Published in final edited form as:

Am J Health Syst Pharm. 2016 June 15; 73(12): 895–900. doi:10.2146/ajhp150567.

The impact of resident research publication on early-career publication success

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Abstract

Purpose—The impact of resident research publication on early-career publication success was evaluated.

Methods—This study included a retrospective cohort of pharmacy residents' abstracts presented at the Great Lakes Pharmacy Resident Conference (GLPRC). Published residency research projects at GLPRC were matched 1:1 to unpublished projects. Residents were followed forward for five years to identify early career publications (post-residency publication-positive) versus no publications (post-residency publication-negative). The following characteristics of post-residency publication-positive and publication-negative residents were compared; publication of residency project, university-affiliated residencies, median number and interquartile range of coinvestigators, presence or absence of a physician coinvestigators, highest nonphysician H-index of coinvestigators, and nonphysician H-index – 1 for any coinvestigator (indicating that a coinvestigator has previously published and been cited).

Results—A total of 152 abstracts were reviewed (76 published and 76 unpublished projects). Using a predefined systematic search strategy, 55 former residents had a postresidency publication within 5 years after presenting their project at the GLPRC. Of the former residents who published their residency project, 38 (50%) were postresidency publication-positive, while 17 former residents (22.4%) who did not publish their residency research project were postresidency publication positive. Univariate and multivariate analyses revealed that publication of the pharmacy resident research project and a university-affiliated residency program was positively associated with postresidency publication success.

Conclusions—Pharmacy residents who published their residency research project after its presentation at GLPRC were twice as likely to have a publication success within five years compared with residents who did not publish their residency project. A university-affiliated

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residency was associated with postresidency publication success within five year after project presentation.

INTRODUCTION

Pharmacists with adequate skills and abilities to advance knowledge through independent research are needed in the pharmacy profession.^{1,2} Fellowship programs are designed and positioned in the pharmacist development pathway to address this need in training pharmacists to conduct high quality research; unfortunately, interest in and availability of fellowship programs are declining.³ Unlike fellowships, residency training opportunities are increasing every year but differ in their research training goals.⁴ ASHP Accreditation Standards for Postgraduate Year One Residency Programs (PGY1) goal R2.2 states a resident should demonstrate ability to evaluate and investigate practice, review data, and assimilate scientific evidence to improve patient care and/or the medication use system.⁵ The standards do not specify goal R2.2 has to be achieved by conducting a research project.⁵ Postgraduate Year Two (PGY2) accreditation standards vary whether conduction of a research project is explicitly required.⁶ However, many pharmacists enter positions where scholarly activity is expected with only PharmD and one or two years of residency training to teach current residents numerous skills required to conduct practice-based research^{7–10} which can lead to a cycle of inadequately trained pharmacists training future residents.¹¹ Description and quantification of the resident research training experience aids in residency program improvement, comparison, and promotion.

Publication of resident projects has been used as a surrogate marker for the level of research training and experience provided to pharmacy residents. In general, less than 15% of pharmacy residents publish findings of their residency projects.^{12–17} Numerous studies have described the barriers to publish resident projects.^{13,18–23} Few studies which evaluate resident improvement in research knowledge and ability exist. A survey of pharmacists completing residency in 2004–05 purported that self-assessed research skills and knowledge had improved during residency; however, objective measurements of research knowledge failed to confirm the perceived improvement in research skills and knowledge.²⁴ A 2012 survey of postgraduate year 1 (PGY1) residents suggested knowledge of biostatistics and research study design was insufficient.²⁵ In a survey of 27 former PGY1 residents from 2007–2013, self-reported research abilities after residency were rated as low and knowledge of statistical tests were moderate.²⁶ Among those respondents, only 11% published their residency project. However, 85% were involved in research in their current position and 48.2% published since residency.²⁶

Resident project publication as a surrogate marker for research knowledge and skills remains largely untested. The impact of the publication of a resident project in future publication success is unknown. The current study aims to expand on the current knowledge of the relationship between residency project publication and post-residency publication success.

METHODS

This is a retrospective cohort of pharmacy resident abstracts presented at the Great Lakes Pharmacy Resident Conference (GLPRC). This study was deemed exempt by the St. Louis College of Pharmacy Institutional Review Board, as all data was accessed on the conference website (<http://www.glprc.com/>).

In a previous study, we identified the publication rate of the resident research project after presentation at the GLPRC in 2003, 2005, and 2007 was 11.4% (n=76).¹⁹ Briefly, we used a pre-defined systematic search strategy which included search engines in the following order: 1) Scopus®, 2) International Pharmacists Abstracts, and 3) MEDLINE (PubMed) to identification the publication (publication positive) or no publication (no publication) of the resident research project presented at GLPRC.

