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Longitudinal Outcomes of Medical Student Research Mentorship: a 15-Year Analysis of the Radiation Oncology Mentorship Initiative

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Abstract

At our institution, students can be mentored by radiation oncology faculty through structured research programs, such as the Medical Student Summer Research Program (MSSRP). The purpose of this study is to report the research productivity of students who engaged in radiation oncology research mentorship, whether through the MSSRP or other avenues of research mentorship. We compiled a database of abstracts and manuscripts co-authored by 58 students who conducted research with radiation oncology faculty from 2005 to 2020. The means, medians, ranges, and interquartile ranges (IQR) of co-authorships and first authorships were calculated for the overall cohort and compared for MSSRP and non-MSSRP students, who matched into radiation oncology and those who did not, and male versus female students. Among all 58 students, 106 abstracts and 70 manuscripts were identified. Of those students, 54 (93.1%) published at least one abstract or manuscript. The mean number of abstract co-authorships per student was 3.07 (median 2, range 0–25, IQR 0–4), and the mean number of manuscript co-authorships per student was 2.22 (median 1, range 0–18, IQR 1–3). There were no significant differences in research output between MSSRP and non-MSSRP students or male and female students. However, the students who matched into radiation oncology published more co-author (3.67 vs. 1.63, $p=0.01$) and first-author (1.62 vs. 0.53, $p=0.006$) manuscripts than those who did not. Further research is warranted to assess whether skills gained from student-directed research translate into residency and beyond.

Keywords Formal research mentorship · Medical student mentorship · Summer research program · Research productivity

Introduction

Mentorship has traditionally been described as a dyadic relationship between the more seasoned mentor and less experienced mentee, in which the mentor supports the professional growth of the mentee [1, 2]. Throughout this relationship, the mentor assumes several roles, including teacher, coach, counselor, and supervisor [2]. In academic medicine, mentorship has been widely described as a significant driver of personal development, career selection, and research productivity [3]. Furthermore, several studies have shown greater research productivity among faculty who report having had mentors, as quantified by metrics such as number of publications, h-index, and time spent on research [4–6].

Within the field of radiation oncology, several studies have emphasized the need for more mentors and formal mentorship programs for junior faculty and residents [6–10]. However, published data on medical student mentorship are comparatively lacking [11–13]. As a dynamic and technology-driven field, radiation oncology benefits from an increased number of research-oriented physicians. Thus, research involvement is often cited as an important selection factor for matching into radiation oncology [14]. While the student receives valuable guidance in a mentor–mentee relationship, the faculty mentor often achieves increased academic productivity and personal gratification [15]. As such, mentoring medical students in research is mutually beneficial and should be encouraged.

As part of the Radiation Oncology Mentorship Initiative (ROMI) at our institution, medical students can be mentored

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in research by radiation oncology faculty through a summer research program or outside of the summer program [11]. The Medical Student Summer Research Program (MSSRP) is an institutionally funded 7- to 10-week experience available to medical students between their first and second years that pairs students with a faculty mentor from any department of their choice to conduct research. Students are selected based on a research proposal submitted months in advance, and generally, around one or two students choose to conduct research with radiation oncology faculty per year. Through this program, students participate in required lectures and workshops designed to promote essential research skills, such as communication, data management, and manuscript preparation. Furthermore, students are required to present a poster at an annual in-house research symposium at the conclusion of the program. Medical students also have the option of taking 4-week Cancer Research Elective rotations in their third and fourth years in which they are similarly expected to work with a chosen research mentor on a project. However, these electives and non-MSSRP mentorship opportunities are more informal in that there are fewer requirements, thus allowing the mentee more flexible to work at their own pace. As such, the goals and expectations from the mentoring relationship are more so driven by the mentee.

The primary aim of this study is to investigate research productivity and career choice of students who engaged in radiation oncology mentorship over the past 15 years at our institution. We report several univariate analyses comparing the research output of the MSSRP and non-MSSRP cohorts, those who matched into radiation oncology and those who matched into other fields, as well as male and female students.

