


REVIEW

A narrative review of student research projects in United States pharmacy curricula

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Keywords

Research
Research project
Student pharmacist

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Abstract

Background: This study explored existing literature on student research projects in United States pharmacy curricula. **Methods:** In August 2023, searches were conducted in two databases, PubMed and Embase, followed by pharmacy education journals and Google Scholar. Articles were reviewed by two researchers and included if they described or evaluated pharmacy student research projects between 2010 and 2023. **Results:** Ten articles representing data from six schools were included. Students from most schools had the option to work individually or in groups. The timing of projects in the curriculum varied, with most students working on them from years three through four, though other schools began their projects earlier in the curriculum. Many students presented or published their projects. **Conclusion:** The similarities and differences for student pharmacist research projects in the United States may affect pharmacy education as colleges of pharmacy review their curricula and determine whether they should also incorporate or revise a research project component in their programmes. Future evaluation may include a systematic review as more literature on student pharmacist research projects becomes available.

Introduction

The Centre for the Advancement of Pharmaceutical Education (CAPE) outcomes and the Accreditation Council for Pharmacy Education (ACPE) do not require colleges of pharmacy to include a research project in the curriculum (Medina *et al.*, 2013). However, they require pharmacy programmes to teach students about study designs and statistics (Assemi *et al.*, 2015; Minshew *et al.*, 2020). As part of this learning process, some schools offer research experiences through capstone or research projects. Universities across the United States (US) have different requirements regarding a research project in the pharmacy curriculum. Capstone and research projects can help assess students' ability to apply their knowledge of research and statistics (Minshew *et al.*, 2020). Pharmacists may pursue various career paths, and while many do not involve research, it is arguable that acquiring research skills is essential to guide patient care in any pharmacy setting. Whether a research project should be a national requirement to assess the

skills needed to be a pharmacist remains controversial. Despite the potential for gaining research experience, challenges include a lack of time for students to commit to projects and a lack of experienced mentors with enough time to guide students through their projects (Deal *et al.*, 2016).

Previous research has surveyed pharmacy schools to determine if and how they offer research experiences to students. Researchers in one study sent out a questionnaire to colleges of pharmacy across the US to acquire descriptions of research projects in their programmes and examine the differences (Murphy *et al.*, 1999). Project requirements varied across colleges, with approximately 20% of programmes requiring research experience for graduation. Among the pharmacy colleges offering research projects, most students completed their work during the fourth year of school while enrolled in their Advanced Pharmacy Practice Experiences (APPEs) (Slack *et al.*, 2016). Additionally, while most programmes allowed students to work in groups with support from coursework, workshops, and guidance documents, electives seemed

to limit the types of research projects students conduct compared to the many topics required programmes offer (Slack *et al.*, 2016). These topics included business, computer information systems, education, and public health. Students disseminated more projects from programmes requiring research projects (Slack *et al.*, 2016). Surveys about perceptions of research projects showed mixed results, with some reporting value to students while others believed these courses to be invaluable (Murphy *et al.*, 1999). Some respondents mentioned that research training should be reserved for fellowship programmes (Murphy *et al.*, 1999).

However, there are no contemporary reports summarising the current state of research project requirements or opportunities in US pharmacy curricula. This paper aimed to conduct an extensive exploration of the body of literature and synthesise a selection of relevant articles about student research projects in the US pharmacy curricula. In particular, this narrative review collated descriptions and associated outcomes of student research projects in the US pharmacy curricula, alongside a discussion of the implications for pharmacy education.

Methods

Design

A narrative literature review was chosen for this study design to explore and synthesise the limited published knowledge on this topic. It is worth noting that a narrative review differs from the more rigorous methodology employed in a systematic review. However, it holds value when exploring topics with little literature available in greater detail. The search was first conducted using two databases (PubMed and Embase) in August 2023 (Table I). Then, all issues of two leading journals focusing on pharmacy education in the US (Currents in Pharmacy Teaching and Learning and the American Journal of Pharmaceutical Education) were manually screened to identify any additional relevant articles that may have been missed. Finally, a citation search of identified articles was conducted using Google Scholar.

The following are examples of keywords used in the search: “*pharmacy curriculum, pharmacy program, research project, research experience, research program, research activity, pharmacy, PharmD, pharmacist, student pharmacist, PharmD student, and pharmacy student.*” The search terms were purposefully broad to capture as many relevant articles as possible. The search was restricted to studies

conducted in the US (as this study focused solely on US colleges of pharmacy) and written in English.