Primary Outcome

The primary outcome of this study is a post-residency publication by the resident within five years of the abstract year other than the project presented at GLPRC. For this study, we compared publication positive abstracts (n=76) and randomly matched 1:1 to publication negative abstracts (n=76) based on state the residency was located and abstract year as publication rates projects differed among states and years.¹⁹ Subsequent publications were identified using Scopus®. Scopus® is an abstract and citation database of peer-reviewed literature which contains 54 million records from over 20,000 peer reviewed journals.²⁷ A feature of Scopus® is an author identification search feature that can identify authors based on names, affiliation, location, etc. Although it has not been validated in the United States, a recent article showed the Scopus® author identification search feature in Japan was 99% precise when compared to the largest funding database.²⁸

In residents with publication positive abstracts, we identified the original published article (Figure 1). In residents with publication negative abstracts, we used a pre-defined systematic search strategy to identify the resident using 1) last name, 2) first initial, 3) country, and 4) affiliation (Figure 2). If the authors were not found we searched co-authors of the abstract to assess if there may be a potential name change. We manually assessed all publications and identified all manuscripts published within five years of the abstract year; publications prior to abstract year were not considered. Those with a publication within five years of their abstract year were considered post-residency publication positive and those without a publication within five years of their abstract year were considered post-residency publication negative.

Covariates and Secondary Outcomes

Using information provided in the abstracts, we identified number of co-investigators and university affiliation for the residencies. We also used Scopus® to identify the H-Index (a measure of the scientific impact an individual researcher calculated in Scopus® based on number of published works and number of citations for the published works)²⁹ and degrees (e.g., PharmD, MD, PhD) of co-investigators as predictors of early publication success after residency. We performed a sensitivity analysis in post-residency publication positive

abstracts to determine an academic affiliation with the post-residency publication to understand the influence of academia on post-residency publications and number of publications within five years of abstract presentation.

Variable Confirmation

Two independent investigators (PMS and SMV) collected variables and used the pre-defined systematic search strategy as stated above. If the investigators were in agreement, then the result was carried forward for analysis. If there was not agreement on the publication result, a consensus was formed between the two sole investigators, and the result was carried forward for analysis.

Statistical Analysis

Descriptive statistics were used to analyze nominal and continuous data. Chi-square (or Fisher's Exact) Mann-Whitney U tests and were used to compare characteristics of post-residency publication positive and negative in publication of the residency project, university-affiliated residencies, median (IQR (interquartile range)) number of co-investigators, physician co-investigator, highest non-physician H-Index of co-investigators, and non-physician H-Index = 1 for any co-investigator (as an indicator that a co-investigator has previously published and has been cited). Physician H-Index values were not used as physician co-investigators typically have minimal involvement as compared to pharmacy co-investigators and may over-estimate the H-Index; therefore, we captured physician co-investigator involvement as a dichotomous variable. H-index was chosen as a measure of research productivity over number of publications because H-index is considered a better estimate of research importance, significance, and overall impact.²⁹

Multivariate logistic regression was used to determine variables that predict post-residency publications within five years of abstract year. Variables were tested for multicollinearity, interactions, and outliers. Since the variables highest (non-physician) H-Index of co-investigators, and H-Index = 1 for any co-investigator have the potential to be multicollinear, we *a priori* decided to perform two separate multivariate analyses. We performed univariate analyses and forced variables into two multivariate analyses when the p-value <0.2. All data was considered two-sided with an alpha of 0.05. All statistical analyses were performed using IBM-SPSS version 22.0 (IBM Corp., Armonk, NY).

RESULTS

A total of 152 abstracts were reviewed, 76 residents who published their residency project and 76 residents who did not publish their residency project matched based on abstract year (2003, n=42; 2005, n=56; 2007, n=54) and location of residency by state (Illinois, n=36; Indiana, n=8; Kentucky, n=2; Michigan, n=32; Ohio, n=50; Wisconsin, n=24).

Using the pre-defined systematic search strategy, 36.2% (n=55/152) of former residents had a post-residency publication within five year of the abstract presentation. Of the former residents who published their residency project, 50.0% (n=38) had a post-residency publication within 5 years of the abstract year compared to 22.4% (n=17) of former residents who did not publish resident research projects had a post-residency publication within five

years. Other variables which may potentially influence post-residency publication success are located in Table 1.

Based on the univariate analyses, number of co-investigators ($p=0.498$) and physician co-investigators on project ($p=0.316$) did not meet the threshold to be entered into either multivariate analyses. In the first set univariate analyses (Table 2) which included the variable highest non-physician H-Index (which suggests high volume, pharmacy researcher involvement) as a continuous variable, publication of residency project, and university-affiliated residency program, were all significant. In the first multivariate analysis, publication during residency odds ratio (OR) 2.86 (95% Confidence Interval (CI) 1.31–6.25) and university-affiliated residency program OR 6.72 (95% CI 2.93–15.42) remained significant whereas highest non-physician H-Index was no longer significant.

In the second univariate analyses (Table 3) which included the variable H-Index of non-physician H-Index 1, publication of residency project, university-affiliated residency program, and H-index of the highest non-physician co-investigators as a continuous variable were all significant. In this multivariate analysis, publication during residency odds ratio (OR) 2.76 (95% CI 1.28–5.98) and university-affiliated residency program OR 5.89 (95% CI 1.28–13.76) also remained significant whereas highest non-physician H-Index was also no longer significant.

In our sensitivity analysis, 74.5% ($n=41$) of former resident researchers with a post-residency publication within five years were affiliated with an academic institution on the publication. Of those with a post-residency publication within five years, the median (IQR) number of publications was 2 (1–5). However, there was no difference in the number of publications between academic (median (IQR) 1 (1–8.25)) and non-academic institutions (median (IQR) 2(1–5)) ($p=0.405$).

Discussion

Our findings suggest a pharmacist who publishes their resident research project is more than twice as likely to publish early in their post-residency career compared to those who did not publish during their residency training as identified in our previous analysis.¹⁹ This underlines the importance of a deliberate approach to the resident research experience, with a reasonable goal to have a research manuscript prepared and submitted by the conclusion of the resident. Research and peer-reviewed publication experience is especially important as many pharmacists are being tasked to perform or mentor research despite having no formal research training. The lack of training raises concerns over research ability, interest, and effectiveness of teaching others the principles of research.^{11,30}

Our study found that residents who completed academic-affiliated programs were more likely to have post-residency publication success. Many academic institutions can offer a unique environment to provide a meaningful research experience. This includes abundant research resources and mentors with incentives to guide residents through the entire research process. These qualities are difficult to quantify and test in a retrospective study.

Furthermore, access to resources similar to those available at academic institutions may be difficult for some pharmacy residency programs.

Mentors or coinvestigators may also influence resident research experience and publication. We assessed coinvestigator's H-index, which measures number of publications and citations, as a measure of research mentorship quality.²⁹ The H-index of non-physician co-investigators did not influence post-residency publication success in the multivariate analyses. However, H-index does not completely measure the quality of research mentorship. Many have described guided, structured resident research programs which result in improvements in publication rate and retention of research interest and skills after residency.^{31–35}

Key components of resident research programs include a research advisory board, research curriculum, or a practice-based research training network (PBRTN).^{31–35} Individuals involved in research programs should possess adequate knowledge, experience, and interest in practice-based research and residency training. Advisory boards help ensure the resident research experience is consistent in quality. Functions of an advisory board may include research preceptor mentoring, project development, ensuring research is completed in a timely manner, and managing a research curriculum. The research curriculum instructs residents through key parts of completing research from initiation to completion. In a PBRTN, a research program at a single (academic) institution partners with nearby programs that may not have all the necessary resources to provide a research curriculum or advisory board.

A research program should be designed to help residents complete a meaningful project and produce a high-quality research manuscript within the residency year. Publication may be an unrealistic goal for every project, but experience with the peer-review process is invaluable. Portable research skills and experiences can engender excitement for scholarly activity after residency and lead to positive returns for the program and profession. Pharmacists who completed research programs during residency, regardless of publication success, report using the research skills learned during the program, felt comfortable serving as a PGY1 research project mentor, and actively pursued research after residency.³²

To improve resident publication success, program directors and project preceptors should encourage completion of research during residency. They should be aware of local, state, regional, and national opportunities for peer-reviewed publication. The *American Journal of Health-System Pharmacy (AJHP) Residents Edition* is an opportunity for residents to submit results of research and quality improvement projects and is an example of a journal that may have favorable peer-review standards for the type and quality of research commonly performed by residents.

