Correlation between research productivity during medical school and radiation oncology residency

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Full Title: Correlation between research productivity during medical school and radiation oncology residency

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ABSTRACT

Purpose:

This analysis investigates whether research productivity during medical school predicts future research productivity during radiation oncology residency.

Methods and Materials:

At our institution, there have been 20 medical students who graduated between 2005 and 2015 and subsequently completed their residency training in radiation oncology. We built a database of all PubMed-indexed publications in which these former students were the first author or co-author. Mean publication rates with 95% confidence intervals (95% CI) were computed. The paired t-test and McNemar-Bowker test of symmetry were used to examine differences in first-author and co-author publications between the medical school and residency periods. An ordinal logistic regression model was employed to measure the odds ratio (OR) of publishing during residency versus during medical school. A Spearman correlation coefficient was calculated for the relationship between the number of publications during medical school and the number during residency.

Results:

A total of 14 and 60 first-author publications (46 and 117 co-author publications) were identified for 20 individuals during medical school and residency, respectively. There was an average of 0.7 (95% CI 0.17-1.23) first-author publications during medical school and 3.08 (95% CI 1.56-4.44) first-author publications during residency (P = .003). Only 15% (3/20) had ≥2 publications during medical school, while 50% (10/20) had ≥2 publications during residency (P = .012). The Spearman correlation coefficient between research publications before and during residency was

.457, *P* = .043. The mean number of co-author publications during medical school and residency were 2.3 (95% CI 0.92-3.68) and 5.85 (95% CI 3.50-8.20), respectively, *P* = .004.

Conclusions:

Based on this retrospective analysis from our institution, student research productivity during medical school, as defined by the number of first-author publications, does correlate with future research productivity during radiation oncology residency.

INTRODUCTION

Scholarly pursuits represent a core component of radiation oncology training, as most US radiation oncology residency programs provide residents with protected time to conduct research. Specifically, 98% of radiation oncology programs in the US offer protected research time, with a median overall duration of 10 months.[1] The development of research tracks, such as the Holman Pathway or the Duke Radiation Oncology Research Scholar (RORS) program, along with the field's relatively large proportion of MD/Ph.D. graduates, further attest to the importance of conducting research during residency to lay the foundation for successful academic careers in radiation oncology.[2–4]

Several past studies have attempted to quantify the research productivity of US radiation oncology residents on a national scale. Morgan et al. showed that between 2002 and 2007, US radiation oncology residents produced an average of 1.01 peer-reviewed first-author publications during their four years of training.[5] In recent years, that number has increased considerably, as Verma et al. found that the 2014 and 2015 graduating classes of US radiation oncology residents produced an average of 2.0 first-author publications.[6] The most recent study by Rowley et al.

reported a mean of 2.90 first-author manuscripts among US radiation oncology residents who graduated between 2015 and 2019.[7] These numbers may help serve as a national benchmark for assessing research productivity among radiation oncology residents and training programs.

Several analyses across various specialties outside of radiation oncology have demonstrated that prior research productivity may predict research productivity during residency.[8–10] However, this question has not yet been explored in the context of radiation oncology, despite its emphasis on research. Thus, this study aims to determine whether research productivity before residency, i.e., during medical school, could predict future research productivity during radiation oncology residency. We hypothesized that a given individual's number of publications during medical school would be correlated with the number of publications during residency. The primary outcome of this study examined this correlation for first-author publications only, whereas the secondary outcome analyzed all peer-reviewed publications, including co-authorships.

METHODS AND MATERIALS

At our institution, there have been 20 medical students who graduated between 2005 and 2015 and subsequently completed their residency training in radiation oncology, graduating between 2010 and 2020. We created a database of all PubMed-indexed publications in which these former students were the first author. For this analysis, the medical school period was defined as the four years preceding medical school graduation (starting from July 1) plus the six months following medical school graduation (until December 31 of the first postgraduate year) to account for publications that were completed during medical school but not yet published. Similarly, the residency period was defined as the period from the start of radiation oncology

residency (July 1 of the second postgraduate year) to six months after residency graduation (December 31 of the residency graduation year). To further increase the accuracy of our search, publication lists were cross-referenced with any publicly available online sources, such as ResearchGate. This study was determined to be exempt by our Institutional Review Board.

