events were found to be associated with the largest improvement in match rates. Participation in electives or multicomponent professional development was found to be associated with improved student knowledge and confidence in interviews. Multicomponent professional development was also found to be associated with student preparedness for the match process. Curricular tracks and IPPE were found to be associated with improved student knowledge, whereas mock interviews were associated with improved student confidence.

Summary: Pharmacy schools support preparation of students for the residency application and interview process in a variety of ways. The current evidence does not support one strategy to be more effective than another. Until additional evidence emerges to guide decisions, schools should select training programs based on balancing the need to support student professional development with resources and workload.

1. Introduction

Obtaining a postgraduate residency match remains a highly competitive process; demand for programs continues to far exceed supply. In 2022, approximately 6417 applicants participated in phase I or phase II of the resident matching program, yet only 5232 positions were offered.¹ Recent estimates suggest that up to 50% of graduating pharmacy students are interested in the pursuit of postgraduate training,² a marked increase over previous years. Several factors—gaining additional knowledge, experience, and specialized training—may explain this piqued student interest.³ More recently, residency training has become a crucial determinant and prerequisite for hiring pharmacists in certain practice settings.⁴ This aligns with the American College of Clinical Pharmacy’s vision that residency training should be a requirement for all practitioners who wish to provide direct patient care services.⁵ As the pharmacy profession continues to evolve from product to patient-centered services, there is a growing need to provide graduates with additional opportunities for interprofessional collaboration, clinical-decision making, leadership, and research. Postgraduate training programs allow for this professional growth and development.

Standard 14 of the Accreditation Council for Pharmacy Education requires schools and colleges of pharmacy to provide academic advising, counseling, and resources that center on postgraduate education and training.⁶ Although this is not a curricular requirement, many United States-based schools and colleges of pharmacy do offer activities and programs that promote residency training to students.⁷ However, there is considerable variability among schools with respect to curricular offerings. Notably, some schools offer elective coursework.

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and advanced clinical tracks that expose students to specialized content areas of pharmacy practice and offer additional direct patient care experiences. Others offer faculty mentored research programs that promote scholarship experience and acquisition of skills that are valued in postgraduate training programs and the workplace in general. These types of programs are embedded longitudinally within the didactic and experiential curricula. Generally, schools offer career development services and informational lectures, panel discussions, and host professional development events such as mock interviews and curriculum vitae (CV) workshops, in which any student may attend based on personal interest and need. Timing of these workshops varies among institutions. Because most students typically focus on career decisions in the later years of their training, many of these offerings are planned in the latter part of the didactic curriculum.

Although many schools and colleges actively offer preparatory support to students, there is a paucity of data describing what influence, if any, these programs have on student competitiveness (eg, match rates, number of interviews offered, etc.). To enhance student candidacy, schools should provide applicant support that is most effective. The objective of this systematic review was to identify the impact of interventions implemented by pharmacy schools to support students pursuing postgraduate residency training.

2. Methods

2.1. Data Sources and Search

We completed this systematic review consistent with the Preferred Reporting Items for Systematic Reviews and Meta-analyses guidance. We conducted a systematic literature search of MEDLINE via OVID (1947) and Scopus (1970) through March 8, 2022 (Appendix).

2.2. Study Selection

Two investigators independently screened the title and abstract of each citation followed by review of qualifying full-text manuscripts to determine final inclusion into the review. Discrepancies were resolved by discussion or a third investigator. A study was included if it evaluated pharmacy students, an intervention delivered by a pharmacy school that aimed to prepare students for successful matching with a postgraduate residency position, and efficacy of the intervention using an experimental or observational design comparing students either before and after the intervention or those that were exposed to the intervention with those unexposed to the intervention. Our primary outcome of interest was to achieve match success in students that applied for a residency. We also collected student self-reported data reflecting their confidence, knowledge, preparedness, and skills.