Limitations

First, our study may not be generalizable to residency programs outside of the Great Lakes Region; however, this is the first time this research question has been addressed and covers a variety of residency programs across six states. Second, our study assesses abstracts from

2003, 2005, and 2007 in order to ensure we are able to capture post-residency publications; however, our estimates may not reflect more recent changes in practice. Third, we used only one database to identify publications as some publications may not be indexed in Scopus®. Scopus has excellent author searching capabilities and was proven to be 99% in a recent Japanese study.²⁸ Fourth, we may not be able to identify post-residency publications in projects where the author changed the last name; to overcome this, we searched co-investigators to assess if there are co-authors on future papers. Many journals suggest incorporating ORCID (Open Researcher and Contributor ID) to submitted manuscripts. ORCID is a registry that can provide a unique identifier, which will remain the same with name changes, that can be queried in future studies.³⁶ Fifth, we were unable to determine if these were PGY-1 versus PGY-2 resident abstracts which may impact the rate of post-resident publication; moreover, a resident presenting their PGY-1 residency project and may be influenced by PGY-2 residency training which is unable to be captured with our project. Sixth, in our analysis we were unable to describe the role of the resident in subsequent publication as we collected all publications and could not evaluate just one. We were also unable to determine the significance of the author order (i.e., is last author the senior author or the author with the least amount of contribution) as institutions may have different methods to determine this.³⁷ Seventh, we are limited on the accuracy of using H-Index as a marker of co-investigator quality as not all publications are indexed in Scopus®; however, it is likely better than publication counts as the H-Index may be a better marker of quality publications. Eighth, we were unable to search for academic affiliation in non-published post-residency projects; therefore, we were limited to comparing academic affiliations in post-residency projects only. More post-residency publications were in authors with an academic affiliation compared to those without an academic affiliation. When comparing number of publications within five year of the abstract presentation, there was no difference in the median number of publication for authors with or without an academic affiliation; however, our study is likely underpowered to detect this difference if one exists.

CONCLUSION

Pharmacy residents who published their resident research project presented at GLPRC were twice as likely to publish within five years compared to pharmacy resident who did not publish their resident research project. Having a university-affiliated residency is associated with post-residency publication success within five year of the resident abstract presentation. However, several other unmeasurable factors may have influenced publication success as well.

Acknowledgments

Funding: This study was supported by Washington University Institute of Clinical and Translational Sciences grant UL1 TR000448 from the National Center for Advancing Translational Sciences.

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Figure 1.
Search Strategy for Post-Residency Publication and Co-Author Characteristics

Figure 2.
Search Engine Author Search

Table 1

Characteristics from Resident Abstract

	Post-Residency Project Publication (+)(n=55)	Post-Residency Project Publication (-)(n=97)	P-Value
Residency Research Publication – n (row %)			<0.001
Positive	38 (50.0)	38 (50.0)	
Negative	17 (22.4)	59 (77.6)	
Residency Type – n (row %)			<0.001
University-Affiliated	45 (56.3)	35 (43.8)	
Non-University Affiliated	10 (13.9)	62 (86.1)	
Number of Co-Investigators – median (IQR)	2 (1–3)	2 (1–3)	0.498
Physician Co-Investigator	14 (43.8)	18 (56.3)	0.316
Highest on H-Index (non-MD) – median (IQR)	5 (3–9)	2 (0–7)	0.004
H – Index (non-MD) – n (row%)			0.002
0	6 (15.4)	33 (84.6)	
1 or more	49 (43.4)	64 (56.6)	

IQR= interquartile range

Table 2

Post-Residency Publication Success – Incorporating Highest Non-Physician H-Index

	Univariate – OR (95% CI)	P-Value	Multivariate – OR (95% CI)
Publication of Residency Project	3.47 (1.72–7.01)	0.001	2.86 (1.31–6.25)
University-Affiliated Residency Program	7.63 (3.43–16.96)	<0.001	6.72 (2.93–15.42)
Number of Co-Investigators	1.01 (0.77–1.33)	0.443	---
Physician Co-Investigator – n (Row %)	1.50 (0.68–3.32)	0.316	---
Highest on H-Index (non-physician) – median (IQR)	1.07 (1.00–1.14)	0.038	1.01 (0.94–1.10)

Table 3

Post-Residency Publication Success – Incorporating Any Publication Success of Co-Investigators

	Univariate – OR (95% CI)	P-Value	Multivariate – OR (95% CI)
Publication of Residency Project	3.47 (1.72–7.01)	0.001	2.76 (1.28–5.98)
University-Affiliated Residency Program	7.63 (3.43–16.96)	<0.001	5.89 (2.52–13.76)
Number of Co-Investigators	1.01 (0.77–1.33)	0.443	---
Physician Co-Investigator – n (Row %)	1.50 (0.68–3.32)	0.316	---
H – Index 1 or greater (non-physician)	4.2 (1.64–10.85)	0.017	1.92 (0.67–5.52)