The Impact of a Scholarly Concentration Program on Medical Student Research in Pediatrics

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ABSTRACT

Introduction: To promote scientific inquiry, medical schools encourage medical students to participate in scholarly concentration programs (SCP). Manuscript publishing, a proxy of productivity, enhances medical student understanding of scientific inquiry. To evaluate an elective medical SCP offered between the first two years of medical school, the pediatrician authors' primary aim was to study the publishing productivity of the program participants in the University of Wisconsin (UW) School of Medicine and Public Health Department of Pediatrics compared to other departments. Secondary aims were to study whether productivity was influenced by the following predictors: (1) self-identified medical student gender, (2) working with a frequent mentor, (3) mentor degree, (4) funding source, and (5) area of research.

Methods: PubMed joint publications from 2002 through 2017 were searched using both medical student and mentor names through 2 years post-graduation.

Results: From all UW School of Medicine Public Health departments, 1108 medical students self-selected projects and mentors. One hundred two (9.2%) students chose the Department of Pediatrics. The majority of these students were female (61%) compared to female medical student participation (42%) in other departments ($P = 0.0004$). The majority of projects were clinical (53%), with basic science (26%) and public/global health (21%) following, though with more public/global health projects chosen in the Department of Pediatrics ($P = 0.002$) versus other departments. Overall, frequent mentors improved publication rates (P=0.0008), though frequent mentors ($P = 0.45$) and publication rates ($P = 0.60$) did not differ between pediatrics and other departments.

Conclusions: Medical students' SCP manuscript productivity benefitted from working with frequent mentors, but productivity in the Department of Pediatrics did not differ from other departments.

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INTRODUCTION

Scholarly concentration programs (SCP) are offered to medical students with the goal of benefiting from: (1) faculty mentoring experience, (2) scholarly knowledge and skills gained in scientific methodology, and (3) communication of scholarly research.[1] SCPs vary between elective to mandatory and a summer project to a 4-year longitudinal project.[2-5] A critical aspect of SCPs is medical student and faculty mentor collaboration on the project.

Data from the Association of American Medical Colleges indicate that medical student participation in scholarly endeavors is increasing.[6] Both allopathic and osteopathic medical schools have deemed SCPs beneficial to medical students,[7] and school administrations encourage participation as supported by the US medical schools' national accreditation body, the Liaison Committee on Medical Education.[8,9] SCPs are found to influence medical students' decisions for both clinical specialty and future careers in academic medicine, while improving medical student research and dissemination skills through conference presentations and manuscript publications.[1,10] Participating medical students tend to value goals that lead to both skill acquisition (ie, learning the process of manuscript writing) and accomplishments (ie, manuscript publication).[3] With this knowledge, evaluating the factors that play a role in manuscript publication can provide guidance to SCPs, medical students, and faculty mentors.

Successful SCPs require strong mentorship and administrative

support.[2] Mentorship from faculty and more senior medical students can benefit junior medical students.[11] Substantial mentor resources have been recommended to promote physician scientist training,[2] with strategies to provide optimal SCP administrative and financial support currently under discussion nationally.[5] SCPs allow medical student participation in different research fields and disciplines. Clinical/translational fields, as well as public/global health (PGH), are particularly critical to child health. Medical students' participation in child health research may promote academic research careers in pediatrics. Little is understood, however, about how SCP project selection and productivity in pediatrics differs from other departments.

In 2002, the University of Wisconsin School of Medicine and Public Health (UWSMPH) allopathic undergraduate medical education organized and offered an 8- to 12-week SCP fellowship for interested single-degree MD students in the summer between the first two years of medical school. The elective SCP fellowship participation increased from 17% of medical students in 2002 to 63% of medical students in 2017.

Our objective was to better understand factors influencing scientific manuscript publication as a proxy to better understanding the impact of SCPs on medical student research in the University of Wisconsin School of Medicine and Public Health (UWSMPH) Department of Pediatrics (DoP) and other departments in the summer SCPs during 2002-2017. Our primary aim was to study the dependent variable of manuscript publication from SCP medical students who choose the DoP versus other departments. Secondary aims examined the impact of these independent predictors on manuscript publication in pediatrics versus other departments: (1) self-identified medical student gender, (2) working with a frequent mentor, (3) mentor degree, (4) funding source, and (5) area of research.