Table I: Search terms used in the database searches

Source	Search terms
PubMed	((((pharmacy curriculum[Title/Abstract]) OR (pharmacy program[Title/Abstract])) AND (((research project[Title/Abstract]) OR (research experience[Title/Abstract])) OR (research program[Title/Abstract])) OR (research activity[Title/Abstract]))) AND ((((((pharmacy[Title/Abstract]) OR (pharmd[Title/Abstract]) OR (pharmacist[Title/Abstract])) OR (student pharmacist[Title/Abstract])) OR (pharmd student[Title/Abstract])) OR (pharmacy student[Title/Abstract])))
Embase	((('pharmacy curriculum':ti,ab) OR ('pharmacy program':ti,ab)) AND (((('research project':ti,ab) OR ('research experience':ti,ab)) OR ('research program':ti,ab)) OR ('research activity':ti,ab))) AND ((((((pharmacy:ti,ab) OR (pharmd:ti,ab)) OR (pharmacist:ti,ab)) OR ('student pharmacist':ti,ab)) OR ('pharmd student':ti,ab)) OR ('pharmacy student':ti,ab)))

Articles were included if they described or evaluated research conducted by student pharmacists as part of the pharmacy curriculum. For example, this inclusion could encompass articles that reported on a research project course or perceptions of research in the curriculum. Studies were also included if published from 2010 onwards, a date arbitrarily selected to balance the need for finding enough relevant articles while ensuring relatively contemporary information.

Studies were excluded if they did not refer to student pharmacy research projects (e.g. pharmacy residency projects were not included) or did not report a description of the research project or any perceptions or outcomes associated with the research project.

The title and abstract were initially screened to determine relevance, followed by a full-text review conducted by at least two researchers working independently. When the final list of potential articles was established, the researchers independently extracted the relevant data using a data collection template. Subsequently, they met to appraise the content of the final articles, agreeing on the most meaningful way to organise the findings.

Results

Records identified

The PubMed search identified 13 records, of which four were deemed relevant and included. The Embase search produced 17 records, five of which were deemed relevant; however, four of these were duplicates of the PubMed records, resulting in only one additional record being included. A manual search of the American Journal of Pharmaceutical Education archives yielded five additional records, while no further records were found

through the manual search of the Currents in Pharmacy Teaching and Learning archives or from Google Scholar.

Records included

A total of ten unique articles published between 2010 and 2023 were included (Kim *et al.*, 2010; Wuller, 2010; Kao *et al.*, 2011; Vellurattil *et al.*, 2014; Assemi *et al.*, 2015; McClendon *et al.*, 2015; Morbitzer *et al.*, 2021; Kim *et al.*, 2022; Axon, 2023; Cooley *et al.*, 2023) (Figure 1).

