

Evaluation of Research and Scholarship Activities with a Pediatric Curricular Track in a Doctor of Pharmacy Program

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OBJECTIVE The University of Oklahoma College of Pharmacy created the Pediatric Degree Option Program (PDOP) to enhance the knowledge and skills of students in pediatric pharmacy. The purpose of the study was to identify the pediatric-focused research and scholarship activities and outcomes of PDOP graduates.

METHODS This was a retrospective study of PDOP graduates from 2011-2022. The primary objective was to identify the overall number of activities conducted during the PDOP. Secondary objectives included the overall number of peer-reviewed and non-peer reviewed publications, and comparison of the median number of scholarship activities per PDOP graduate between those who did and did not complete a PGY1 residency. Inferential statistics were performed using Mann-Whitney U and Chi-square or Fischer's exact test as appropriate, with an *a priori* *p* value <0.05.

RESULTS Fifty-two PDOP graduates completed the program. Following graduation, 23 (44.2%) individuals completed a postgraduate year-one (PGY1) residency. PDOP graduates completed a total of 53 research and scholarship activities. The majority (*n*=44; 83.0%) were original research projects, and 41 (77.4%) graduates published ≥1 manuscript. There was a significant difference in manuscript authorship between graduates who did and did not complete a residency (18 versus 7, *p*<0.001). Seventeen (26.2%) of the PDOP scholarship projects involved collaboration with a PGY1/postgraduate year-two (PGY2) resident.

CONCLUSIONS This study demonstrated that students enrolled in a curricular track were exposed to various aspects of the research and scholarship process. Many of the activities resulted in a publication or presentation for the PDOP graduate.

ABBREVIATIONS APPE, advanced pharmacy practice experience; IRB, institutional review board; OU, University of Oklahoma; PDOP, Pediatric Degree Option Program; PGY1, postgraduate year one; PGY2, postgraduate year two

KEYWORDS pediatrics; pharmacy; research; manuscripts; curricular track

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Introduction

Children <18 years of age account for approximately 25% of the United States population.¹ Pharmacists play a significant role in the care of pediatric patients. A 2013 white-paper including members of the American College of Clinical Pharmacy Pediatric Practice and Research Network and the Pediatric Pharmacy Association highlighted the impact that pharmacists have on the care of pediatric patients including prevention of medication errors, improvement in quality of life, and economic outcomes, and these findings are still relevant today.² Despite the vital role that pediatric pharmacists have, Prescott and colleagues³ noted that pharmacy students in Doctor of Pharmacy programs only receive a median of 16 hours of pediatric didactic content within pharmacy curricula and only about 20%

of students complete an advanced pharmacy practice experience (APPE) rotation in pediatrics. As a result, there remains limited opportunities to provide the knowledge and skills for pharmacy students to expose them to a future career in pediatric pharmacy. In 2020, a joint statement on pediatric education in Doctor of Pharmacy programs was published and provided recommendations on ways colleges of pharmacy could enhance their professional programs.⁴ One recommendation was the creation of pediatric pharmacy concentrations or curricular tracks within Doctor of Pharmacy programs. Pediatric curricular tracks provide students with in-depth training in pediatrics, often including at least one didactic elective in pediatric pharmacy, an independent study involving pediatric research, and at least one pediatric focused APPE.⁴

Few programs across the United States offer a pediatric curricular track within their Doctor of Pharmacy program. In 2010, the University of Oklahoma (OU) College of Pharmacy initiated its curricular track, called the Pediatric Degree Option Program (PDOP), with the first graduate of the program in 2011.^{5,6} A detailed description of the PDOP that describes the overall purpose, the admission requirements for students, and primary faculty and adjunct support preceptors involved have been described in the literature.⁵ One element that was included within the OU College of Pharmacy PDOP was a focus on research and scholarship in pediatric patients. The emphasis on research and scholarship in pediatric patients is important because off-label use of medications in children is common. Petkova and colleagues⁷ conducted a systematic review of studies across the world evaluating the incidence of off-label medications in pediatric patients and noted that the number of off-label medications in the United States ranged from 36-57%, depending upon the patient population. Thus, pediatric pharmacists should develop the skills necessary to conduct medication use evaluations and literature searches to investigate the efficacy and safety of medications. As part of the program, PDOP graduates had the opportunity to complete research and scholarship activities. Johnson and colleagues⁵ conducted an evaluation on the impact of the PDOP on pediatric-focused APPEs and faculty scholarly productivity. Between 2011-2016, all 30 graduates completed pediatric-focused scholarly activities, defined as participation in original institutional review board (IRB)-approved projects and/or quality improvement activities focused on the pediatric population, as a co-author on a peer-reviewed or non-peer-reviewed manuscript, and as a presenter at a conference on clinical research.⁵ At the time the study was conducted, the PDOP program had only been in existence for five years. Additional data has since been collected and can be used to evaluate the types of research and scholarship activities graduates have completed in the PDOP. The purpose of the study was to identify the pediatric-focused research and scholarship activities and outcomes of PDOP graduates over a 12-year timeframe.