METHODS

Scholarly Concentration Program

The Institutional Review Board (IRB) quality improvement tool determined IRB review was not required because, in accordance with federal regulations, the project does not constitute research as defined under 45 CFR 46.102(d). Potential project ideas submitted by UWSMPH faculty mentors were offered to medical students. Medical students either self-selected these projects or generated their own projects and mentorship from any UWSMPH faculty member. Medical students and mentors further developed their proposal and applied for SCP grant funding. Departmental or Medical Student Research Committee faculty then reviewed projects and either accepted or suggested revision before acceptance. After summer SCP completion, all participating medical students were expected to submit a research abstract for presentation (poster or podium) at an annual medical student research forum the next semester. Medical students were not required to submit manuscripts.

Dataset

We reviewed data from a prospectively collected cumulative SCP dataset with medical student enrollment from 2002 through 2017. In addition to self-identified medical student gender and area of research, we collected from proposals primary mentor department and mentor's primary/secondary degrees, including MD, PhD, master's degrees, and combinations of the aforementioned. We then grouped mentors (1) into a single MD degree group, (2) into a MD-masters group, and (3) those with MD-PhD or single PhD into a PhD group. We combined the PhD and MD-PhD mentored students into one group because: (1) research training was more extensive in these mentors than other groups, (2) the PhD mentor group was the smallest group. If missing, we collected mentor degrees from departmental websites. We defined frequent mentors as mentoring more than 3 medical students in the SCP before the current student, because it was the geometric mean of mentee/mentor in the dataset, while also ensuring that the mentor had experience with the SCP and had previous experience working with medical students. Each mentor, however, was only identified once, regardless of number of mentees within the time period. We collected specific funding sources for each medical student in the SCP, including the Herman and Gwen Shapiro Foundation, predoctoral training grants, mentor grants, and departmental-supported funding. From the student's proposal title, we demarcated the SCP projects into either clinical, basic science, or PGH fields (categorized by authors AB and PK).

Dependent Variables

We determined the dependent variables of any and first author joint research publication through a PubMed search that included any publications jointly authored by both primary mentor and medical student for a duration that included the year of the SCP fellowship until 2 years after student medical school graduation (5-year window). We did not include publications with a different mentor either before or during the 5-year window. The final PubMed search occurred on June 20, 2020, after medical students enrolled in the summer 2017 SCP graduated. We discriminated students as either first author or any author. We chose this discrimination because we assumed as first author, the student contributed more significantly to the work, whereas if the student was listed elsewhere in the author order, the contribution may be less significant. We analyzed publications within the 5-year window for 898 medical students, 4-year window for 87 medical students, and 3-year window for 114 medical students.

Data Analysis

Data were analyzed by STATA 15 (StataCorp, LLC, College Station, Texas). We observed a natural inflection point with relatively higher student participation in 2010 and demarcated both an early 2002-2009 and a late 2010-2017 student epoch to deter-

Table 1. Comparisons of Self-identified Medical Student Gender, Frequent Mentorship, Mentor Degree, Type of Funding, and Type of Research in the Department of Pediatrics vs Other Departments

Variable	Subvariable	N (%)	DoP MS n (%)	Other Dept MS n (%)	χ^2	Cramer's V	*P* value
Self-identified MS gender		1108 (100%)	102 (9%)	1006 (91%)	13.31	-0.11	0.0004
	Female	485 (44%)	62 (61%)	423 (42%)			
	Male	623 (56%)	40 (39%)	583 (58%)			
Frequent mentor >3 mentees		360 (33%)	37 (36%)	321 (32%)	0.76	0.026	0.45
Mentor degree					14.04	0.0611	0.2
	MD only	609 (55%)	58 (57%)	551 (55%)			
	MD + Master's	167 (15%)	16 (16%)	151 (15%)			
	PhD ± MD	332 (30%)	28 (27%)	304 (30%)			
Had training grant		118 (11%)	5 (5%)	113 (11%)	4.03	-0.06404	0.07
Type of research					14.07	0.1134	0.002
	Clinical	582 (53%)	41 (40%)	542 (54%)			
	Basic science	288 (26%)	25 (24%)	264 (26%)			
	Public/global health	233 (21%)	36 (36%)	197 (20%)			

Abbreviations: DoP, Department of Pediatrics; MS, medical student.

mine if publication rates changed over time with χ^2 and Cramer's V to estimate effect size. Because 4 authors are affiliated with the DoP, we compared data in pediatrics to other departments. We defined any publication and any first author publication as the 2 categorical dependent variables. χ^2 testing and Cramer's V were used to estimate effect size. We did not model interactions between independent and dependent variables by multivariable logistic regression because the test of independence showed that multiple variables were not independent from frequent mentorship. A P value < 0.05 was deemed significant.