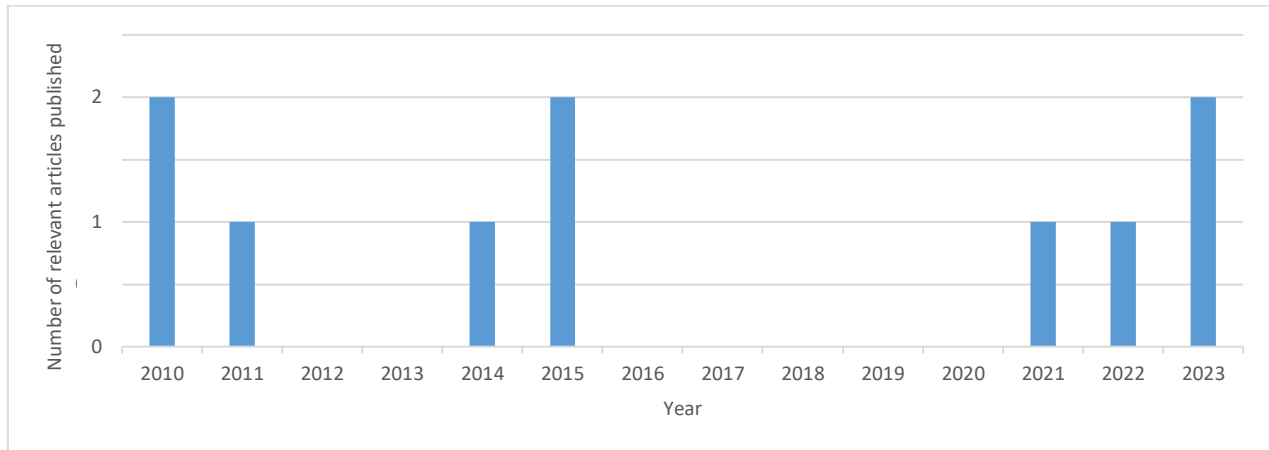


Figure 1: Number of relevant articles published by year

All articles used a survey instrument to determine the perceptions of student pharmacists, faculty, or preceptors regarding research within a pharmacy programme. The ten articles represented data from six distinct schools of pharmacy. Three reports were from University of California, San Francisco School of Pharmacy (Kim *et al.*, 2010; Kao *et al.*, 2011; Assemi *et*

al., 2015), two from the University of Arizona (Axon, 2023; Cooley *et al.*, 2023), two from the University of North Carolina (Morbitzer *et al.*, 2021; Kim *et al.*, 2022), one from Chicago State University (Vellurattil *et al.*, 2014), one from Southern Illinois University (Wuller, 2010), and one from the University of Mississippi (McClendon *et al.*, 2015) (Table II).

Table II: Characteristics of research projects offered in the pharmacy curriculum

First author, Year	Types of projects	Required or elective	Timing in curriculum	Time commitment	Individual or teamwork	Deliverables
Kim, 2010	Literature review, statistical analysis, drug information	Required	Years 3-4	80 hours 2 units	Either	Papers, posters, presentations
Wuller, 2010	Research projects, business plans, survey-based projects, guideline or drug utilisation review	Required	Years 3-4	120 hours	Either	Written paper, poster presentation
Kao, 2011	Literature review, statistical analysis, drug information	Required	Years 3-4	80 hours	Either	Papers, posters, presentations
Vellurattil, 2014	Lab research, clinical research, educational research, business plan development, drug utilisation review	Required	Years 3-4	Third-year Spring: workshops 4 hours Fourth-year: workshops 2 hours	Unspecified	Manuscripts, posters

First author, Year	Types of projects	Required or elective	Timing in curriculum	Time commitment	Individual or teamwork	Deliverables
Assemi, 2015	Prospective clinical sciences research, retrospective clinical sciences research, health policy-related research, pharmacoeconomic research	Required	Years 3-4	120 hours	Either	Presentation at institutional forum, poster at professional meeting, oral presentation at professional meeting, submission for publication
McClendon, 2015	Decided on along with mentor	Required	Years 1-4	Unspecified	Individual	Paper, presentation
Morbitzer, 2021	Experimental, quasi-experimental, observational	Elective	Years 2-3	16 hours/week 6 credit hours	Individual	Second-year Spring: written proposal Third-year Fall: oral proposal Third-year Spring: written report, poster presentation
Kim, 2022	Decided on along with mentor	Elective	Year 4	2014-2017: 4 credit hours 2017: no credit	Unspecified	Poster, presentation
Axon, 2023	Decided on along with mentor	Required	Years 3-4	Unspecified	Either	Poster, research report
Cooley, 2023	Clinical care, pharmacy services, patient services and education, literature or media based studies, student surveys and education, lab studies	Required	Years 3-4	Unspecified	Either	Poster presentation, publication

Types of projects

The types of projects conducted varied across colleges. At the University of North Carolina, studies included experimental, quasi-experimental, or observational designs; however, types and topics of research were decided through discussion with the faculty mentor (Morbitzer *et al.*, 2021; Kim *et al.*, 2022). Similarly, the topics at the University of Arizona involved laboratory studies, clinical care, pharmacy services, patient services and education, literature reviews, and student questionnaires (Cooley *et al.*, 2023), but students could determine the type of research with their mentor (Axon, 2023). Students at the University of Mississippi also chose their types of projects with their mentors (McClendon *et al.*, 2015). At the University of California, San Francisco, project types included literature reviews, statistical analyses, and drug information (Kim *et al.*, 2010; Kao *et al.*, 2011). Topics chosen by students at Southern Illinois University covered business plans, survey-based projects, and guidelines or drug utilisation reviews (Wuller, 2010). Examples of project types at Chicago State University included lab projects, clinical research, drug utilisation reviews, business plan development, and educational research (Vellurattil *et al.*, 2014).