Statistical Analysis

Demographic characteristics, including gender, research year, and MD/Ph.D. status, were summarized using descriptive statistics. The normality of the difference in the number of publications between medical school and residency was tested using the Shapiro-Wilk test. The test was insignificant for differences in both first-author and co-author publications. The results are therefore presented as mean and 95% confidence intervals (95% CI). The paired t-test compared the differences in first-author and co-author publications between the medical school and residency periods. Student's t-test was used to assess for differences in first-author publications during residency by first-author publication status during medical school.

Each radiation oncologist was categorized as having 0, 1, or ≥2 publications during medical school and/or residency. To compare the two paired groups with 3 categories, the generalized McNemar-Bowker test of symmetry was used. An ordinal logistic regression model was employed to measure the odds ratio (OR) of publishing during residency versus during medical school. A Spearman correlation coefficient was calculated for the relationship between the number of publications during medical school and the number during residency. 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

Demographic Characteristics

Out of the 20 graduates included in this analysis, 15 (75%) were male, and 5 (25%) were female. Overall, 3 (15%) were MD/Ph.D., 3 (15%) underwent a research year, and the remaining 14 (70%) completed medical school in four years without a research year or Ph.D. degree.

First-author publications

The 20 graduates from our institution produced a total of 14 and 60 first-author publications during medical school and radiation oncology residency, respectively. The mean number of first-author publications during the medical school period was 0.7 (95% CI 0.17-1.23), and the mean number of first-author publications during the residency period was 3.08 (95% CI 1.56-4.44), P = .003. Only 15% (3/20) had 2 or more publications during medical school, while 50% (10/20) had 2 or more publications during residency, P = .012.

The average number of first-author publications during residency among those who published at least once during medical school was 5.13 (95% CI 2.46-7.79), while the average number of first-author publications among those who did not publish prior to residency was 1.58 (95% CI; 0.24-2.92), P =0.008 (data not shown in Tables). Furthermore, residents with one or more medical school publications were about 15 times more likely to publish at least once during residency (OR 15.15; 95% CI 1.46-156.7), P = .023 (**Table 1**).

Figure 1 graphically compares average first-author publications in the medical school and residency periods. **Figure 2** plots the distribution of publications during the medical school and residency periods. The Spearman correlation coefficient of .457 suggests a positive monotonic relationship between medical school and residency publications, P = .043.

Co-author publications

The 20 graduates from our institution produced a total of 46 and 117 co-author publications during medical school and radiation oncology residency, respectively. The mean number of co-author publications during the medical school period was 2.3 (95% CI 0.92-3.68), and the mean number of co-author publications during the residency period was 5.85 (95% CI 3.50-8.20), $P = .004$. Only 35% (7/20) had 2 or more co-author publications during medical school. There was a positive but non-significant correlation (Spearman correlation coefficient of .388) between medical school and residency co-author publications, $P = .091$. Complete results are presented in **Table 2**.

DISCUSSION

We found a positive correlation between medical school and radiation oncology residency first-author publications in our study cohort. Compared to residents with no first-author publications, those who published at least one first-author manuscript during medical school were approximately 15 times more likely to publish a first-author manuscript during residency. The mean number of first-author publications during residency was 3.08, comparable to the most recent national benchmark of 2.90, as published by Rowley et al.[7] Overall, our findings suggest that first-author publications during medical school may serve as a predictor for future research productivity during radiation oncology residency.