RESULTS

Demographic Characteristics

From 2002 through 2017, 1108 of approximately 2800 enrolled medical students (40%) participated in SCP fellowship projects, with 415 individual primary mentors. The ratio of female/male medical students was higher in pediatrics than in other departments ($P = 0.0004$) (Table 1). Most medical students (n = 1025, 93%) selected projects within clinical departments: 490 students (48%) chose medical and 539 students (52%) chose surgical specialties. The Department of Internal Medicine supported the largest percentage of medical students (n = 308, 28%), followed by the departments of general surgery (n = 236, 21%), orthopedics (13%), and pediatrics (9%).

Of primary mentors, we identified 358 (86%) as frequent (>3 mentees). Selection of frequent mentors in pediatrics did not differ from other departments (Table 1). Mentor degrees or funding sources did not differ between the DoP and other departments (Table 1). However, for the DoP, the ratio of medical students who chose PGH research was higher than in other departments ($P = 0.002$) (Table 1).

Joint Publications With Mentor: Primary Aim

In the later epoch of the program (2010-2017), both any publication (36.7% vs 23.5%, $\chi^2 = 12.8$, Cramer's V = 0.11, $P < 0.0001$)and first author publication rates were higher (18.4% vs 9.8%, $\chi^2 = 8.8$, Cramer's V = 0.089; $P = 0.003$) as compared to the earlier epoch. In the whole cohort, we found that 380 medical students (34%) in the SCP fellowship produced a joint manuscript with their summer project mentor, including 186 (17%) as first authors. Overall, any or first author joint publication rates did not differ between self-identified male and female medical students (Table 2). Rates of any and first author publications were higher with frequent mentors, mentors with a single MD degree, and training grants, with effect size greatest with training grants (Table 2). Publication rates did not differ by type of research ($P = 0.057$) but differed slightly ($P = 0.041$) by first author (Table 2).

Joint Publications With DoP Mentor vs Other Departments: Secondary Aims

The joint publication rate for any and first author publications in the DoP did not differ from other departments based on gender, frequent mentorship, mentor degree, mentor training grant, or type of research ($P > 0.05$ for all comparisons) (Table 3).

DISCUSSION

Over time, graduation surveys from UWSMPH, as well as summary data from United States medical schools, report rising rates of research participation by medical students during medical training.[6] It is important to better understand what makes concentrated SCPs effective in both enhancing medical school education and opening up career opportunities. We found that publication rates were higher in the later cohort, perhaps due to organized training grants, more experienced mentors, and maturation of training resources within the departments and school-sponsored fellowship programs. Previous work found that publication productivity increased after better-defined SCP expectations, along with increased financial and administrative support.[4] In the current study, training grants showed the largest effect size, followed closely by both frequent mentorship and the mentor having a single MD degree, although frequent mentorship was not independent from training grants and mentor degree. While research in the Department of Pediatrics exhibited some differences from

other departments, with relatively greater rates of PGH research and more female students, publication rates were comparable.

Reported publication rates in SCPs for other medical schools range from 5% to 75%, with 45% on average for any publication and one-third as first author.[2,4,12-15] The publication rate of 34% in our study may be lower than average because we only searched PubMed (and residency applications generally include papers not indexed on PubMed[16]), and because we examined only medical student-mentor collaborations, excluding publications with other mentors who were not within the SCP fellowship. We searched PubMed for 2 years after medical student graduation to allow for (1) project maturation, (2) medical students participating in research electives during their fourth year, and (3) delays in submission-to-publication. In support of our strategy, it was previously found that two-thirds of manuscripts listed as "submitted" or "in press" in radiology electronic residency applications were published 2 years post-graduation.[17]

Scientific writing is beneficial by engaging students in the research process apart from clinical care, providing in-depth learning about a singular interest, and increasing skills in interpreting the medical literature. Medical students report improved self-efficacy in research methodology and communication of study findings following completion of a SCP fellowship.[18] Writing in a field of interest promotes both collaboration and contacts and, thus, career mentorship. Many medical school graduates report that SCP both influenced career choice and ongoing interest in the project's topic,[1] especially because our projects were self-selected. In addition, medical students participating in clinical research are more likely to enter residencies in that specialty, though it is unclear if the choice of residency influenced the research area or vice versa.[19,20]

Physician-scientist numbers are declining.[21] Early exposure to SCP fellowships or specific research experience increases a medical students' interest in entering an academic career.[10,12,14] Three aspects of medical student research previously were found to be associated with an intent for career-long research: (1) SCP satisfaction, (2) female medical students gender, and (3) publication rates.[14,22] Publishing SCP projects may be a potential strategy to increase the physician-scientist workforce,[14] especially with relatively less emphasis on research than volunteerism for acceptance to medical schools.[23] Pediatric-specific data support this, with about 58% of already published medical students publishing during residency compared to only one-third during residency if they did not publish as a medical students.[24,25]

SCP publication rates have not previously been shown to differ based on sex, consistent with our findings.[26] Our study noted there was increased female medical student participation in pediatric research compared to male medical students, consistent with a greater proportion of female physicians in the field of pediatrics. However, publication rates did not differ among self-identified gender in medical students participating in SCP overall or between the DoP and other departments, despite the overall differences in

Table 2. Overall Whole Cohort Rates of Medical Student Any and First Author Publication by Self-identified Medical Student Gender, Frequent Mentorship, Mentor Degree, Type of Funding, and Type of Research

Publication	Variable	Overall N (%)	χ^2	Cramer's V	*P* value
	Self-identified MS gender	485 female, 623 male			
Any[a]	Female	32%	1.97	0.04	0.16
Any[a]	Male	36%			
1st[b]	Female	16%	0.31	0.017	0.31
1st[b]	Male	23%			
	Mentorship	360 frequent, 749 infrequent			
Any[a]	Frequent	57%	11.44	0.102	0.001
Any[a]	Infrequent	31%			
1st[b]	Frequent	24%	17.90	0.127	0.0001
1st[b]	Infrequent	14%			
	Mentor degree	MD only 609, MD + Master 167, PhD ± MD 332			
Any[a]	MD only	39%	13.94	0.112	0.001
Any[a]	MD + Masters	32%			
Any[a]	PhD ± MD	36%			
1st[b]	MD only	19%	9.61	0.093	0.008
1st[b]	MD + Masters	7%			
1st[b]	PhD ± MD	13%			
	Funding	118 training, 990 no training			
Any[a]	Training grant	50%	15.04	0.114	0.0001
Any[a]	No training grant	32%			
1st[b]	Training grant	33%	25.39	0.152	0.0001
1st[b]	No training grant	15%			
	Type of Research	583 clinical, 288 basic science, 233 public/global health			
Any[a]	Clinical	38%	5.74	0.072	0.057
Any[a]	Basic science	30%			
Any[a]	Public/global ealth	31%			
1st[b]	Clinical	19%	6.37	0.076	0.041
1st[b]	Basic science	13%			
1st[b]	Public/global health	16%			

Abbreviation: MS, medical student.
[a]Rate of any publication between medical student and mentor.
[b]Rate of first author publication between medical student with mentor.

Table 3. Rates of Any and First Author Publications Based on Self-identified Medical Student Gender, Frequent Mentor, Mentor Degree, Use of Training Grant, and Type of Research Between Department of Pediatrics Medical Students and Other Departments