Methods

We retrospectively reviewed all publications, consisting of abstracts (including oral and poster presentations) and manuscripts, co-authored by 58 (16 MSSRP and 42 non-MSSRP) students who were mentored by radiation oncology faculty at our institution from 2005 to 2020. The non-MSSRP group includes those who were enrolled in either the 4-week Cancer Research Elective or other extracurricular research mentorships. We searched radiation oncology faculty curriculum vitae as well as PubMed to identify publications with student authors. The criteria for inclusion in our analysis are journal publications or conference abstracts, published either during or after medical school, with at least one student co-author and at least one radiation oncology faculty mentor at our institution. Because all MSSRP students are required to present a poster at an institutional annual research symposium, we excluded posters that were presented here to prevent systematic bias when comparing the MSSRP and non-MSSRP groups. Undergraduate students, Master's students, medical students from outside institutions, and residents who have conducted research within our department were also excluded from the analysis.

Data were collected on abstracts and manuscripts co-authored by students and authorship positions of students. For each student, we counted how many publications they authored, specifically how many times they were co-author, and how many times they were the first author. For those in our cohort who already graduated from medical school, we also looked at whether or not students matched into radiation oncology residency programs. Students' post-graduate career choices were found by referencing our institution's internal National Residency Matching Program (NRMP) records. This study was determined to be exempt by our Institutional Review Board.

Statistical Analysis

The means, medians, standard deviations (SD), ranges, and interquartile ranges (IQR) of co-authorships and first authorships were calculated for the overall, MSSRP, and non-MSSRP cohorts and were compared using Wilcoxon-Mann–Whitney tests. Fisher's exact tests were used to compare the distribution of authorships between MSSRP and non-MSSRP cohorts, using cutoffs of students with 0, 1, and ≥ 2 publications. Similar analyses were performed to look for differences between radiation oncology and non-radiation oncology groups and between male and female students. Statistical computations were performed on SAS 9.4 system (SAS Institute, Cary, NC). All tests were two-sided, and a p value of < 0.05 was considered statistically significant.

Results

All Students

Among all 58 students, 106 unique abstracts and 70 unique manuscripts have been presented or published as of December 1, 2020. Of the 106 abstracts, 76 (71.7%) had a student as the first author, while out of the 70 manuscripts, 51 (72.9%) had a student as the first author. Furthermore, 61 (57.5%) abstracts had one student author, while 45 (42.5%) abstracts had two or more student authors. Forty (57.1%) manuscripts had one student author, while 30 (42.9%) had two or more student authors. Out of the 58 students, 54 (93.1%) published at least one abstract or manuscript. Six (10.3%) students published at least one abstract but no manuscripts, 11 (19.0%) published at least one manuscript but no abstracts, and the remaining 37

(63.8%) published both abstracts and manuscripts. In addition, several of the students who have not yet published have a manuscript in preparation. At the time of this analysis, there were approximately ten manuscripts with student co-authors that were accepted and pending publication, submitted and under review, or in progress. As they were not yet published, they were not included in this analysis.

The mean number of abstract co-authorships per student was 3.07 (median 2, SD 4.34, range 0–25, IQR 0–4), and the mean number of manuscript co-authorships per student was 2.22 (median 1, SD 2.85, range 0–18, IQR 1–3) (Table 1). Additionally, the mean number of abstract first authorships per student was 1.31 (median 1, SD 1.67, range 0–7, IQR 0–2), and the mean number of a manuscript first authorships per student was 0.88 (median 0, SD 1.26, range 0–6, IQR 0–1) (Table 1).

The distributions of abstract and manuscript co-authorship positions are shown in Fig. 1.

MSSRP vs. Non-MSSRP

Among 16 MSSRP students, there were a total of 51 abstract co-authorships and 34 manuscript co-authorships. Among 42 non-MSSRP students, there were a total of 127 abstract co-authorships and 95 manuscript co-authorships. The MSSRP students produced 19 first-author abstracts and 8 first-author manuscripts, while the non-MSSRP students produced 57 first-author abstracts and 43 first-author manuscripts.

Table 1 presents the analysis of MSSRP vs. non-MSSRP cohorts. There was no significant difference in the mean number of abstract co-authorships, manuscript co-authorships, abstract first authorships, and manuscript first authorships comparing MSSRP to non-MSSRP students. MSSRP

Table 1 Analysis of MSSRP vs. non-MSSRP cohorts

	Overall $N=58$	MSSRP $N=16$	Non-MSSRP $N=42$	p^*
	Mean (SD) Median (IQR)			
Abstract co-authorships	3.07 (4.34)	3.19 (4.13)	3.02 (4.47)	0.951
	2 (0–4)	2 (1–3)	2 (0–4)	
Manuscript co-authorships	2.22 (2.85)	2.13 (2.42)	2.26 (3.02)	0.632
	1 (1–3)	1 (0.5–3.5)	1 (1–3)	
Abstract first authorships	1.31 (1.67)	1.19 (1.80)	1.36 (1.64)	0.572
	1 (0–2)	1 (0–1.5)	1 (0–2)	
Manuscript first authorships	0.88 (1.26)	0.50 (0.89)	1.02 (1.35)	0.139
	0 (0–1)	0 (0–1)	1 (0–2)	
	n (column %)			
Abstract co-authorships				
0	15 (25.9)	3 (18.8)	12 (28.6)	0.560
1	10 (17.2)	4 (25.0)	6 (14.3)	
2 or more	33 (56.9)	9 (56.3)	24 (57.1)	
Manuscript co-authorships				
0	10 (17.2)	4 (25.0)	6 (14.3)	0.619
1	23 (39.7)	6 (37.5)	17 (40.5)	
2 or more	25 (43.1)	6 (37.5)	19 (45.2)	
Abstract first authorships				
0	23 (39.7)	7 (43.8)	16 (38.1)	0.871
1	17 (29.3)	5 (31.3)	12 (28.6)	
2 or more	18 (31.0)	4 (25.0)	14 (33.3)	
Manuscript first authorships				
0	31 (53.5)	11 (68.8)	20 (47.6)	0.423
1	14 (24.1)	3 (18.8)	11 (26.2)	
2 or more	13 (22.4)	2 (12.5)	11 (26.2)	

Abbreviations: *MSSRP* Medical Student Summer Research Program; *N* number; *SD* standard deviation; *IQR* interquartile range

p values are for MSSRP vs. non-MSSRP comparison

*Group differences in continuous variables were tested using the Wilcoxon-Mann–Whitney test, and group differences in categorical variables were tested using the Chi-square test (or Fisher's exact test)