Research and Scholarship Activities in the Pediatric Degree Option Program

The PDOP has included 2 different tracks that students can complete to meet the 16 credit hour requirements of the program, track 1 (6 hours of didactic coursework and three APPE rotations) and track 2 (8 hours of didactic course work and two APPE rotations). At the OU College of Pharmacy, these APPE rotations were completed over 1 calendar month and consisted of 4 credit hours per APPE rotation. The requirements of the PDOP from 2011-2022 are listed in Table 1.

From 2010-2014, PDOP graduates completed didactic courses on the Oklahoma City or Tulsa campuses which were delivered synchronously, and pediatric APPE rotations could be completed in the Oklahoma City or Tulsa area. Beginning in 2015, the OU College of Pharmacy underwent a programmatic change where all graduates would complete the Doctor of Pharmacy program on the Oklahoma City campus. The PDOP graduating class of 2018 was the last class to have students on both campuses. As a result of these programmatic changes, the number of pediatric faculty and the overall Doctor of Pharmacy students class size declined.

Graduates in the 2010-2018 classes were given the option to participate in research and scholarship activities. The PDOP directors identified students interested in research and scholarship during one-on-one meetings to discuss each student's individual plan of study. Research and scholarship projects were identified from OU College of Pharmacy faculty and adjunct support preceptors who participated in the PDOP. To complete the research and scholarship activities, students were enrolled in a self-paced, independent study for didactic credit during their second or third professional year and/or one research APPE rotation during their fourth professional year. Alternatively, students could also complete these activities in a volunteer capacity associated with no elective credit during their second, third, or fourth professional year. In addition, students were given the opportunity to participate as research assistants on ongoing IRB-approved research projects. These projects were OU College of Pharmacy faculty and/or adjunct support preceptor-led projects, some of which were assigned as postgraduate year one (PGY1) Pharmacy or postgraduate year two (PGY2) Pediatric pharmacy resident projects. They were also given the opportunity to participate in the development and execution of a new original IRB-approved study or other scholarly manuscripts (i.e., case reports and review articles). To minimize the burden on the OU College of Pharmacy faculty and/or adjunct support preceptors, multiple students may have been assigned to a single project.

Graduates from 2019-present are required to complete track 1. In addition, a decision was made to require all students to participate in an original IRB-approved research project. These PDOP graduates participated in all phases of the research process, including development and submission of an IRB protocol, in a structured manner like the conduct of research with PGY1 Pharmacy residents. As mentioned above, more than one student may have been assigned to a single project. Based on their interests, students may have also volunteered to participate as a research assistant in another ongoing IRB-approved project and/or scholarly manuscript.

Table 1. Didactic and Pediatric-Focused Advanced Pharmacy Practice Experiences in the Pediatric Degree Option Program from 2011-2022