Variable	Authorship	Category	Dept of Pediatrics n (%)	Other Departments n (%)	χ^2	Cramer's V	*P* value
Publication Rate	Any[a]		38 (37.3%)	380 (34.1%)	0.43	0.020	0.52
	1st[b]		16 (15.6%)	186 (16.9%)	0.11	0.010	0.74
Self-identified medical student gender			62 female, 40 male	423 female, 583 male			
	Any[a]	Female	38.7%	31.1%	1.43	0.054	0.23
	Any[a]	Male	35.0%	36.3%	0.03	0.0065	0.63
	1st[b]	Female	17.7%	15.9%	0.13	0.017	0.72
	1st[b]	Male	12.5%	17.7%	0.73	0.034	0.39
Frequent mentors >3 mentees			37 frequent, 65 infrequent	321 frequent, 685 infrequent			
	Any[a]	Frequent	48.6%	40.0%	0.91	0.050	0.35
	Any[a]	Infrequent	30.7%	31.0%	0.002	0.0016	0.97
	1st[b]	Frequent	13.5%	24.9%	2.41	0.082	0.12
	1st[b]	Infrequent	16.9%	13.2%	0.69	0.030	0.41
Mentor degree			58 MD only, 16 MD+Master's, 28 PhD ± MD	551 MD only, 151 MD+Master's, 304 PhD ± MD			
	Any[a]	MD only	41.4%	38.7%	0.16	0.016	0.67
	Any[a]	MD+Masters	31.3%	32.5%	0.01	0.0076	0.92
	Any[a]	PhD±MD	32.1%	26.5%	0.41	0.035	0.53
	1st[b]	MD only	17.2%	19.3%	0.150	0.016	0.70
	1st[b]	MD+Masters	19.8%	12.5%	0.50	0.269	0.48
	1st[b]	PhD±MD	11.3%	16.6%	0.22	0.026	0.64
Mentor training grant			2 yes, 100 no	102 yes, 902 no			
	Any[a]	Yes	40.0%	50.9%	0.23	0.044	0.63
	Any[a]	No	37.1%	31.9%	1.065	0.033	0.30
	1st[b]	Yes	20.0%	33.9%	0.41	0.060	0.52
	1st[b]	No	15.4%	14.8%	0.026	0.005	0.87
Type of research			41 clinical, 25 basic science, 36 public/global health	201 clinical, 76 basic science, 62 public/global health			
	Any[a]	Clinical	39.0%	37.5%	0.04	0.008	0.85
	Any[a]	Basic Science	45.8%	29.0%	2.96	0.102	0.09
	Any[a]	Public/global health	30.5%	31.5%	0.012	0.007	0.91
	1st[b]	Clinical	19.5%	19.4%	0.0003	0.0007	0.97
	1st[b]	Basic Science	12.0%	12.5%	0.001	0.002	0.99
	1st[b]	PGH	13.9%	16.2%	0.13	0.023	0.72

[a]Rate of any publication between medical student and mentor
[b]Rate of first author publication between medical student with mentor.

gender participation between pediatrics and other departments.

Publication rates were improved overall among medical students who worked with frequent mentors. The increased exposure in frequent mentors to SCP and to medical student researchers may explain this higher rate of publications. Other confounders such as faculty member productivity, rank, and academic track, were not collected or included in analysis but may influence medical student productivity. It is unclear if frequent mentors were overall more productive (as defined by publication rate), had a higher rank, or were on different research tracks that may have tilted the publication rates in favor of the frequent mentors.

In this study, most mentors held single MD degrees. Higher publication rates were seen among mentors with a single MD degree than those with more than one degree or a PhD. Although the reason for this finding is unclear and was not reported in previous SCP cohorts, many medical student projects studied existing datasets, which may publish at higher rates than other pilot projects or preliminary basic science. Our SCP guidelines supported research projects with scholarly methodological approaches, including systematic reviews and scholarly quality projects.

Publication rates were increased overall if the medical student had a training grant from their mentor, though no differences were noted between the DoP and other departments. The infrastructure and requirements for a training grant may push more medical students toward publishing, as evident in our findings. The lack of differences between pediatrics and other departments

suggest that the training grant opportunities exist in all departments providing improved resources for medical students to publish their work.

Interestingly, there was a higher percentage of medical students participating in PGH research in the DoP than in other departments, though no difference in publication rates were noted. This difference in project selection is not well understood, though could be related to a general pediatric focus on public health policy and improving the care of all children.

Strengths of this study include a large, growing SCP in a medical school with strong research infrastructure and support systems. There are a few weaknesses, however. Although annual data were collected prospectively, some data points were missing. Data were limited by less granularity about student experience, including our inability to track presentations from regional or national meetings. We did not track name changes or preferred name for manuscripts, potentially leading to underrepresenting manuscripts from medical students who changed their last name between the SCP fellowship and eventual manuscript publication. While medical students self-identified their gender on the survey, options at the time of dataset origination were only binary and not inclusive of transgender or nonbinary individuals. Additionally, mentors did not self-select gender data on the fellowship application and, thus, medical student and mentor gender was not compared. The definition of frequent mentorship did not include potential mentorship of other medical trainees, such as residents and/or fellows, and, therefore, could be underestimating a mentor's experience with medical trainees.

CONCLUSIONS

Having a structured and funded SCP summer fellowship facilitated medical student and mentor participation in research. Overall, training grants and frequent mentors improve publication rates--often a desired medical student outcome of the SCP fellowship. Identifying and supporting improved faculty mentorship may allow for the improved mentorship of medical students, leading to increased productivity and publications. Financial resources and administrative support going towards this faculty mentoring has the potential to increase the likelihood that faculty mentors may be willing to work with more and more students. Relatively more women medical students select pediatrics projects, including more PGH projects, but medical students in the Department of Pediatrics publish at rates comparable to other departments.

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