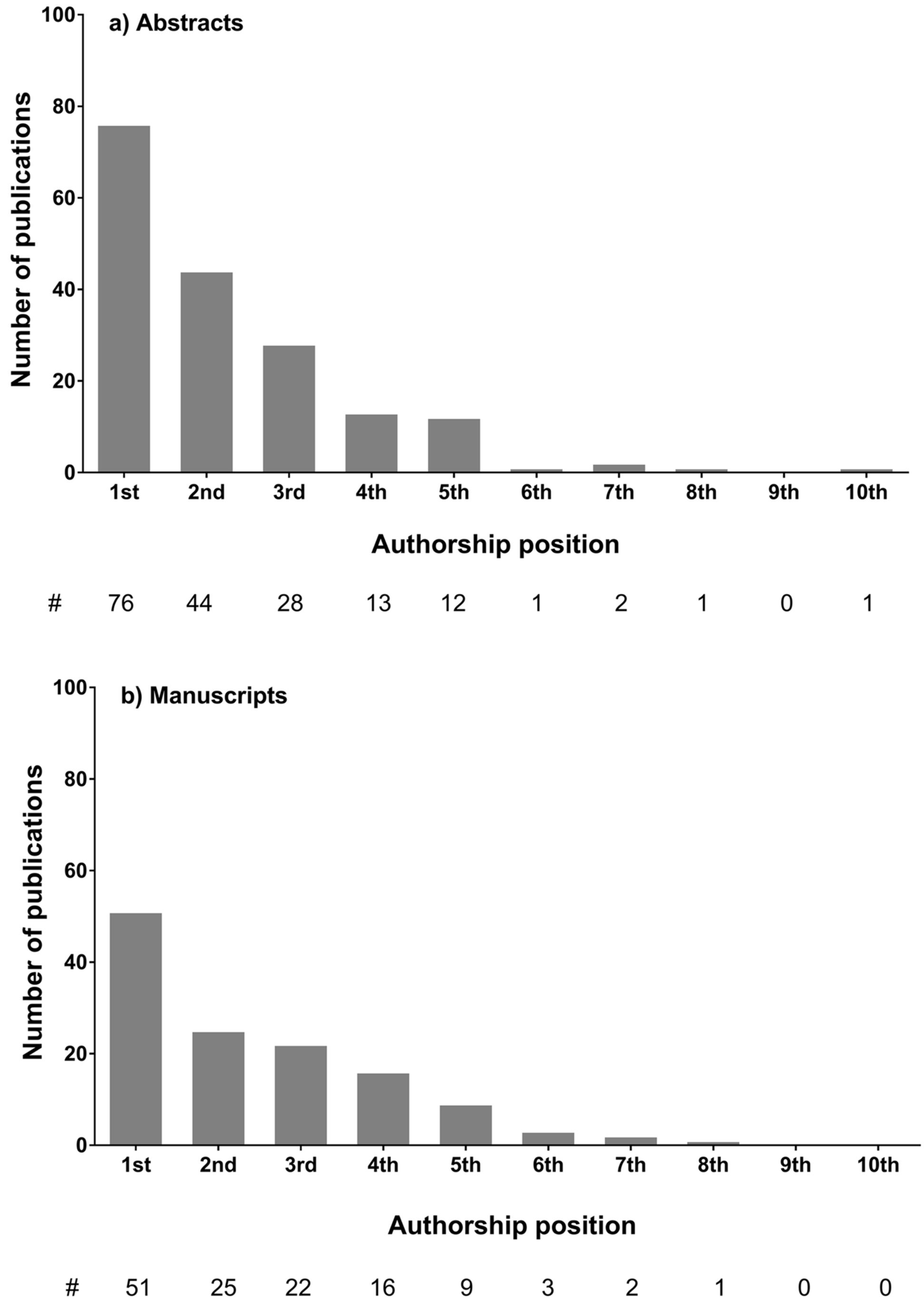

Fig. 1 Distributions of co-authorship positions for abstracts and manuscripts among all students

students produced an average of 2.13 (SD 2.42, median 1, IQR 0.5–3.5) manuscript co-authorships, whereas non-MSSRP students produced an average of 2.26 (SD 3.02, median 1, IQR 1–3) manuscript co-authorships ($p = 0.63$, Table 1).

The Chi-square analysis performed after grouping students based on whether they had 0, 1, 2, or more authorships is also presented in Table 1. Of MSSRP students, 37.5% had 2 or more manuscript co-authorships, and 45.2% of non-MSSRP students had 2 or more manuscript co-authorships ($p = 0.62$, Table 1).

Career Choice

Among the 51 students (10 MSSRP and 41 non-MSSRP) who have graduated, the top three specialties that students matched into were radiation oncology with 21 (41.2%) students, internal medicine with 9 (17.6%) students, and radiology with 6 (11.8%) students. The overall distribution is summarized in Fig. 2.

Radiation Oncology vs. Non-radiation Oncology

Since 2005, 26 students have matched into radiation oncology from our institution. Out of these 26 students, 21 (80.8%) conducted research with a faculty mentor at our institution. The data on co-authorships and first authorships among the 21 radiation oncology and 30 non-radiation oncology students who participated in radiation oncology research are summarized in Table 2. The 7 current medical students who have not yet matched into residency programs were excluded.

There was a statistically significant difference in the mean number of manuscript co-authorships among radiation oncology students (mean 3.67, SD 3.98, median 3, IQR 1–5) and non-radiation oncology students (mean 1.63, SD 1.52, median 1, IQR 1–2) ($p = 0.01$, Table 2). Similarly, the number of manuscripts first authorships among radiation oncology students (mean 1.62, SD 1.56, median 2, IQR 0–3) was significantly different from the number of manuscripts first authorships among non-radiation oncology students (mean 0.53, SD 0.86, median 0, IQR 0–1) ($p = 0.006$, Table 2). The differences in number of abstract co-authorships and first authorships were not statistically significant.

The Chi-square analysis comparing radiation oncology vs. non-radiation oncology cohorts is also presented in Table 2. While 71.4% of radiation oncology students had 2 or more manuscript co-authorships, only 33.3% of non-radiation oncology students had 2 more manuscript co-authorships ($p = 0.006$, Table 2).

Male vs. Female

Out of the 58 students mentored in research by radiation oncology faculty at our institution, 35 (60.3%) were male and 23 (39.7%) were female. Overall, there was no significant difference in the mean number of abstract co-authorships, manuscript co-authorships, abstract first authorships, and manuscript co-authorships. Table 3 summarizes the data on co-authorships and first authorships between male and female cohorts, including the Chi-square analysis.

Discussion

In this study, we examined the impact of formal research mentorship on research output and career choice among medical students at our institution. Studies on mentorship within radiation oncology have focused on mentorship of residents or junior faculty rather than medical students [11–13]. Holliday et al. surveyed 158 academic radiation oncologists, of which 96 (60.8%) reported having had a mentor, and out of the respondents with mentors, the majority started their mentoring relationship either during residency or during their first 5 years as faculty (43.8% and 40.6%, respectively). Having a mentor in radiation oncology was also found to correlate with increased publications, citations, and h- and m-indices [6]. Sayan et al. showed that residents who participated in a formal mentorship program had much higher rates of overall satisfaction with the mentorship experience compared to those who did not (90% vs. 9%, $p < 0.001$) [10]. While the benefits of mentorship for radiation oncology residents and junior faculty have been previously established, the goal of our analysis was to assess the advantages of formal mentorship at an earlier stage of

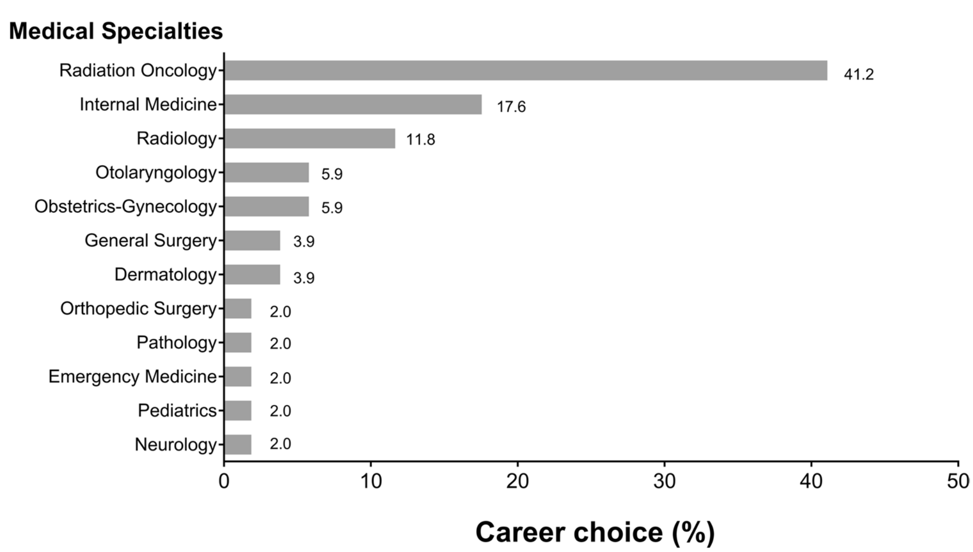

Fig. 2 Distribution of matched specialties among all students

Table 2 Analysis of radiation oncology vs. non-radiation oncology cohorts

	Radiation oncology $N = 21$	Non-radiation oncology $N = 30$	p^*
	Mean (SD) Median (IQR)		
Abstract co-authorships	4.71 (6.02)	2.37 (2.92)	0.165
	3 (1–4)	1.5 (0–4)	
Manuscript co-authorships	3.67 (3.98)	1.63 (1.52)	0.014
	3 (1–5)	1 (1–2)	
Abstract first authorships	2.0 (1.97)	1.03 (1.45)	0.051
	2 (0–3)	1 (0–1)	
Manuscript first authorships	1.62 (1.56)	0.53 (0.86)	0.006
	2 (0–3)	0 (0–1)	
	n (column %)		
Abstract co-authorships			
0	4 (19.1)	8 (26.7)	0.279
1	2 (9.5)	7 (23.3)	
2 or more	15 (71.4)	15 (50.0)	
Manuscript co-authorships			
0	3 (14.3)	3 (10.0)	0.006
1	3 (14.3)	17 (56.7)	
2 or more	15 (71.4)	10 (33.3)	
Abstract first authorships			
0	6 (28.6)	13 (43.3)	0.101
1	4 (19.1)	10 (33.3)	
2 or more	11 (52.4)	7 (23.3)	
Manuscript first authorships			
0	7 (33.3)	18 (60.0)	0.001
1	3 (14.3)	10 (33.3)	
2 or more	11 (52.4)	2 (6.7)	

Abbreviations: *N* number; *SD* standard deviation; *IQR* interquartile range

*Group differences continuous variables were tested using the Wilcoxon-Mann–Whitney test, and group differences in categorical variables were tested using the Chi-square test (or Fisher's exact test)

Table 3 Analysis of male vs. female cohorts

	Male $N = 35$	Female $N = 23$	p^*
	Mean (SD) Median (IQR)		
Abstract co-authorships	3.80 (5.26)	1.96 (2.03)	0.279
	2 (1–4)	1 (0–3)	
Manuscript co-authorships	2.69 (3.40)	1.52 (1.50)	0.181
	2 (1–4)	1 (1–2)	
Abstract first authorships	1.51 (1.95)	1.0 (1.09)	0.537
	1 (0–2)	1 (0–2)	
Manuscript first authorships	1.03 (1.48)	0.65 (0.78)	0.695
	0 (0–2)	0 (0–1)	
	n (column %)		
Abstract co-authorships			
0	8 (22.9)	7 (30.4)	0.520
1	5 (14.3)	5 (21.7)	
2 or more	22 (62.9)	11 (47.8)	
Manuscript co-authorships			
0	6 (17.1)	4 (17.4)	0.232
1	11 (31.4)	12 (52.2)	
2 or more	18 (51.4)	7 (30.4)	
Abstract first authorships			
0	13 (37.1)	10 (43.5)	0.869
1	11 (31.4)	6 (26.1)	
2 or more	11 (31.4)	7 (30.4)	
Manuscript first authorships			
0	19 (54.3)	12 (52.2)	0.587
1	7 (20.0)	7 (30.4)	
2 or more	9 (25.7)	4 (17.4)	

Abbreviations: *N* number; *SD* standard deviation; *IQR* interquartile range

*Group differences continuous variables were tested using the Wilcoxon-Mann–Whitney test, and group differences in categorical variables were tested using the Chi-square test (or Fisher's exact test)

a prospective radiation oncologist's career, during medical school.

Through our analysis, we evaluated research mentorship in both the MSSRP and non-MSSRP cohorts. There were no statistically significant differences in research output between the two groups. It is worth noting that MSSRP students start working with radiation oncology faculty mentors early between their first and second years, often continuing their research throughout medical school, whereas the non-MSSRP students may have started research with radiation oncology mentors anywhere between their first and fourth years. Furthermore, the MSSRP is more structured than other mentorship programs in that all students are required to attend educational didactics and to present their research at an annual in-house symposium. One additional advantage of the MSSRP is that research is often conducted with the guidance of more senior medical students. Connecting junior medical students with senior medical students allows for collaboration and informal mentorship between peers. Despite their differences, both forms of research mentorship involve regular meetings between mentor and mentee as well as the shared motivation for eventual publication, which we believe are essential components to the success of any research mentorship program.

In a separate analysis, we divided students based on whether they pursued and matched into radiation oncology residency programs or not. On average, the students who matched into radiation oncology had statistically higher numbers of first-author and co-author manuscripts in comparison to students who matched into other fields.

This difference likely reflects both the increased motivation to publish among students who choose to pursue radiation oncology and the influence of prior research experience as a selection criterion for matching into radiation oncology [14]. Another potential explanation is that students who matched into other fields may be more likely to have published research supervised by non-radiation oncology faculty, leading to publications that would not have been included in this analysis.

It is not surprising that the most represented specialty among student matches in our analysis was radiation oncology (41.2%). However, it is also worth noting the significant number of students who pursued other specialties (58.8%), and it is likely that for many of them, their publications in radiation oncology may have helped them match into their intended field. Research promotes skills such as critical thinking, accurate interpretation of scientific data, and ability to synthesize findings, all skills that are desirable by residency programs across numerous specialties [16–18]. Furthermore, through our experience, collaboration in research has the additional benefit of creating mentorship relationships between senior medical students and junior medical students. In a study of a longitudinal scholarly research program at another institution, Conroy et al. showed that a significantly greater proportion of students with peer-reviewed publications matched to higher National Institutes of Health (NIH) funding ranked residency programs ($p = 0.02$) [19]. This highlights that increased research productivity often leads to improved match outcomes for medical students.

Prior research on the effectiveness of medical student research programs has mostly focused on assessing research skills or career interests through pre-program and post-program surveys [20, 21]. Cain et al. surveyed students who participated in the MSSRP at their institution and showed that 75% of students became more interested in research and 85% of students could better understand research methodology through the MSSRP [20]. In a study of a medical student radiology research program, Shah et al. showed that both students' perceived knowledge of radiology as a specialty and their perceived knowledge of research skills increased through their participation in the program ($p = 0.02$ for both) [21]. These studies provide additional evidence for the benefits of formal research mentorship, including the development of research skills and interest in research-oriented careers. In context, our results complement the above by establishing that students also have excellent research output due to their participation in formal research programs.

There are several limitations to our study that are worth noting. First, the results derived from our institution are not generalizable to all institutions. A host of factors such as the general quality of the mentor–mentee relationship, motivation of students to publish, cultural approaches toward mentoring, and availability of research funding may affect research productivity and career choice. While most students' research resulted in peer-reviewed publication, there were four (6.9%) students who did not publish any abstracts or manuscripts. Also, the retrospective data collection involved in this study does not include non-indexed abstracts or manuscripts that have not been recorded in faculty curriculum vitae, PubMed, or ResearchGate, which may have led to underreporting of publications. Furthermore, our analysis does not include a true control group. Nonetheless, we hope that the outcomes from formal medical student research mentorship at our institution will encourage future research and implementation of similar programs at other institutions.

Conclusions

In this 15-year analysis, we report on the research productivity of students mentored by radiation oncology faculty at our institution. No statistically significant differences in research output were observed based on gender or type of research program. Although our analysis showed that students matching into radiation oncology published more manuscripts, the benefits of research mentorship likely apply to medical students pursuing other fields as well. Further research is warranted to assess whether skills gained from student-directed research translate into residency and beyond.

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Data Availability Research data are stored in an institutional repository and will be shared upon request to the corresponding author.

Code Availability Not applicable.

Declarations

Conflicts of Interest The authors declare no competing interests.

References

1. Sambunjak D, Marusić A (2009) Mentoring: what's in a name? JAMA 302(23):2591–2592. https://doi.org/10.1001/jama.2009.1858
2. Keshavan MS, Tandon R (2015) On mentoring and being mentored. Asian J Psychiatr 16:84–86. https://doi.org/10.1016/j.ajp.2015.08.005
3. Sambunjak D, Straus SE, Marusić A (2006) Mentoring in academic medicine: a systematic review. JAMA 296(9):1103–1115. https://doi.org/10.1001/jama.296.9.1103
4. Shollen SL, Bland CJ, Center BA, Finstad DA, Taylor AL (2014) Relating mentor type and mentoring behaviors to academic medicine faculty satisfaction and productivity at one medical school. Acad Med 89(9):1267–1275. https://doi.org/10.1097/ACM.0000000000000381