Course	Brief Description	Credit Hours	Required Course During Time Period (Yes, Optional, Not available)	
			2011-2018	2019-2022
Didactic Electives				
Pharmacotherapy considerations in pediatrics	Case-based delivery focusing on ambulatory care topics (hypertension, community acquired pneumonia) and acute care topics (cystic fibrosis exacerbations, septic shock)	3	Yes	Yes
Introduction to pediatric pharmacotherapy	Lecture-based content delivery focusing on drug development, various self-care topics, problem solving, counseling tips, and palatability of medications	2	Optional ^a	Not available ^b
Pediatric medication safety	Discussion-based delivery focusing on best practice for pediatric prescriptions and including hands-on review of prescriptions and utilization of drug information sources	2	Optional ^a	Not available
Independent study	Self-paced course with one-on-one teaching with a faculty member on a quality improvement or research project	1-3	Optional ^a	Yes ^c
APPEs				
In-patient rotations (general pediatrics, PICU, CICU, infectious disease, NICU, hematology/oncology)	Students participate in multidisciplinary rounds with teaching teams. Activities include medication reconciliation, therapeutic drug monitoring, medication counseling, and provision of drug therapy recommendations.	4	Yes ^d	Yes ^d
Nephrology/kidney transplant	Students participate in rounds with the nephrology in-patient team and attend the renal transplant clinic approximately 1-2 half days per week. Activities include drug information responses, medication reconciliation, medication counseling, provision of drug therapy recommendations, therapeutic drug monitoring, and renal dose adjustment	4	Optional ^e	Optional ^e
Ambulatory care	Students attend various out-patient clinics approximately 5 half-days per week. Activities include disease state management, drug information responses, medication reconciliation, medication counseling, provision of drug therapy recommendations and prescription insurance assistance	4	Optional ^e	Optional ^e
Diabetes camp	Students participate as a counselor for both day-camp and a week-long overnight camp for children with diabetes. Activities include monitoring for, preventing, and treating hypoglycemia and hyperglycemia, carbohydrate counting, calculating insulin doses, administering insulin, assisting with insulin dose adjustments, and administering other medications.	4	Optional ^e	Optional ^e
Research	Student completes a concentrated rotation focused in completion of an ongoing research project and/or scholarly article. Activities include data collection, data entry, data analysis, and/or completion of writing assigned sections of an article	4	Optional ^e	Yes

APPE = Advanced pharmacy practice experiences; CICU = Cardiac intensive care unit; NICU = Neonatal intensive care unit; PICU = Pediatric intensive care unit

^a Students could select from these courses in order to meet the didactic credit hour requirement for track 1 (6 hours of didactic course work) and track 2 (8 hours of didactic course work)

^b Course no longer offered beginning with 2019 PDOP graduates

^c Beginning with the PDOP graduates in 2019, the independent study course was approved for 3 credit hours and took place in the Fall semester of the 3rd year of the Doctor of Pharmacy program.

^d Students had to complete ≥1 in-patient rotation.

^e Students could select the remaining 1-2 APPE rotations based on the track that the PDOP graduate completed (i.e., track 1 required three APPE rotations and track 2 required two APPE rotations), preceptor availability, and the PDOP graduate's interests.

Table 2. Overview of the Research and Curriculum within the Pediatric Degree Option Program Beginning with the PDOP Graduating Class of 2019			
Course	Year of the Professional Program	Description of Research and Scholarship Activities	Topics Covered
Independent study didactic elective	Third	• As part of the content for the course, students complete research training required by the IRB and additional topics regarding clinical research • Students are assigned a pediatric pharmacy research project during the independent study and work on the development of the IRB protocol and present the presentation of the research-in-progress at the end of the semester	• CITI/IRB training • Overview of clinical research design • Developing a great research question • Working with your research team • Ethical considerations in research • Off-label use of medications • Expanded access/compassionate use of medications • How to deliver a poster/platform presentation
Research APPE rotation	Fourth	• The students complete the assigned research project from their independent study course • Activities include data collection, data entry, data analysis, completion of writing assigned portions of their research article, and completion of a peer-review of manuscript submitted for publication with a preceptor • Students are assigned additional topic discussions for medical writing and peer-review	• Medical writing • Abstract writing • Peer-review of manuscripts

APPE = Advanced pharmacy practice experiences; CITI = Collaborative Institutional Training Initiative; IRB = Institutional review board

For all research and scholarship activities, one of the OU College of Pharmacy faculty served as the research mentor. Depending on the research and scholarship project, other OU College of Pharmacy faculty or other adjunct support preceptors participated as members of the research team. Additional OU College of Pharmacy faculty or staff were employed to assist with the qualitative or quantitative analyses. To prepare PDOP students for work on research and scholarship activities, they participated in several topic discussions throughout their experiences. Beginning with the 2019 PDOP graduates, these topic discussions were more formalized. Table 2 describes an overview of the research and scholarship activities and topics that were covered through their required coursework. It should be noted that all students participating in original IRB-approved research projects were required to complete the required IRB training through the Collaborative Institutional Training Initiative.⁸