Similar investigations have been conducted across other medical specialties, including orthopedic surgery, otolaryngology, and plastic surgery.[8–10] Wright-Chisem et al. found that among orthopedic surgery residents at two US academic institutions, the number of publications

produced before residency was positively correlated with the number of publications produced during residency (Pearson correlation .363, $P < .001$).[8] Among Canadian otolaryngologists, Kohlert et al. found that otolaryngology residents who had at least one publication prior to residency were nearly six times more likely to publish at least once during residency (OR 5.85; 95% CI 2.7-12.7, $P < .0001$). They also observed a positive correlation between the number of publications before and during residency (Spearman correlation .472, $P < .0001$).[9] It is widely known that medical students applying to competitive specialties often would take an additional research year or more (beyond the four-year medical school curriculum) to build their research portfolios and increase the odds of matching to their desired specialty.[2,8,10] Applebaum et al. found that compared to US plastic surgery residents who took no research years during medical school, those who took one or two research years published significantly more during residency ($P < .001$).[10]

Within the field of radiation oncology, there is abundant literature on the topic of resident research productivity.[4–7,11–13] However, literature that addresses whether prior research productivity during medical school predicts future productivity during residency is relatively sparse. Gutovich et al. conducted a survey-based study to identify predictors of radiation oncology resident research productivity and, in doing so, found that the amount of designated research time during residency was the sole determinant of first-author papers during residency ($P < .01$), while participation in the Holman Pathway was the sole predictor of research grants awarded during residency ($P < .001$).[13] Although they reported a borderline significant correlation between first-author publications prior to residency and grants received during residency ($P = .06$), they did not specifically comment on whether first-author publications prior

to residency correlated with first-author publications during residency. To our knowledge, our study is the first to establish this correlation in radiation oncology.

It is not surprising that research productivity during medical school is commonly cited as an important selection factor for matching into radiation oncology, as it is a highly research-oriented field.[2,14,15] Jang et al. found that on multivariate analysis, alpha-omega-alpha (AOA) honor society status (P = .0033), participating in a research year (P = .001), and the number of journal publications (P = 0.047) significantly correlated with higher rates of interview invitations. Huang et al. showed that the number of first-author publications was associated with matching to a higher-tier residency program based on Doximity rankings for program reputation.[14] As a field that has traditionally emphasized clinical excellence and scholarly innovation, radiation oncology may benefit from recruiting more candidates with strong backgrounds in research. At our institution, the Radiation Oncology Mentorship Initiative connects medical students with radiation oncology faculty and provides opportunities for both formal and informal research mentorship.[15–18] Our study demonstrates that the number of first-author manuscripts published during medical school could be useful for assessing an applicant's potential research output during residency.

Several limitations must be noted. First, this is a single-institution study with a small sample size of 20. In this cohort, there was an even smaller population of MD/Ph.D. or research year students, so we could not account for these factors with any meaningful statistical significance. Second, it is possible that individuals who published more during medical school matched to residency programs with more dedicated research time and more research infrastructure support or funding for research, leading to greater publication numbers during residency. This would not have been accounted for in our analysis. Third, authors who may have

published under a different name, e.g., if they changed their last name during residency, may have publications not included in this analysis. Similarly, any publications published after our specified time range or not searchable in PubMed would not have been included. Lastly, the quantity of research publications does not equal quality, as it is well-known that basic science projects generally take longer to complete. Simply counting the number of first-author publications may not accurately represent the individual's true research productivity and scientific contribution to the field.

Nonetheless, our study provides a framework for further investigation of research productivity in radiation oncology. This could potentially be applied to evaluate predictors of resident research productivity on a larger national scale, similar to studies by Rowley et al. and Morgan et al.[5,7] Furthermore, it would be worthwhile to investigate how other factors, such as residency program size, protected research time, Holman Pathway, MD/Ph.D. degree, research years, as well as research infrastructure, staffing, and support, may impact research productivity during radiation oncology residency.

CONCLUSIONS

Based on this retrospective analysis from our institution, research productivity during medical school, as defined by the number of first-author publications, has a positive correlation with future research productivity during radiation oncology residency. Medical student research productivity may serve as a useful measure for identifying future research contributions as radiation oncology residents.