Required versus elective projects

Among the six colleges included in the articles, all required their students to conduct research projects, except the University of North Carolina, where research projects were an elective course.

Timing of projects in the curriculum

There was variation in the timing of research projects offered in the curriculum. Students at the University of California, San Francisco, the University of Arizona, Chicago State University, and Southern Illinois University began their research projects in the third-year spring term and completed them in the fourth-year spring term (Assemi *et al.*, 2015; Axon, 2023; Cooley *et al.*, 2023; Kao *et al.*, 2011; Kim *et al.*, 2010; Vellurattil *et al.*, 2014; Wuller, 2010). At the University of Mississippi, students began formulating a research topic in their first year and completed their projects in their fourth year (McClendon *et al.*, 2015). At the University of North Carolina, one report indicated research projects were conducted in years two and three, while a second report showed a different process, whereby the research project was completed during the fourth year (Kim *et al.*, 2022; Morbitzer *et al.*, 2021).

Individual versus team projects

Students at the University of Mississippi worked individually on their projects (McClendon *et al.*, 2015), as did those at the University of North Carolina (Morbitzer *et al.*, 2021). Other colleges allowed students to work independently or in groups (Kim *et al.*, 2010; Wuller, 2010; Kao *et al.*, 2011; Assemi *et al.*, 2015; Axon, 2023; Cooley *et al.*, 2023). In some cases, it was unspecified how work was conducted (Kim *et al.*, 2022; Vellurattil *et al.*, 2014).

Deliverables

Final project deliverables typically included a poster presentation (either within the college or at a meeting) and written reports (turned in to class for grading and/or published in a journal).

Description of research projects in each programme

The two reports from the University of North Carolina indicated two different processes at different times in their institution. The University of North Carolina built an elective to foster scientific inquiry and innovation (Kim *et al.*, 2022; Morbitzer *et al.*, 2021) and launched a new pharmacy curriculum in 2015, offering research and scholarship training to students enrolled in the programme (Morbitzer *et al.*, 2021). These courses took place over three terms, from the second-year spring term to the third-year spring term, totalling six of the eight required elective credit hours. By the end of the courses, students would have completed a written proposal and an oral presentation of their project. They would also have presented a poster of their project findings and prepared a research report. From 2014 to 2017, the University of North Carolina had a 4-credit hour research elective for APPE students (Kim *et al.*, 2022). A new process was implemented in 2017 for APPE students without class credit. A pre-post study was conducted to assess differences between the previous three years and the three years post-implementation of the new research project programme.

The University of California, San Francisco, required student pharmacists to conduct research projects individually or in groups. These projects were initiated as students began their APPE rotations. Students were expected to contribute about 80 hours of work towards their projects, and at the end of their fourth year, students completed a final paper and presented their projects to their peers (Kim *et al.*, 2010; Kao *et al.*, 2011; Assemi *et al.*, 2015).

At many of these colleges, research projects started towards the culmination of the third year and continued through the fourth year, with a project

presentation in the final term (Vellurattil *et al.*, 2014; Axon, 2023; Cooley *et al.*, 2023). At Chicago State University, third-year student pharmacists were required to attend two workshops (approximately four hours) to develop a project proposal. Overview and expectations of the projects were established, and the institutional review board process was discussed. Once a project was chosen, an additional workshop was mandatory to provide students with project guidance. A final poster and paper were presented and assessed by faculty mentors (Vellurattil *et al.*, 2014). Students at the University of Arizona design and conduct research projects during a mandatory research course sequence. A two-credit-hour proposal writing class is offered in the third-year spring term, followed by four self-directed research credit hours across the fourth year, where students conduct their study, present their findings at a poster session, and submit a manuscript for a grade (Axon, 2023; Cooley *et al.*, 2023).

Following a similar structure, student pharmacists at Southern Illinois University had a mandatory 1-credit-hour APPE preparation capstone class in the third-year spring term and a 3-credit-hour APPE course in their fourth year. They could choose their project, select an advisor, and then complete a 5-week APPE experience. Students submitted a written paper and presented a poster to complete the experience (Wuller, 2010).

Research projects required by student pharmacists at the University of Mississippi began earlier in their pharmacy school career. In 2009, the college redesigned the fourth-year seminar research course and developed a 4-year programme to incorporate research into the curriculum. The new pathway had two aspects: developing research skills and a mentoring system for students. The four-year programme begins in the first year of pharmacy school, where students learn basic research skills, formulate a research topic, generate a research hypothesis, and then submit their research hypotheses. In the second year, research topics are developed through supporting lectures, writing workshops, and Institutional Review Board (IRB) applications. In the third year, students submit their IRB applications and conduct their research projects. Finally, students present their research findings in the fourth year (McClendon *et al.*, 2015).

Outcomes of surveys from included studies

Table III summarises the outcomes of the surveys from the studies included in this review. The primary outcome assessed by the surveys was student pharmacists' perception of research in the pharmacy curriculum (Kim *et al.*, 2010; Vellurattil *et al.*, 2014; Morbitzer *et al.*, 2021; Axon, 2023). Morbitzer and colleagues (2021) surveyed 24 students using a 26-item

tool. Of the 24 students, 23 reported being satisfied or very satisfied with their research experience, and 20 believed that their experience helped them postgraduation. Kim and colleagues (2010) collected 229 complete responses to their survey. The items that had the highest agreement were: “Students were pleased with the selection of a project advisor” (90%), “Students were pleased with their project topic” (89%), and “The project was a valuable learning experience” (88%). The two items that received the heaviest disagreement were: the school should continue to require a research project (11%), and the amount of time the student could devote to the project was adequate (8%). Vellurattil and colleagues (2014) sent their survey to 71 students and received 65 responses (91.6% response rate). Several items consisted of progressive Likert-type scales with an option from 0 (minimal) to 9 (significant). When students were questioned about the importance of research-related activities in the pharmacy curriculum, they most commonly selected a response of 4 (n=19, 29%) on a 0-9 scale, where higher numbers indicated a more positive response. When asked about the importance of skills and experience doing research for success in the pharmacy programme, they again commonly selected option 4 (n=18, 28%). In 2023, Axon surveyed third-year pharmacy students at the University of Arizona in Spring 2021. Of the 132 students enrolled, 54 students completed the questionnaire. Of these, 82% were not planning to pursue a career that involved research, and three students would have liked additional time to select a project and complete course activities. Overall, the primary outcome of this study was that pharmacy students typically perceived a remotely taught research proposal writing class positively.

A survey at Southern Illinois University assessed the impact of having a capstone requirement in the pharmacy curriculum (Wuller, 2010). Fifty-six emails were sent to mentors of projects, and 31 surveys were completed and returned, yielding a 57% response rate. Eighty surveys were sent to students who completed projects, and 77 were completed and returned (96% response rate). To the survey item, “The capstone project required too much work for a 3-credit hour course,” 42 (55%) students responded, “strongly agree or agree.” To the survey item, “I found creating the capstone project was one way to apply material learnt in the classroom to a real-life situation,” 35 (46%) students responded, “strongly agree or agree.” Twenty-six (84%) mentors responded “strongly agree or agree” to the survey item “I would be willing to work with another student on a capstone project.” To the survey item, “I could use the results from the capstone

project to benefit my facility/research,” 26 (84%) mentors responded, “strongly agree or agree.”

The University of Mississippi assessed student perception and programme impact (McClendon *et al.*, 2015). The class of 2013 was the first graduating class in the new research pathway. In this class, 23 of the 32 students (79%) who participated in the American Society of Health-System Pharmacists (ASHP) Resident Matching Programme matched to a residency programme, against 72% (12 of 18) from the class of 2012. Overall, there was a 26% match in the class of 2013 compared to a 13% match in the class of 2012. Of the 37 students who completed the survey in the class of 2014, 22 (59%) felt the new pathway aided them in developing a relationship with a mentor. Fourth-year students tended to agree more than second- and third-year students that their project improved their research and problem-solving skills and made them independent workers.

The main outcome assessed by a study from 2015 was the dissemination of research findings (Assemi *et al.*, 2015). The extent of dissemination was categorised into institutional forum presentations, professional meeting poster presentations, professional meeting oral presentations, and papers submitted to a journal for publication. A total of 111 projects were evaluated, and of those, only 28 (25%) were not circulated. Of the remaining 83 projects, 27 were internally disseminated (at a school or university), and 56 were externally disseminated. Twenty were presented and published as posters, 32 were published in a peer-reviewed journal, three projects were combined into a single publication, and one was split into two publications. At the end of the survey assessing dissemination, the preceptors were asked to provide feedback on their experiences. Almost 95% of them expressed that they would continue to precept student research projects.

Another study aiming to determine the value of research projects required in the pharmacy curriculum from the preceptors’ perspectives included 235 projects with 125 primary preceptors. About 82% of preceptors reported that precepting a research project was of value to them, and 88% felt research projects were valuable learning experiences for student pharmacists (Kao *et al.*, 2011).

A further study examined preceptors’ perceptions of the impact of research in pharmacy curricula through a questionnaire that assessed research projects of 2020 graduates from the University of Arizona. A total of 39 research projects were completed by the class of 2020, and 60 surveys were sent to preceptors for the projects (55% were returned). Preceptors identified four main factors that could improve the projects’ impacts: (1) greater effort from students (33%), (2) greater student

knowledge of the practice setting (28%), (3) more time to conduct the study (17%), and (4) more student time at the study site (17%) (Cooley et al., 2023).

A pre-post study from the University of North Carolina compared data from a previous process to a new one three years post-implementation. In the new process implemented in 2017, students completed their research projects during their final year (Kim et al., 2022), while in the previous one, students enrolled in the elective programme began their projects in their second year and completed them during their third year (Morbitzer et al., 2021). Although these courses remained elective, the number of research conducted increased from 18 to 35 with the new process, and the number of publications increased from nine to 20 (Kim et al., 2022).

Table III: Outcomes of surveys from included studies

First author, Year	Outcomes of surveys from included studies
Kim, 2010	Student perspectives of research in the pharmacy curriculum
Wuller, 2010	Impact of a capstone requirement in the pharmacy curriculum
Kao, 2011	Preceptors' perception of research in the pharmacy curriculum
Vellurattil, 2014	Student perspectives of research in the pharmacy curriculum
Assemi, 2015	Dissemination of research findings
McClendon, 2015	Student perception and programme impact
Morbitzer, 2021	Student perspectives of research in the pharmacy curriculum
Kim, 2022	Comparison of previous and new research project process
Axon, 2023	Student perspectives of research in the pharmacy curriculum
Cooley, 2023	Preceptors' perception of research in the pharmacy curriculum

Discussion

Studies conducted at these colleges of pharmacy described student pharmacists' perceptions of completing research projects during their pharmacy education. A high percentage of students reported overall satisfaction with their experiences and felt they were valuable (Kim et al., 2010; Kao et al., 2011). The faculty mentors also expressed that the project results were beneficial to their research (Wuller, 2010). In addition, preceptors reported their willingness to continue precepting students in the future. However, a primary theme found in many of the surveys completed by students was insufficient time to work on their

projects. Some students felt that there was not enough time to complete their projects, while others believed that the projects required more work than the number of credits offered (Wuller, 2010; Kim et al., 2010; Axon, 2023). Preceptors also reported that an extended study duration would increase the impact of students' projects (Cooley et al., 2023).

At most colleges in these studies, student research projects began during the second term of the third year and continued on throughout their final year. This point is noteworthy given that students are undertaking their APPE rotations and preparing for their licensure exams during their final year, making it difficult for them to arrange time to work on their research projects, whether alone or in groups. Some students seemed to have good experiences with their projects when completed earlier in the curriculum or when the course was elective (Morbitzer et al., 2021; Kim et al., 2022).

Variations were observed when it came to the perception of research projects and their overall impact. In one study, many students did not anticipate being in positions that require research after graduation (Axon, 2023). Reasons why this may be the case are unknown, although it is possible that most student pharmacists are focused on clinical practice and may not appreciate the role of research in their practice. Pharmacy faculty may wish to consider how they communicate the role and importance of research skills to student pharmacists and better integrate how research skills can be used in their clinical practice. For instance, even if the student does not plan to pursue a research career, they may call upon their research skills to identify and critically appraise the literature and apply the evidence appropriately to their patients.