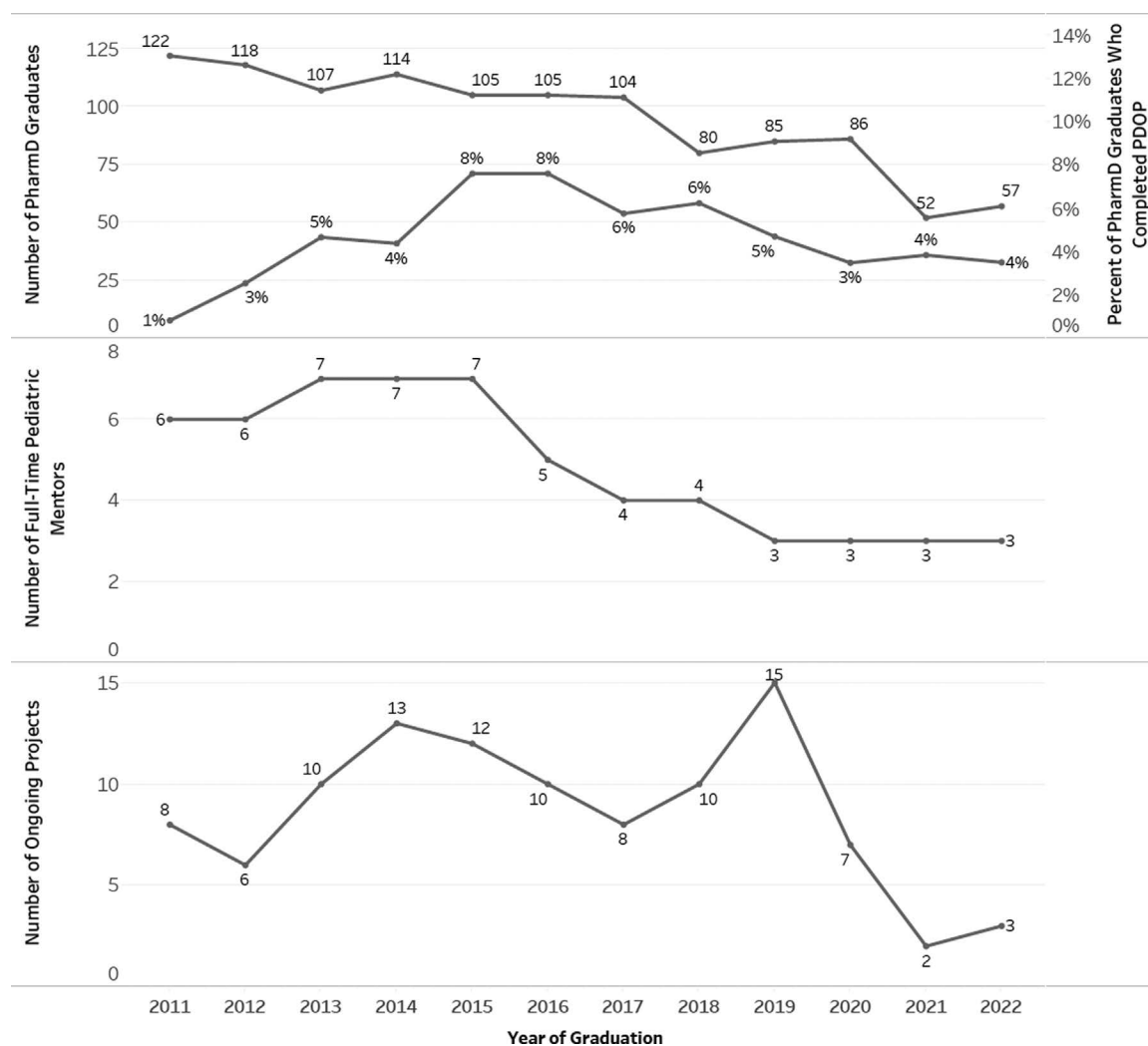
Materials and Methods

Study Design. This study was a retrospective cohort study of OU College of Pharmacy PDOP graduates from 2011-2022. Graduating students were identified by records maintained by the PDOP director that contain the name of the student, graduating year, research and scholarship activities, coursework completed, and

initial position after graduation, and these records were utilized to provide ongoing reports to the OU College of Pharmacy Dean's Office and the Curriculum and Assessment Committees for accreditation reports. The 2022 end date was selected for the study to allow time for publication, as previous studies have identified the mean time to publication of research projects by pharmacy trainees is approximately 2 years after initiation of the project.^{9,10} IRB approval was waived for this study as it was based on de-identified data that was maintained in the existing database for the PDOP.

Data Collection and Study Objectives. Data collection included the PDOP track completed, the type of APPE rotations and didactic courses that students completed, the graduation year, and types of research and scholarship activities. Specific data collected for each project included type of research and scholarship activity (i.e., original IRB-approved research, case report/case series, or review article), if a manuscript was published, the type of presentation given (platform, poster, or both), and if the project received an award. The number of active ongoing projects per year were collected and included a count of projects in any phase of development (e.g., protocol development, data collection, manuscript preparation). If a project spanned more than one year, it would be included in the count for subsequent years.

Figure 1. Overview of Pediatric Degree Option Program (PDOP) Graduates, Projects, and Number of Pediatric Faculty Members Per Year



The primary objective was to identify the overall number of pediatric-focused research and scholarship activities. Research and scholarship activities were defined as participation in original IRB-approved pediatric focused projects, as a co-author on a peer-reviewed or non-peer-reviewed manuscript, and as a presenter at a conference on clinical research.⁵ Any involvement on an original IRB-approved research or scholarly manuscript (i.e., case report/case series, or review article) were counted as one project. For example, development of an IRB protocol and data collection on the same project counted as one project. Projects that were not submitted for IRB-approval (e.g., drug monographs, formulary projects) were not included as part of this definition since they did not meet the definition for human-subjects research. Secondary objectives included the overall number of original IRB-approved research projects, peer-reviewed and non-peer re-

viewed publications, and authorship and contributor roles on peer-reviewed and non-peer-reviewed publications. Contributors on manuscripts were defined as those who do not meet the four criteria for authorship as proposed by the International Committee of Medical Journal Editors and were acknowledged as participants in published manuscripts.¹¹ Other secondary objectives included the overall number of poster and platform presentations, the initial position of each PDOP graduate after graduation and whether they collaborated on a PGY1 Pharmacy or PGY2 Pediatric pharmacy resident project, and a comparison in the median number of scholarship activities per PDOP graduate between those who completed a PGY1 Pharmacy residency versus those who did not.

Statistical Analyses. Descriptive statistics were employed. Continuous data were compared using Wilcoxon rank-sum test. Categorical data were compared

Table 3. Overview of Track Completed and Research Coursework in PDOP Graduates from 2011-2018 and 2019-2022 (n=52)

Variables	2011-2018 (n=41) ^a	2019-2022 (n=11) ^b
	Number (%)	
Track completed		
Track 1	35 (85.4)	11 (100)
Track 2	6 (14.6)	—
Involvement in research	36 (87.8)	11 (100)
Research coursework completed:		
Independent study for self-directed learning	32 (78.0)	11 (100)
APPE research rotation	32 (78.0)	11 (100)
Either independent study didactic elective or APPE research rotation	39 (95.1)	11 (100)
Both independent study didactic elective and APPE research rotation	25 (61.0)	11 (100)

APPE = Advanced pharmacy practice experience

^a From 2011-2018, the number of graduates per year were 2011 (n=1), 2012 (n=3), 2013 (n=5), 2014 (n=5), 2015 (n=8), 2016 (n=8), 2017 (n=7), and 2018 (n=4).

^b From 2019-2022, the number of graduates per year were 2019 (n=4), 2020 (n=3), 2021 (n=2), and 2022 (n=2).

using Chi-square tests or Fisher's Exact tests, as appropriate. Data analysis was performed using SAS v9.4 (Statistical Analysis System; Cary, North Carolina), with the a priori alpha being set at $p < 0.05$.

Results

Demographics of PDOP Graduates. There was a total of 52 students evaluated that were enrolled in the PDOP between the years of 2011 to 2022, including 41 graduates from 2011-2019 and 11 graduates from 2019-2022. Figure 1 provides an overview of the total number of the OU College of Pharmacy Doctor of Pharmacy graduates per class, and the percentage of PDOP graduates per Doctor of Pharmacy class from 2011-2022. The majority of PDOP graduates completed track 1 (n=46; 88.5%). Table 3 provides an overview of the track completed and the research coursework that PDOP graduates completed. Forty-seven students (90.4%) participated in at least one research or scholarship activity. The remaining five students were PDOP graduates between the timeframe of 2011-2018. Three of these five students completed an independent study didactic elective where they worked on non-IRB-approved projects. The majority (n=35; 67.3%) of PDOP graduates completed both an independent study didactic elective and an APPE research rotation. Figure 1 provides the number of full-time pediatric faculty mentors per year from 2011-2022.