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15. XXXX

16. XXXX

17. XXXX

18. XXXX

FIGURE CAPTIONS

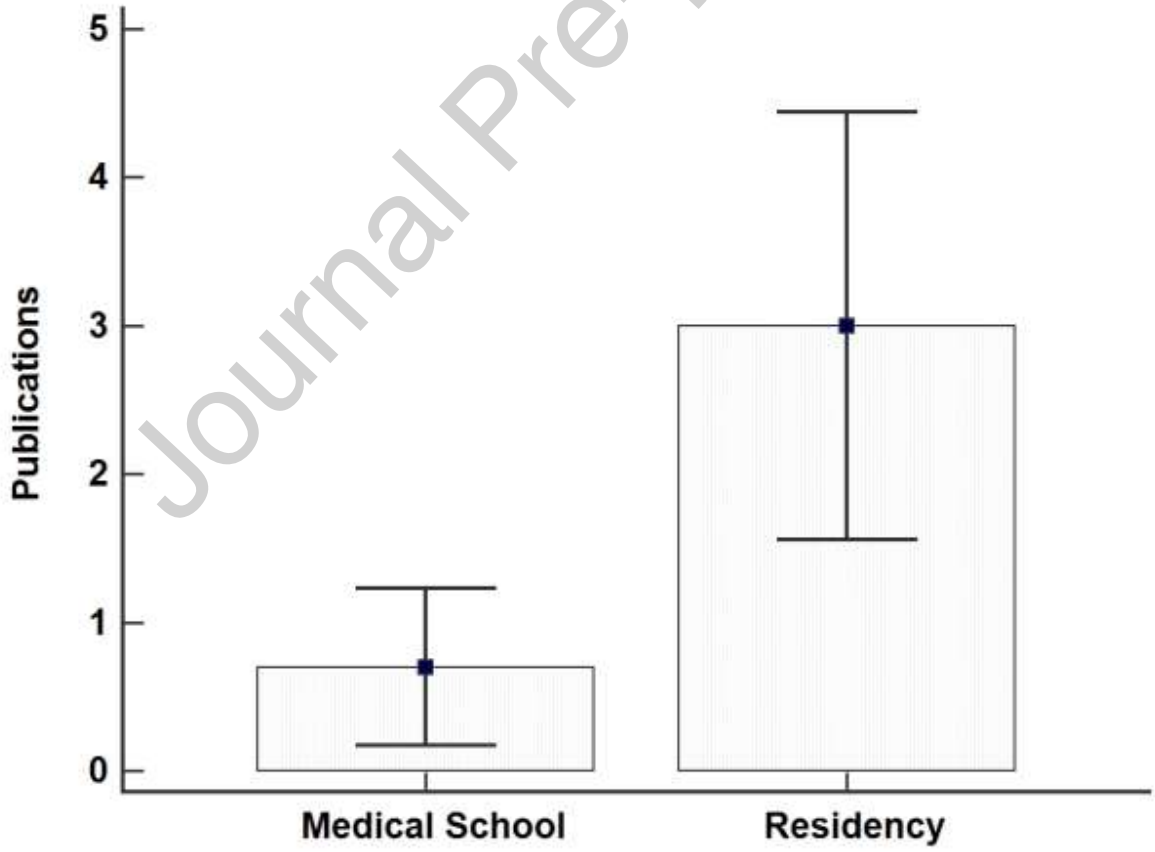

Figure 1. First-author publications during medical school vs. residency

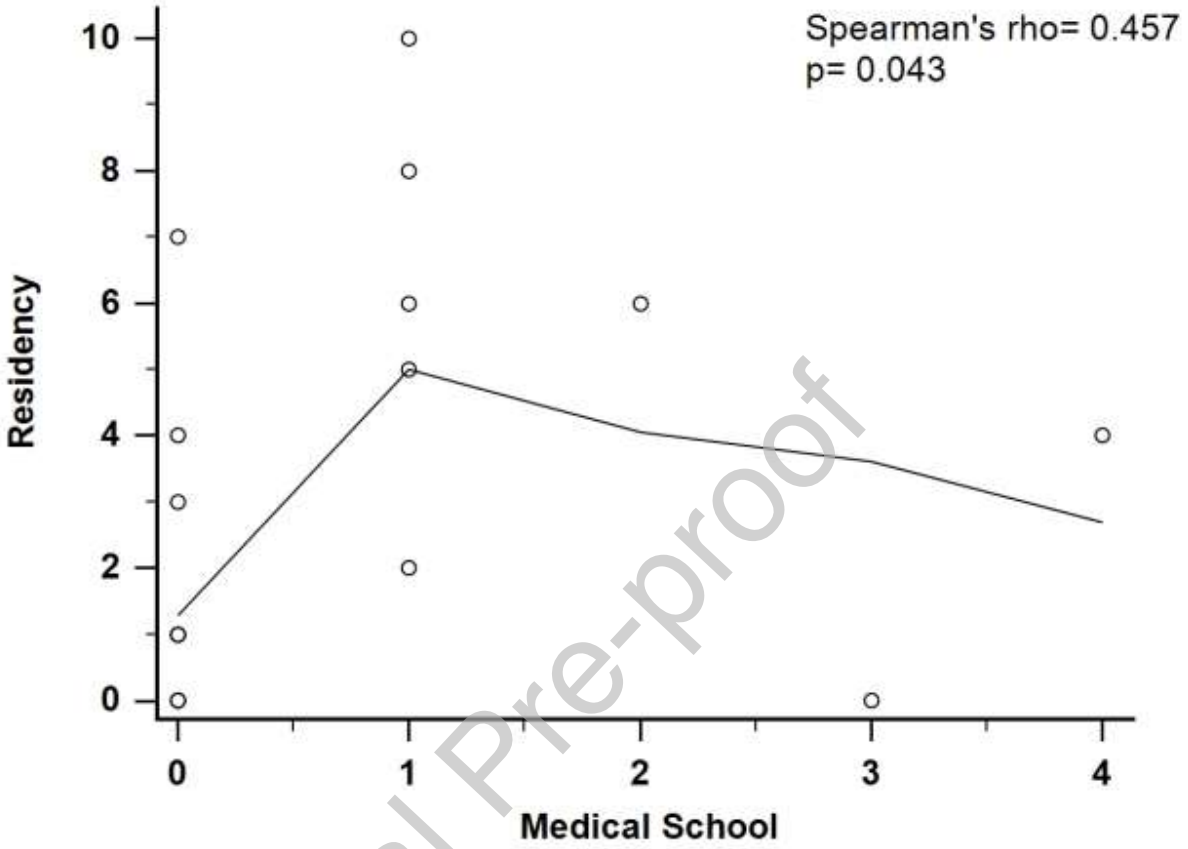

Figure 2. Spearman correlation between first-author publications during medical school vs. residency

Table 1. Analysis of first-author publications during medical school vs. residency

	Medical School N=20	Residency N=20	*P*[*]
Mean (95% CI)	0.7 (0.17-1.23)	3.08 (1.56-4.44)	0.003
	n (column %)		
0	12 (60.0)	5 (25.0)	0.012
1	5 (25.0)	5 (25.0)	
2 or more	3 (15.0)	10 (50.0)	
	OR (95% CI)		
0	Reference		0.023
1 or more	15.15 (1.46-156.70)		

Abbreviations: N= total number; CI= confidence interval; IQR= inter-quartile range; n= number; OR= odds ratio.

[*]Group differences for continuous variables were tested using the paired t-test, and group differences in categorical variables were tested using Bowker's test of symmetry.

Table 2. Analysis of co-author publications during medical school vs. residency

	Medical School N=20	Residency N=20	P^*
Mean (95% CI)	2.3 (0.92-3.68)	5.85 (3.50-8.20)	0.004
	n (column %)		
0	8 (40.0)	2 (10.0)	0.034
1	5 (25.0)	2 (10.0)	
2 or more	7 (35.0)	16 (80.0)	
	OR (95% CI)		
0	Reference		0.115
1 or more	7.49 (0.61-91.58)		

Abbreviations: N= total number; CI= confidence interval; IQR= inter-quartile range; n= number; OR= odds ratio.

*Group differences for continuous variables were tested using the paired t-test, and group differences in categorical variables were tested using Bowker's test of symmetry.

Declaration of interests

☒The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: