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A 15-year Profile of US Radiation Oncology Residency Growth by Geographic Region, Metropolitan Size and Program Size

Mudit Chowdhary, MD, Neilayan Sen, MD, Gaurav Marwaha, MD, Ashley A. Weiner, MD, PhD, Neha Vapiwala, MD, Kirtesh R. Patel, MD, Trevor J. Royce, MD, MS, MPH



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Authors: Mudit Chowdhary, MD¹, Neilayan Sen, MD¹, Gaurav Marwaha, MD¹, Ashley A. Weiner, MD, PhD², Neha Vapiwala, MD³, Kirtesh R. Patel, MD⁴, Trevor J. Royce, MD, MS, MPH²

¹Department of Radiation Oncology, Rush University Medical Center, Chicago, IL, USA

²Department of Radiation Oncology, University of North Carolina School of Medicine, Chapel Hill, NC, USA

³Department of Radiation Oncology, University of Pennsylvania School of Medicine, Philadelphia, PA, USA

⁴Department of Therapeutic Radiology, Yale School of Medicine, New Haven, CT, USA

Corresponding Author

Trevor J. Royce MD MS MPH

Assistant Professor

Department of Radiation Oncology

University of North Carolina at Chapel Hill

101 Manning Drive, CB 7512

Chapel Hill, NC 27599

Office: 984-974-0400

Fax: 984-974-8607

Email: trevor_royce@med.unc.edu

Twitter: @tjroycemd

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Abstract

Purpose: The size and growth of US radiation oncology (RO) residency positions has important implications for the RO workforce. There are no data on residency growth by geographic region, major urban centers, and program size. We aim to fill this gap.

Methods and Materials: A database of all RO programs & positions from 2003-2018 was created using National Resident Matching Program data. Programs were categorized by US Census Bureau geographic region, major metropolitan location (top 10 combined statistical area vs. all other) and program size (small [≤ 6 trainees], medium [7-12] and large [> 12 trainees]). Linear regression with interaction terms was used to determine the effect of region, major metropolitan location, and program size on RO program & position growth over time.

Results: There has been a 69% (54 to 91) & 82% (106 to 193) increase in the number of RO programs & annual positions from 2003-2018. Differences in program & position growth, respectively, was seen in each category. Growth in the Northeast (92% & 83%), South (81% & 113%), and West (125% & 130%) has outpaced the Midwest (17% & 33%). Growth in top 10 metropolitan areas (77% & 92%) is higher than in all other areas (63% & 73%). Growth in medium (68% & 80%) and large (175% & 153%) programs are greater than in smaller (36% & 33%) programs.

Conclusion: There has been a major increase in the number of RO residency programs & positions over the past 15 years. Growth is occurring in every major category but there are differences in magnitude within each category. This information can inform future decisions about RO training programs in the United States.

Introduction

The size and growth of US radiation oncology (RO) residency positions has important implications for the RO workforce. There are no data on RO growth by geography, metropolitan status or program size. The purpose of this report is to fill this gap in the published literature.¹⁻⁴

Methods

A database of RO programs and numbers of positions offered per program from 2003 to 2018 was constructed using publicly available information from the National Resident Matching Program (NRMP)⁵.

Each program was given a geographic, major metropolitan area and program size designation. Geography was defined using US Census Bureau regional (Northeast [NE], South [SO], Midwest [MW], and West [WT]) and subregional (Supplement, Table 1) designations⁶. Programs were considered to be in a major urban, metropolitan location if they are in one of the top 10 US Combined Statistical Areas (CSA) by population (Supplement, Table 2)⁷. Program size was defined as small (≤ 6 trainees), medium (7-12 trainees) or large (> 12 trainees) in any given year based on the cumulative number of available spots over the prior 4 years. This method allows the program size definition to be dynamic by year as programs expand or contract.

Linear regression with categorical-continuous interaction terms were used to determine the effect of region, major metropolitan area and program size on RO program & position growth over time (Supplemental Equations). A p-value less than 0.05 was used to determine statistical significance. Statistical analyses were performed with SAS software (version 9.4; SAS Institute, Cary, NC).

Results

From 2003 to 2018, there has been a 82% & 69% increase in the number of annual offered RO positions (106 to 193) & programs (54 to 91), respectively (**Figure 1**). Tables 1 & 2 show the overall growth in number of residency positions & programs in major subcategories.

The highest and lowest annual program & position percent growth, respectively, were seen in the WT (125% & 130%) and MW (17% & 33%). On subregional analysis, 2 subregions (Middle Atlantic [NE] & Pacific [WT]) accounted for 49% & 43% of all new program and relative position growth (**Supplemental Figure**). Programs & positions in the NE, SO and WT all had higher annual growth rates relative to the MW ($p<0.05$).

There has been a numeric growth in programs (40.7% vs. 42.9%) & positions (47.2% vs. 49.7%) located in the top 10 major metropolitan areas compared to all others from 2003 to 2018. Annual growth rates in RO programs & positions were not statistically different between the major metropolitan locations vs. all others.

The proportion of medium (46.3% to 47.1%) & large (7.4% to 13.8%) programs has increased, while the proportion of small programs has decreased (46.3% to 39.1%) (**Table 2**). Medium and large programs demonstrate a significantly higher annual position growth rate relative to small programs ($p<0.05$).

Supplemental Table 3 shows linear regression analysis with difference in annual RO program & position growth rate based on region, metropolitan size & program size.

Discussion

In this study of US RO residency growth, we found an overall 69% & 82% increase in the number of total RO programs & annual offered positions from 2003-2018. This growth

occurred in all examined categories. We found programs in the MW are growing at slower rates than all other regions. Moreover, subregional analysis showed 2 subregions (Middle Atlantic and Pacific) account for 49% & 43% of all new program & positions, respectively. The top 10 metropolitan areas account for 43% & 50% of programs & annual positions, which are growing at rates equal rates to all other areas combined. Finally, we found that medium & large programs are expanding more rapidly than smaller programs.

These results showing RO residency growth should be interpreted in the context of the current US RO training program climate. In 2019, a decline in applicants led to an unprecedented 30 RO unfilled positions went through the National Residency Matching Program ('The Match')⁸. This appears to be the start of a trend as there has been an even greater decline in 2020 applicants. Fewer applicants has obvious implications for growing programs. Further, considering that graduates tend to practice where they train^{3,9}, the distribution and number of RO training programs has potential implications for the RO workforce. Our data provide a previously undescribed level of granularity to the growth and potential distribution of the RO workforce.

Conclusions

In this study of domestic RO residency growth, we found an increase in residency programs & positions over the past 15 years. Growth is occurring in every major category, but there are differences in magnitude within each category, including (1) Geographic: MW growing at rates slower than other regions, 2) Urban: the major urban areas are growing at equal rates as elsewhere, and 3) Size: larger programs are growing more rapidly than smaller programs. This information can inform future decisions about RO training programs in the United States.

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Figure Legend

Figure 1: Regional growth in programs/year (A) & annual positions/year (B) from 2003 to 2018.

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Table 1 – Characteristics of radiation oncology annual positions by geographic region and major metropolitan area in 2003 and 2018.

	Number of Annual Positions		Percent Growth
Year	2003 (n=106)	2018 (n=193)	82.1%
Geography			
Northeast	29 (27.4%)	53 (27.5%)	82.8%
Midwest	33 (31.1%)	44 (22.8%)	33.3%
South	30 (28.3%)	64 (33.2%)	113.3%
West	14 (13.2%)	32 (16.6%)	129.6%
Major Metropolitan Area			
Yes	50 (47.2%)	96 (49.7%)	92.0%
No	56 (52.8%)	97 (50.3%)	73.2%
Program Size*			
Small (≤ 6 spots)	33 (31.1%)	44 (23.3%)	33.3%
Medium (7-12 spots)	54 (50.9%)	97 (51.3%)	79.6%
Large (>12 spots)	19 (17.9%)	48 (25.4%)	152.6%

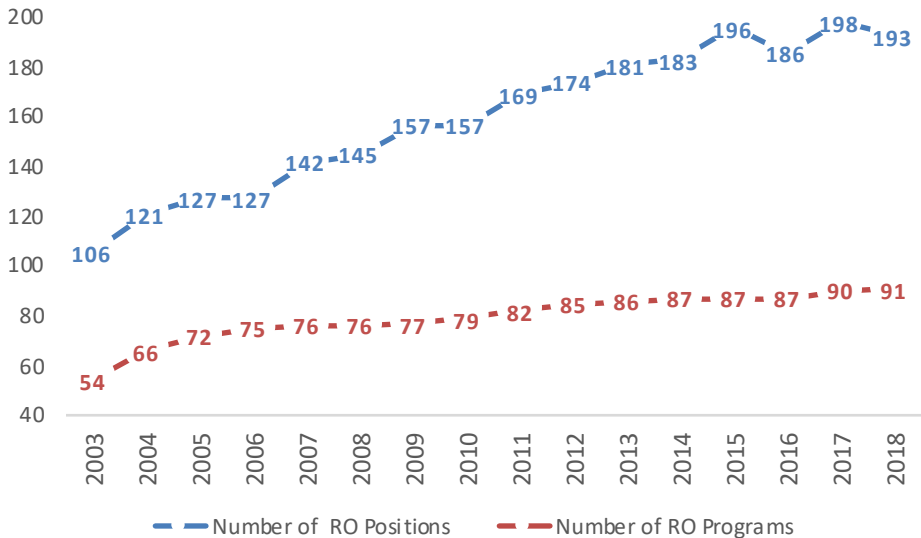
*Program Size: Based on Cumulative Number of Available NRMP Radiation Oncology Resident Spots from 2003-2006 & 2015-2018. Four programs were started after 2015 and were not included in the program size analysis.

Linear Regression Analysis showed statistically significant annual growth rates based on geography (NE, SO, and WT vs MW) and Program Size (Medium & Large vs. Small)

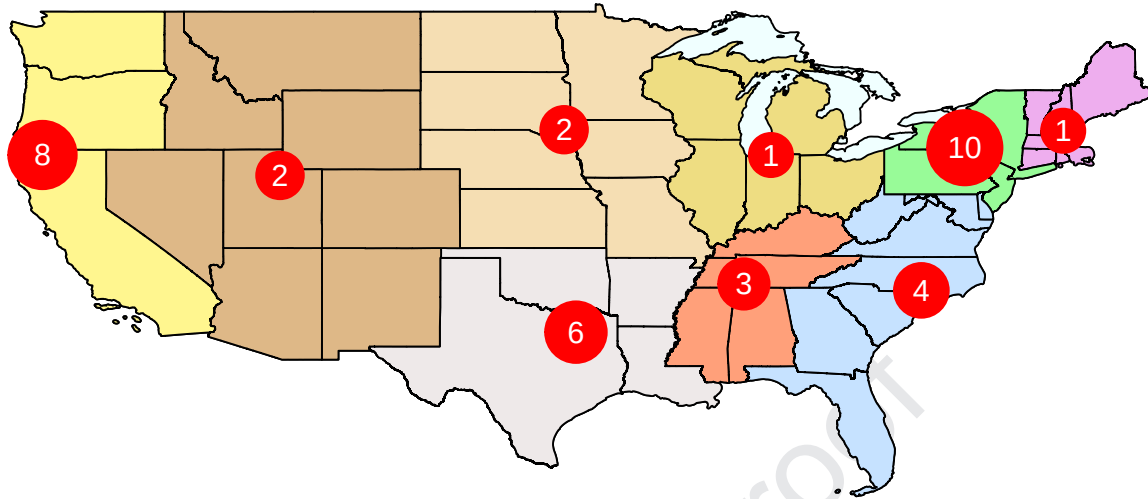
Table 2 – Characteristics of radiation oncology programs by geographic region, major metropolitan area, and program size in 2003 and 2018.

	Number of Programs		Percent Growth
Year	2003 (n=54)	2018 (n=91)	68.5%
Geography			
Northeast	12 (22.2%)	23 (25.3%)	91.7%
Midwest	18 (33.3%)	21 (23.1%)	16.7%
South	16 (29.6%)	29 (31.9%)	81.3%
West	8 (14.8%)	18 (19.8%)	125.0%
Major Metropolitan Area			
Yes	22 (40.7%)	39 (42.9%)	77.3%
No	32 (59.3%)	52 (57.1%)	62.5%
Program Size*			
Small (≤ 6 spots)	25 (46.3%)	34 (39.1%)	36.0%
Medium (7-12 spots)	25 (46.3%)	42 (47.1%)	68.0%
Large (>12 spots)	4 (7.4%)	11 (13.8%)	175.0%

**Program Size: Based on Cumulative Number of Available NRMP Radiation Oncology Resident Spots from 2003-2006 & 2015-2018, Four programs were started after 2015 and were not included in the program size analysis.*



A



B