2.3. Data Extraction and Risk of Bias Assessment

Using a standardized data collection tool, 2 investigators independently collected the following data from included studies: study design and methodological characteristics to evaluate the study’s risk of bias, intervention characteristics, baseline characteristics of the included population, and reported outcomes. For the outcome of match rates, we report the proportion of students that successfully matched out of the number of students that participated in the match, in both the intervention and control groups. In some cases, a study used a different population of students (denominator), such as students that participated in the intervention regardless of whether they entered the match, when reporting their outcomes. Because this is not comparable to the former definition of match rates, we have indicated that as such throughout the results.

To assess the risk of bias of included studies, we used the methodological index for nonrandomized studies tool. This tool addresses 12 unique components of internal validity for nonrandomized comparative studies. Each study was evaluated by 2 independent reviewers, and each of the 12 components was scored by the reviewer as 0 (not reported), 1 (reported but inadequate), or 2 (reported and adequate). The 2 reviewers then reconciled discrepancies to arrive at a final judgment. The protocol for this systematic review was not registered.

3. Results

Our bibliographic database search yielded 1541 citations, of which 60 were reviewed at the full-text level and 12 were included in this review (Appendix Figure).

All studies were observational in design and were found to share common threats to internal validity (Appendix Table) that should be considered when interpreting the results. The risk of selection bias was common, not only because these were not randomized studies but also because inclusion of participants was not consecutive. In most cases, students were self-selected into the intervention or were required to meet minimum criteria to be considered for enrollment into the intervention. The risk of type II error was common due to a lack of sample size estimations; only 1 study provided an estimate. Finally, and most importantly, this literature base is subject to the effects of confounding factors.

To synthesize the types of interventions and effects on outcomes, we grouped interventions based on the type of activity.

Four studies evaluated elective courses; 2-credit courses offered to students in the third professional year (n = 3) and a 1-credit course offered to students in the fourth professional year (n = 1) (Table 1). The course contents consistently included key features such as preparing a CV and letter of intent (LOI) and participating in mock interviews among other contents that varied: midyear preparation, presentation skills, preparation of thank you notes, and research projects. Caballero and colleagues19 studied students in the fourth professional year and reported match rates to be higher in students enrolled in the elective vs nonparticipants (79% vs 57%, P = .009). The remaining 3 studies in students in the third professional year did not compare participant match rates with those of nonparticipants, rather self-rated confidence in achieving the learning objectives before and after completing the elective, which were specific to preparation for the residency application and matching process was measured. These studies consistently found a significant improvement in student confidence in topics found within the course learning objectives.18,19,21 Hammond and colleagues17 also measured student knowledge and found the proportion of examination questions answered correctly to increase in 7 of 10 content areas, on comparing students before and after completing the elective.

Two studies evaluated multiyear curricular tracks that focused on providing mentorship, professional development opportunities (ie, writing a LOI, CV, etc.), and tailored advanced pharmacy practice experience schedules (Table 2). Other components varied, including electives to enhance clinical skills, teaching and leadership experience, and professional presentation opportunities. Select students were accepted into the track based on an application process and several minimum criteria, including grade point average (GPA). Slazak and colleagues23 found that cumulatively over 7 years of offering the track, match rates were higher among track participants (n = 58) vs nonparticipants (n = 224), regardless of phase 1 (82.6% vs 61.6%), phase 2 (100% vs 19.5%), both phases (91.4% vs 62.7%), or inclusive of the scramble process (96.6% vs 67%) (P < .05 for all comparisons). Coons and colleagues22 found that the average score on a knowledge based examination of student direct patient care activities (n = 20 participants) and clinical skills encounters (n = 15 participants) increased from before to after completing the track.

One study evaluated the impact of a 4-hour IPPE that included residency training content, such as explaining the role of a postgraduate pharmacy residency, and an overview of the process to apply to a residency program. This was required for students in the second and third

Table 1
The Characteristics and Results of Studies Evaluating Curricular Tracks.

<table>
<thead>
<tr>
<th>Study, Sample size</th>
<th>Population</th>
<th>Activities</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| Slazak\textsuperscript{16}  
N = 282  
58 participants  
224 nonparticipants | Entering as P2, completing as P4, 1-8 credits (OR < 3.5 with letter of support from faculty advisor), pharmacy work experience, professional organization involvement/leadership, post grad training plans, professional goals | Mentoring, enhanced didactic curriculum, introductory pharmacy practice experience, teaching, journal club, research/scholarship, APPE, professional presentation, showcase attendance | Phase 1 match: 48/58, 82.8%; nonparticipant: 138/224, 61.6%, P < .005  
Phase 2 match: 5/5 100%; nonparticipant: 8/41, 19.5%, P < .005  
Phase 1 + 2 match: 53/58, 91.4%; nonparticipant: 146/233, 62.7%, P < .001  
Phase 1 + phase 2 + scramble track: 56/58, 96.6%; nonparticipant: 156/233, 67%, P < .05 |
| Coons\textsuperscript{16}  
N = 68 | Entering as P3, completing as P4, no credits (required application, GPA > 3.0 in P1-P3 year, commitment to pursuing residency, LOI, 2 letter of recommendations, transcript, CV, interview, 2 prerequisite courses) | Mentor, advanced clinical practice research, info sessions, CV, LOI, interview skills, mock interview, midyear prep, clinical competency, presentation skills, other (personal career advising, peer-to-peer learning, specific APPEs, manuscript writing) | Knowledge based exam (n = 20)  
Mean (SD) before 161 (20) vs after 184 (16), P < .001  
Clinical skill score (n = 15) Mean (SD) before 12.4 (3.7) vs after 16.2 (3.2) P = .02 |

Abbreviations: APPE, advanced pharmacy practice experience; CV, curriculum vitae; GPA, grade point average; LOI, letter of intent; SD, standard deviation

Table 2
The Characteristics and Results of Studies Evaluating Electives.

<table>
<thead>
<tr>
<th>Study, Sample size</th>
<th>Population</th>
<th>Activities</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| Cho\textsuperscript{21}  
N = 14 | P3, 2 credit-hours, 15 weeks, in-person | Lecture-based, didactic, instruction, group discussion, application exercises, residency round table discussions, mock interview, longitudinal research project, CV workshop, manuscript preparatory seminars/sessions, LOI | Student self-assessed confidence in ability to perform 13 activities using a 5-point Likert scale before and after the course (n = 14) Improvement (P < .05) in 11 objectives: develop a CV, write a LOI, write a letter of appreciation, interview, exhibit presentation skills, conduct research, gain a mentor, exhibit leadership skills, create a poster presentation, construct a manuscript, pursue extracurricular activities. |
| Hammond\textsuperscript{20}  
N = 41 | P3, 2 credit-hours, 14 weeks, in-person | CV, LOI, mock interview, presentation skills, info sessions, interview skills, match process, thank you notes, clinical competency, research, manuscript | Student self-assessed confidence in achieving 20 course learning objectives using 5-point Likert scale before and after the course (n = 41)  
Mean scores improved for all objectives (P < .001); program characteristics, common activities, create a CV, create a LOI, applicant evaluation methods, qualities of a good resident, program selection, interviews, match and scramble processes, teaching opportunities, roles of preceptors, research projects, determining authorship, ethics in research, compose thank you letters, speaking, manuscript preparation Knowledge based exam before and after the course (n = 41)  
% items correctly answered in 7 of 10 topic areas increased (P < .01) in basic postgraduate training concepts, desirable applicant qualities, success as a resident, interview preparation, match and scramble process, teaching and precepting, and research and medical writing. |
| Caballero\textsuperscript{19}  
N = 99; 29 participants, 70 non participants | P4, 1 credit-hour, 8 weeks, in-person | CV, LOI, clinical competency, presentation skills, mock interview | Match rate  
Elective: 23/29 (79%), control 40/70 (57%), P = not reported |
| Bryles\textsuperscript{10}  
N = 36 | P3, 2 credit-hours, 15 weeks, distance learning | Information sessions, showcase, CV, panel, midyear prep, letter of recommendation, LOI, thank you notes, match process, interview skills, mock interview, clinical competency, mock match | Student self-assessed confidence in achieving 9 course learning objectives using 5-point Likert scale before and after the course (n = 36);  
Median score improved for all objectives (P < .001); characteristics of programs, common activities, requirements for a certificate, composing LOI and thank you notes, develop CV, program search, matching process, interviewing expectations, interview practice |

Abbreviations: CV, curriculum vitae; LOI, letter of intent
Two categories of professional development events were identified in the literature: one-time mock interviews (3 studies) (Table 4) and multicomponent events offering training on a variety of aspects associated with the residency application and matching process (3 studies) (Table 5). These events were faculty-run and in some cases supported by current pharmacy residents or student organizations. The events were voluntary for students and were not associated with credit-hours.

Two studies that evaluated mock interview programs enrolled students in the fourth professional year and both reported match rates in participants vs nonparticipants. Caballer and colleagues reported match rates of 84% and 57% in participants and nonparticipants, respectively, but only students that secured at least one residency interview were allowed to participate. This is unlike other studies that report match rates in all students that participate in the match and not just those with an interview offer. Baruwal and colleagues reported similar match rates in participants vs nonparticipants (78% vs 75%) but upon multivariate logistic regression it was found that the odds of matching were associated with student GPA (odds ratio 1.15, 95% confidence interval 1.01–1.32) and mock interview participation (odds ratio 2.81, 95% confidence interval 1.27–6.22). Faculty also felt that students were more prepared for interviewing after comparing their impressions before and after the mock interviews. The final study allowed participation of students of all professional years and found student self-assessed confidence in completing various types of interviews (virtual, in-person etc.) increased comparing the confidence level before and after the mock interviews. The programming of these events was comprehensive covering multiple aspects of the residency preparation and application process. Two of the studies had multiple events on separate days and in total provided 8–12 h of content. Richter and colleagues reported higher match rates in students that participated in > 50% of the events of their program (57% vs 20%, P < .05) or who participated in the specific mock interview event (67% vs 30%) vs those who did not; however, in the end, students that did not register in the match were included in these match rates. Both studies reported overall improvement in student self-assessed preparedness and in individual topics consistent with the training content. Stover and colleagues also found student knowledge and self-assessed confidence to be higher after completing the training program.

Three studies evaluated multicomponent events; 2 focused on students in the fourth professional year and 1 was offered to both students in the third and fourth professional years. The characteristics and results of studies evaluating professional development events—mock interviews are provided in Table 4. The characteristics and results of studies evaluating introductory pharmacy practice experience are provided in Table 3.

### Table 3
The Characteristics and Results of Studies Evaluating Introductory Pharmacy Practice Experience.

<table>
<thead>
<tr>
<th>Study, Sample size</th>
<th>Population</th>
<th>Activities</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Darley25 N = 276</td>
<td>P2 or P3, 1 4-hour, in-person experience</td>
<td>Students visit a residency program onsite, speak with residency program director, preceptors, and current residents, and directly observe residents in their practice environments</td>
<td>Student self-assessed perceived knowledge of residency training using a 5-point Likert scale before and after the introductory pharmacy practice experience (n = not reported) Improvement (P &lt; .01) in all topics: understanding of the residency application process, qualifications that make a more competitive candidate, characteristics and structure of programs, responsibilities and the typical day of a resident, and types of careers for which a residency may be beneficial.</td>
</tr>
</tbody>
</table>

### Table 4
The Characteristics and Results of Studies Evaluating Professional Development Events—Mock Interviews.

<table>
<thead>
<tr>
<th>Study, Sample size</th>
<th>Population</th>
<th>Activities</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baruwal25 N = 131; 91 participants, 40 nonparticipants</td>
<td>P4</td>
<td>Mock interview with the following components: students required to dress professionally, provide curriculum vitae, list of programs they applied for, letter of intent, 2:1 faculty interview, interview with current PGY1/PGY2, group interview with faculty members + I–P residents, clinical case, administrative and behavioral questions, wrap up session with feedback and questions.</td>
<td>Match rate Interview participants 71/91 (78%) vs nonparticipants 30/40 (75%), P = NR Multivariable logistic regression analysis showed both mock interview participation (OR, 2.81; 95% CI, 1.27–6.22) and GPA (OR, 1.15; 95% CI, 1.01–1.32) were significantly associated with matching Faculty-assessed student preparedness for interviewing before and after the mock interviews &lt; 60% vs &gt; 92% of faculty agreed or strongly agreed overall students improved interview skills Student self-assessed confidence in interviewing skills using a 5-point Likert scale before and after the workshop (n = 24) Confidence improved in all interview types (P &lt; .01) except the ethical case. The largest magnitude of benefit was seen in P2 and P4 years.</td>
</tr>
<tr>
<td>Fernandez25 N = 28</td>
<td>P1, P2, P3, P4</td>
<td>Interviewing skills workshop and mock interviews held 1 weekday evening 2 weeks before residency interviews began, workshop consisted of 5 stations, 10 min each (panel interview, group interview, teleconferencing interview, video conferencing interview, clinical or ethical case situation)</td>
<td>Match Rate in students that secured at least 1 interview Mock interview 16/19 (84%) vs nonparticipants 40/70 (57%), P = NR Elective 23/29 (79%) vs mock interview 16/19 (84%), P = .73</td>
</tr>
<tr>
<td>Caballer19 N = 89; 19 participants, 70 nonparticipants</td>
<td>P4 and secured ≥ 1 residency interview, not in the residency preparation elective course</td>
<td>Mock interview, 1-time event with a 3:1 student to faculty ratio</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; NR, not reported; OR, odds ratio
4. Discussion

Our systematic review aimed to identify the impact of interventions implemented by pharmacy schools to support students pursuing postgraduate residency training. Schools have deployed various strategies, including elective courses, multiyear curricular tracks, IPPEs, and organized professional development events, most of which were found to be associated with improved match rates. Currently, tracks and multicomponent professional development events were associated with the largest improvement in match rates between participants and nonparticipants, with a difference of 20–30%. Apart from improvement in match rates, some interventions were also associated with improved student knowledge and confidence in interviews and self-perceived preparedness for the match process. Despite these findings, the overall strength of evidence is limited to observational data with significant risk of bias. Only 1 study adjusted for baseline characteristics, and thus the impact of these interventions when other confounding factors known to influence residency match rates (eg, leadership and work experience, academic performance, etc.) are present is unknown. Considering these studies are all observational in design, adjustment for confounding factors is one of the most critical steps in reducing bias and leading to improved strength of evidence. Furthermore, we were unable to assess equity of baseline characteristics in most cases because they were not reported or were very sparse. Since some interventions required students to have a minimum GPA or other performance-based criteria, it is likely that participants had additional qualities enhancing their candidacy for successful matching outside of the intervention itself. There are also nonmodifiable pharmacy programs or student characteristics that influence residency match rate, leading to the question as to what extent pharmacy programs can influence match
rates through their interventions. Examples of such factors include applicant gender or age, public vs private school status, PharmD program length, geographic region of the school, and the number of residency positions available in the state where the school is located. 32–34