Another study showed the benefit of research projects, as students reported they were able to apply class material to real-life situations (Wuller, 2010). In light of these findings, faculty at colleges of pharmacy should consider the value of the research project in the curriculum. Perhaps some students value research projects, while others may prefer to spend their time honing a different skill set. Perhaps research projects are only valuable if there is sufficient time, resources, and faculty support for the projects. Notably, the timing of research projects in the curriculum should be considered so that students have sufficient time to complete their projects. Moving the research project courses forward in the curriculum may allow students to focus better on completing their projects before they begin their APPEs (which, for many students, may hold a higher priority than their research projects). This action would have the added advantage of students being able to disseminate the complete findings of their work at a professional conference during their final

year. However, moving the research project courses earlier in the curriculum has to be balanced against other competing priorities in the typically full pharmacy curriculum. More discussion is necessary among the academy regarding the value and timing of research projects in the pharmacy curriculum.

One of the programmes' goals at some of these colleges was the dissemination of project results (Kim *et al.*, 2010; Assemi *et al.*, 2015; Kim *et al.*, 2022). Many students could present their projects at institutional forums or professional meetings or publish their reports, which could help their competitiveness in their careers. In one of the studies, the number of students who matched in the ASHP Resident Matching Programme increased from previous years when a new research programme was introduced (McClendon *et al.*, 2015). While a direct correlation cannot be established here, it is reasonable to conclude that these opportunities help students with problem-solving skills and public speaking.

Other healthcare colleges have similar pathways for students to complete research projects. For example, The New York University School of Medicine offers a 5-year dual-degree programme, where students earn both their Medical Doctor and Master of Science in Clinical Investigation degrees (MD/MSCI). Students undertake one year of their master's classes and then begin research after three years of medical school. Then, they complete their clinical rotations during their fifth and final year. The majority of students in this programme undertook research in a speciality area and also pursued a residency in a related field. At the time of the study, students had many abstracts in submission, were listed as authors in a lot of accepted papers, and had more in submission (Gillman *et al.*, 2015).

As another example, the literature shows that nurses usually view research as too complex and may not use it in practice due to a lack of perceived value. Cedarville University conducted a pre-post assessment to evaluate nurses' perceptions of research and assess the impact of the course. Students took a one-term, 3-credit hour class and were required to present their project at a poster session alongside nursing and pharmacy colleagues. Nurses' perceptions of research significantly improved, and they also had a better awareness of research in their profession (Keib, 2017).

Although this review has focused on research projects in US pharmacy programmes, there may be interest in comparing these findings internationally in future work. For instance, one report (albeit using data from a 2004 study) found that all United Kingdom schools of pharmacy required student pharmacists to complete a

research project as part of the Master of Pharmacy (MPharm) programme (Wilson *et al.*, 2005).

Limitations

There are several limitations to this narrative literature review. Firstly, the methodology of a narrative literature review is not systematic; thus, some relevant articles may not have been included. However, there are limited published studies on this topic, and relevant databases and pharmacy education journals were searched by two researchers to try to identify all relevant articles. Secondly, the studies included in the review had limitations, mainly because they were conducted at a single institution (hence lack external validity) or were conducted several years ago (and hence lack contemporary relevance). Future work is needed to address the limitations of this review. For example, additional studies are needed to capture contemporary data from multiple institutions. As more studies are published, a systematic review may be warranted to synthesise this additional knowledge.

Conclusion

This narrative review, although limited by the study design, provides insight into research projects conducted by student pharmacists at US colleges of pharmacy. The findings indicate that pharmacy research projects appear to improve students' perceptions of research and allow them to apply class material to real-life situations. Additionally, students could publish their projects and have better success in matching to residency programmes. Although many students do not believe they will hold positions that require research, they can use skills learnt from their pharmacy research projects in their future careers. However, the timing and value of research projects in the pharmacy curriculum should be considered and balanced against other competing priorities. Furthermore, there are few studies on programmes that require projects earlier in the curriculum or in which such projects are elective. Colleges of pharmacy are encouraged to disseminate descriptions and outcomes of pharmacy research experiences offered to students at their institutions for the academy to understand and learn from their approaches. An updated literature review may be warranted in the future if additional information about research projects in US pharmacy curricula becomes available.

Conflict of interest

Dr. Axon has received research funding from the American Association of Colleges of Pharmacy, Arizona Department of Health Services, National Council for Prescription Drug Programs, Pharmacy Quality Alliance, Merck & Co., and Tabula Rasa HealthCare Group outside of this study. The other authors have no conflicts of interest to disclose.

Source of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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