5. Reid MB, Misky GJ, Harrison RA, Sharpe B, Auerbach A, Glasheen JJ (2012) Mentorship, productivity, and promotion among academic hospitalists. J Gen Intern Med 27(1):23–27. https://doi.org/10.1007/s11606-011-1892-5
6. Holliday EB, Jagsi R, Thomas CR, Wilson LD, Fuller CD (2014) Standing on the shoulders of giants: results from the Radiation Oncology Academic Development and Mentorship Assessment Project (ROADMAP). Int J Radiat Oncol Biol Phys 88(1):18–24. https://doi.org/10.1016/j.ijrobp.2013.09.035
7. Ko HC, Kimple RJ (2018) The resident individual development plan as a guide for radiation oncology mentorship. Int J Radiat Oncol Biol Phys 101(4):786–788. https://doi.org/10.1016/j.ijrobp.2018.02.153
8. Lalani N, Griffith KA, Jones RD, Spratt DE, Croke J, Jagsi R (2018) Mentorship experiences of early-career academic radiation oncologists in North America. Int J Radiat Oncol Biol Phys 101(3):732–740. https://doi.org/10.1016/j.ijrobp.2018.03.035
9. Engel S, Lischalk JW, Barry P et al (2017) Radiation Oncology Resident Mentorship: results of a resident-coordinated mentorship program. J Am Coll Radiol 14(12):1607–1610. https://doi.org/10.1016/j.jacr.2017.07.011
10. Sayan M, Ohri N, Lee A et al (2019) The impact of formal mentorship programs on mentorship experience among radiation oncology residents from the Northeast. Front Oncol 9:1369. https://doi.org/10.3389/fonc.2019.01369
11 Boyd GH, Rand AE, DeNunzio NJ, Agarwal A, Hirsch AE (2019) The radiation oncology mentorship initiative: analysis of a formal mentoring initiative for medical students interested in radiation oncology. J Cancer Educ. https://doi.org/10.1007/s13187-019-01539-w
12. Hirsch AE, Agarwal A, Rand AE et al (2015) Medical student mentorship in radiation oncology at a single academic institution: a 10-year analysis. Pract Radiat Oncol 5(3):e163-168. https://doi.org/10.1016/j.prro.2014.08.005
13. DeNunzio N, Parekh A, Hirsch AE (2010) Mentoring medical students in radiation oncology. J Am Coll Radiol 7(9):722–728. https://doi.org/10.1016/j.jacr.2010.03.018
14. Sidiqi B, Gillespie EF, Wang C, Dawson M, Wu AJ (2019) Mind the gap: an analysis of "gap year" prevalence, productivity, and perspectives among radiation oncology residency applicants. Int J Radiat Oncol Biol Phys 104(2):456–462. https://doi.org/10.1016/j.ijrobp.2019.02.006
15. Levine MS (2003) The art of clinical research with medical students. Acad Radiol 10(5):527–535. https://doi.org/10.1016/s1076-6332(03)80063-6
16. Mehta K, Sinno S, Thanik V, Weichman K, Janis JE, Patel A (2019) Matching into integrated plastic surgery: the value of research fellowships. Plast Reconstr Surg 143(2):640–645. https://doi.org/10.1097/PRS.0000000000005212
17. Wadhwa H, Shah SS, Shan J et al (2019) The neurosurgery applicant's "arms race": analysis of medical student publication in the Neurosurgery Residency Match. J Neurosurg 1–9. https://doi.org/10.3171/2019.8.JNS191256
18. Campbell ST, Gupta R, Avedian RS (2016) The effect of applicant publication volume on the orthopaedic residency match. J Surg Educ 73(3):490–495. https://doi.org/10.1016/j.jsurg.2015.11.011
19. Conroy MB, Shaffiey S, Jones S et al (2018) Scholarly research projects benefit medical students' research productivity and residency choice: outcomes from the University of Pittsburgh School of Medicine. Acad Med 93(11):1727–1731. https://doi.org/10.1097/ACM.0000000000002328
20. Cain L, Kramer G, Ferguson M (2019) The Medical Student Summer Research Program at the University of Texas Medical Branch at Galveston: building research foundations. Med Educ Online 24(1):1581523. https://doi.org/10.1080/10872981.2019.1581523
21. Shah P, Sheng M, Mankoff DA et al (2019) Impact of early radiology research experiences on medical student perceptions of radiology and research. Curr Probl Diagn Radiol 48(5):423–426. https://doi.org/10.1067/j.cpradiol.2018.05.011