Given our findings related to the paucity of information in this area, schools may choose a strategy to support student candidacy based on other practical factors such as available resources (eg, affiliations with academic institutions, availability of grant funding to support student-based research, etc) and faculty workload. Three key activities of the residency application process are consistently offered by schools and should be continued: CV development, LOI writing, and mock interviews. Multicomponent professional development events can accommodate these activities in a condensed series of short events over days, which may be favored when minimal faculty bandwidth is available as a resource. The capacity to accommodate students from professional development events may also be greater compared with those from an elective or curricular track. Because generally there are limits on class enrollment or additionally imposed requirements such as minimum GPA or a formal application process, workload related barriers may be addressed through departmental or school-based merit systems for participation in these events or through collaboration with local preceptors, alumni, and residency programs. If schools have the capacity to develop and implement formal curricular components, then electives or curricular tracks may be preferred because they have the capacity to cover topics in greater depth and breadth. However, these strategies do confer a larger student time commitment, over an entire semester—or even multiple years—as opposed to attending events more sporadically, which can be tailored to an individual’s unique needs and schedule. This may be more critical if the timing of the student support is during the advanced pharmacy practice experience year when students must commonly use evenings after rotations for additional preparatory coursework. However, students may prefer course electives, which provide course credit, likely toward their elective requirements for graduations.

Regardless of how schools choose to support students, it is important they be flexible in approach and adapt to the ever-changing interview process. For example, the COVID-19 pandemic heavily influenced the mode residency programs used for interviews and the decision of whether or not to shift to virtual platforms. 35 Both residency programs and residency applicants have reported the benefits of virtual interviews that included convenience, decreased time, increased flexibility with interview dates, and reduced cost. Building upon this model, schools can utilize a virtual platform to deliver their residency preparation training program. Prerecorded webinars, virtual meetings, and virtual mock interviews can circumvent scheduling issues with students on experiential rotations and minimize faculty workload, in addition to providing students with real-world practice of virtual etiquette, interview process, and associated communication skills. Additionally, the residency interview process has also expanded to incorporate more assessments of clinical knowledge and problem-solving skills to better evaluate if candidates are prepared for the challenges of postgraduate training. 36 Schools should consider integrating more opportunities for topic discussions, journal clubs, SOAP note writing, and case-based consultation as part of their programmatic offerings to better assist students with building their clinical acumen. Although these types of activities are likely better suited for curricular electives and tracks, they can also be offered on demand as part of a multicomponent program. Because residency interviews continue to evolve, so should the schools’ support offerings.

Just like all systematic reviews, this work has limitations. To synthesize the data, we categorized interventions generally based on the intervention type (eg, elective or curricular track). We recognize the limitation of this strategy because of implicit heterogeneity of the interventions themselves, which may lead to differences in quality and effectiveness that deviate from those of the general category summarized in this review. In addition to the concerns because of the risk of bias previously mentioned, some studies were more descriptive rather than experimental in design and lacked an unexposed cohort for comparison. Few studies evaluated the timing of interventions, and no studies compared if early participation in these programs and interventions (eg, in the first or second professional years) is associated with better odds of matching. Direct comparison of different interventions is also lacking; thus, it remains unclear which interventions may impact match rates and other student centric outcomes the most. We were interested in collecting data related to workload when implementing a described intervention because it may influence implementation feasibility or effectiveness of the intervention related to its quality; this data was not routinely reported or quantified. In addition, some studies calculated match rate including unregistered or nonparticipating students, that deviates from the standard calculations made by the American Society of Health-System Pharmacists and precludes us from comparing this outcome across studies. To overcome these limitations of the evidence base, future studies should apply methods to adjust for confounding factors and use standard calculations of match rates.

In summary, pharmacy schools support preparation of students for the residency application process in a variety of ways. The current evidence does not support one strategy to be more effective than another. Until additional evidence emerges to guide decisions, schools should select training programs based on balancing the need to support student professional development with workload.

Declaration of Competing Interest

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CRediT authorship contribution statement

Diana M Sobieraj: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing. Kathleen K. Adams: Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization. Cassandra R. Doyno: Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization. Stefanie C. Nigro: Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization. Kristin Waters: Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization.

Appendix A. Supplementary Material

Supplementary data associated with this article can be found in the online version at 10.1016/j.ajpe.2023.01.002.

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