Table 4. Description of Pediatric Research and Scholarship Activities (Projects) (n=53)

Variable	Number (%) or Median (IQR)
Type of project:	
Original IRB-approved research	44 (83.0)
Review article	3 (5.7)
Case report/case series	6 (11.3)
PGY1 Pharmacy or PGY2 Pediatric pharmacy resident project:	
Original IRB-approved research	15 (28.3)
Case report/case series	2 (3.8)
Manuscript published	41 (77.4)
Presentation given	29 (54.7)
Presentation type:	
Platform	1 (1.9)
Poster	26 (49.1)
Both	2 (3.8)
Award received for project	5 (9.4)
Number of students per project	1.0 (1 to 2)

IRB = Institutional review board; PGY1 = Postgraduate year one; PGY2 = Postgraduate year two

Twenty-three (44.2%) completed a PGY1 residency after graduation. For the remaining 29 (54.7%) PDOP graduates 19 (36.5%) took a position practicing in community pharmacy, 9 (17.3%) took a position in a health-system, and 1 (1.9%) took a position as a certified specialist at a poison information center.

Research and Scholarship Activities. A total of 53 unique pediatric-focused research and scholarship activities were identified. A summary of these projects can be found in Table 4. Figure 1 also provides the number of ongoing active research and scholarship projects per year from 2011-2022. The median [interquartile range (IQR)] number of ongoing research and scholarship projects per year was 9 (6.8-10.5). The number of PDOP graduates who worked on each activity varied with a median of one PDOP graduate per project. Twenty (37.7%) projects had ≥ 1 PDOP graduate on the project, and the maximum number of PDOP graduates working on a project was six. The most common activity was an original research IRB-approved project (n=44; 83.0%). Of these 44 projects, 24 (54.5%) involved voluntary participation by the PDOP graduates on a project in progress, including 15 (34.1%) that were an assigned pharmacy resident project and nine that (20.4%) were OU College of Pharmacy faculty and/or adjunct support preceptor project. The remaining 20 (45.5%) were a project that was developed specifically for the PDOP graduates, and they were involved throughout the entire development and execution of the project.

Most projects (n=41; 77.3%) were published (Table 4). PDOP graduates delivered 29 (54.7%) presentations as

a platform and/or poster presentation at various professional conferences both locally and nationally. Only three of these presentations involved a research and scholarship activity that was not ultimately published. Of the 17 resident projects, five (29.4%) had PDOP graduate co-authors on the published peer-reviewed manuscript and six (35.3%) had PDOP graduate co-authors on the platform and/or poster presentations. Five (13.9%) of the 36 projects that were non-PGY1 or PGY2 pharmacy resident projects received a local or national research award.

Comparison of Research and Scholarship Activities. Table 5 provides a comparison of research and scholarship activities per PDOP graduate who did and did not complete a PGY1 Pharmacy residency. There was not a significant difference in the types of projects between those who did and did not complete a PGY1 Pharmacy residency, nor was there a significant difference in manuscript publication. A greater number of PDOP graduates who completed a PGY1 Pharmacy residency were co-authors on a manuscript versus those who did not complete a PGY1 Pharmacy residency (18 versus 7, $p < 0.001$). In contrast, a greater number of PDOP graduates that did not complete a PGY1 Pharmacy residency were listed as contributors on manuscripts in comparison to those that completed a PGY1 Pharmacy residency, 15 versus 6, $p = 0.06$. There were significantly more PDOP graduates that completed a PGY1 Pharmacy residency who presented an original IRB-approved research project at local (9 versus 3, $p < 0.001$) and national (21 versus 14, $p < 0.014$) conferences versus those who did not complete a residency.

Discussion

This study evaluated the research and scholarship output of students enrolled in the pediatric-focused curricular tracks or concentrations over a 12-year period. Our findings demonstrate that the majority ($n = 47$; 90.4%) of PDOP graduates were successfully engaged in various aspects of the research process, resulting in meaningful scholarly contributions to the field of pediatric pharmacy. Several studies have described outcomes of curricular tracks or concentrations within Doctor of Pharmacy programs.^{5,6,12–20} To our knowledge, there are only 3 pediatric pharmacy curricular tracks or concentrations offered within Doctor of Pharmacy programs.^{5,6,19,21} All three programs involve students in pediatric research. Given the number of medications that are used off-label in pediatrics and the concerns for establishment of pediatric medication safety and efficacy, the goal would be that these original IRB-approved research studies and scholarly manuscripts completed by students would fill gaps in the literature.

Most of these other studies evaluating outcomes of curricular tracks or concentrations have focused on other clinical specialties (e.g., adult acute care, criti-

cal care, psychiatry, geriatrics), leadership/pharmacy business management, and global health and have not included a focus on development of research skills. Parsons and colleagues¹² conducted a survey of curricular tracks or concentrations within 134 Doctor of Pharmacy programs and had 65 (48.5%) respondents. Sixteen (11.9%) respondents offered 38 curricular tracks or concentrations. Only seven (18.4%) of the 38 curricular tracks or concentrations required a project, but it was not apparent if this project was a research or scholarship activity, or if it was a non-IRB-approved project that was not intended to be published or presented outside of the institution. Volger and colleagues¹⁹ reported on their experience with a pediatric curricular track or concentration at Southern Illinois University Edwardsville School of Pharmacy. Their program required all students to complete a clinical research project within an independent study course during their third professional year. These findings align with the current OU College of Pharmacy PDOP graduate requirements that were implemented in 2019. However, their study did not provide specific details on the outcomes of their projects, so it is difficult to compare to our study.

The OU College of Pharmacy PDOP graduates completed or assisted with 44 original IRB-approved research projects. In the previous eight studies describing their curricular track or concentration, six mentioned that they offered students opportunities to participate in original IRB-approved projects.^{13–20} It is difficult to compare these studies with our study because not all of them provided a specific number of original research projects completed, and some of the studies only included an evaluation 1–3 years after initiation of their program. We found no statistical difference in the number of original IRB-approved projects between those who did and did not complete a PGY1 pharmacy residency. Four of the other studies evaluating curricular tracks or concentrations did report the number of students who went on to complete a PGY1 Pharmacy residency after graduation, but they did not compare differences in those who did and did not complete a residency program.^{16–19} Given that until 2019 participation in research was an option with the PDOP, our findings seem to suggest that students who are not residency bound still seek out opportunities for participation in research activities. It is plausible that their participation in these activities may help foster critical thinking and time management skills that may aid students no matter their postgraduate career paths.

Within the OU College of Pharmacy PDOP program, several of our projects involved “layered learning” with other PDOP students or pharmacy residents. Fifteen (34.1%) of our 44 original IRB-approved research projects were an assigned residency project, and one-third had ≥ 1 student working on the same project. Involving multiple students and residents on one project is a “layered learning” approach that could help ensure

Table 5. Comparative Analysis of Aggregate and Individual Research and Scholarship Activities Among PDOP Graduates with and without a PGY1 Residency (n=52)

Variable	Overall (N=52)	Residency (n=23)	No Residency (n=29)	P-value
Number (%) and Median (IQR)				
Projects				
Types of projects:				
Original IRB-approved research	33 (63.5)	17 (73.9)	16 (55.2)	0.16
Review article	4 (7.7)	3 (13.0)	1 (3.4)	0.31
Case report/case series	8 (15.4)	5 (21.7)	3 (10.3)	0.44
Manuscripts				
Published ≥1 manuscript	38 (73.1)	19 (82.6)	19 (65.5)	0.168
Manuscript type:				
Peer-reviewed	38 (73.1)	19 (82.6)	19 (65.5)	0.17
Non peer-reviewed	1 (1.9)	1 (4.3)	--	0.44
Role on manuscript:				
Author	25 (48.1)	18 (78.3)	7 (24.1)	<0.001
Contributor	21 (40.4)	6 (26.1)	15 (51.7)	0.06
Total number of manuscripts	1 (1 to 2)	2 (1 to 2)	1 (1 to 1)	0.40
Presentations				
Presented at a conference	35 (67.3)	21 (91.3)	14 (48.3)	0.001
Presentation type:				
Platform	3 (5.8)	2 (8.7)	1 (3.4)	0.58
Local poster	12 (23.1)	9 (39.1)	3 (10.3)	<0.001
National poster	33 (63.5)	21 (91.3)	12 (41.4)	0.014
Total number of presentations	2 (2 to 3)	3 (2 to 3)	2 (1 to 3)	0.03

IRB = Institutional review board

timely completion of the research project. Coons and colleagues¹⁷ developed a Pharmacotherapy Scholars program at the University of Pittsburgh School of Pharmacy that focused on preparation for postgraduate residency training from 2013-2019. They noted 60 students completed the program and reported that they had as many as eight students on one research project. Most of our projects had 1-2 students, but we did have one large project in which six students were working on data collection. The “layered learning” approach may provide pharmacy residents with opportunity for mentorship and co-precepting responsibilities.

The majority of PDOP graduates in our program published ≥1 manuscript with their original IRB-approved research project or scholarly manuscript (n=41; 77.4%) and presented their research project at a research conference (n=29; 54.7%). Other studies evaluating curricular tracks or concentrations evaluated both metrics and reported that students presented their research at conferences and several students were able to publish their findings.¹⁶⁻²⁰ However as noted previously, the total number of projects was not reported, and the timeframe for some of these studies was only 1-3 years after inception. So, it would be difficult to compare the findings to our study. In our study, we did find that a

significantly higher number of PDOP graduates who completed a PGY1 Pharmacy residency were an author on a published manuscript versus those who did not complete a residency. None of the other studies evaluating curricular tracks or concentrations evaluated this metric. These results suggest that those who are focused on postgraduate training may be more motivated to complete all phases of a research or scholarship activity that may lead to publication to enhance their competitiveness as a PGY1 Pharmacy resident.

Aside from the impact on the individual PDOP graduates, the research and scholarship activities did help increase scholarly productivity for the faculty mentors. Johnson and colleagues⁵ evaluated the number of scholarship activities pre- (2005-2010) versus post-implementation (2011-2016) of the PDOP program for the first five years of the program. In this study, they found that implementation of the PDOP program allowed for twice the number of scholarship projects for participating faculty compared to baseline. The number of faculty members did decline over time with the programmatic change that occurred with the OU College of Pharmacy beginning in 2014. However, for most projects, there was more than one faculty member who served as a mentor on these projects, so

this helped offset the time commitment of a particular faculty member. Unfortunately, in this study, we were unable to quantify the number of mentorship hours that faculty spent to provide guidance to the PDOP graduates on their projects and teaching activities related to research. To help streamline delivery of teaching content, a standardized research curriculum was implemented (Table 2).

This study has several limitations. First, this was a single-center study, so the results may not be generalizable to all Doctor of Pharmacy programs as they may not have a pediatric curricular track or concentration, and/or they may not have a required research and scholarship component as part of their curricular track or concentration. Second, for our PDOP, there were anywhere from 3-7 OU College of Pharmacy pediatric-focused faculty and 2-4 adjunct support preceptors in addition to the OU College of Pharmacy faculty/staff who helped with data analysis during the 12-year timeframe and were able to serve as a mentor for research and scholarship activities. Our results would have likely been different if we did not have this level of support to guide the PDOP graduates on their research and scholarship activities. Third, there was a reduction in the number of Doctor of Pharmacy students did decrease over the 2011-2022 timeframe. However, the percentage of PDOP graduates per Doctor of Pharmacy class ranged from was between 3-8% from 2011-2022. Fourth, as noted, graduates in the PDOP were not required to participate in research until the 2019 graduating class, and graduates from 2019-2022 were required to complete Track 1 with more formalized research topic discussions. However, as we noted, 90% of PDOP graduates participated in ≥ 1 research or scholarship activity, and most (67%) completed Track 1 including an independent study and APPE research rotation. Last, the retrospective nature of the study limits our ability to assess the quality of the research experiences or the long-term impact on graduates' careers. Bennett and colleagues²² surveyed pharmacy residents who participated in a team-based research program associated with the OU College of Pharmacy and found that participation in a structured research program was associated with future participation in clinical research after residency graduation and overall confidence in mentoring of students and residents in clinical research. However, it is unclear if we would note similar findings with PDOP graduates, as their experiences were within a Doctor of Pharmacy program rather than a postgraduate training experience.

Conclusion

This study demonstrates that a structured pediatric curricular track with a strong emphasis on research can successfully engage pharmacy students in meaningful scholarship activities. The high rates of project completion and output in terms of publication and presentation

suggest that such programs can contribute significantly to students' research skills and to the broader field of pediatric pharmacy. Future efforts should focus on further optimizing research curricula within Doctor of Pharmacy programs and evaluating the long-term impact on graduates' careers and contributions to pediatric medication use and safety.

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Ethical Approval and Informed Consent. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines on human experimentation and has been approved by our institution review board. Given the nature of this study, informed consent and assent were not required.

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