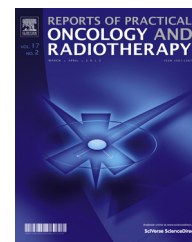




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Original research article

Use of the g-index for assessment of citation-based scholarly activity of United States radiation oncology residents and subsequent choice of academic versus private practice career



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ABSTRACT

Introduction: The Hirsch index (h-index) evaluates citation-based scholarly activity, but has limited ability to acknowledge those publishing a smaller number of manuscripts with exceedingly high citations. The g-index addresses this limitation by assessing the largest number of manuscripts (g) by an author cited at least (g × g) times, but has yet to be applied to radiation oncology resident productivity.

Methods: A list of recent radiation oncology resident graduates (comprising 86% of the 2016 graduating class) and their post-residency career choice was compiled. The Scopus bibliometric citation database was searched to collect and calculate g-index data for each resident.

Results: The mean g-index score for all resident graduates was 7.16. Residents with a PhD had significantly higher g-index scores (11.97 versus 5.80; $p < 0.01$), while there was no statistically significant difference in g-index scores between male and female residents. Residents choosing academic careers had higher g-index scores than those choosing private practice (9.47 versus 4.99; $p < 0.01$). Programs graduating at least three residents produced significantly higher g-index scores/resident than those graduating two residents, and while comprising only 25% of programs and 45% of residents, produced 60% of academic careers ($p < 0.02$).

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Conclusion: Radiation oncology resident graduates published on average a minimum of seven manuscripts cited at least 49 times. PhD-degree graduates had significantly higher g-index scores, as did residents choosing academic over private practice careers. There was no significant gender-related difference in g-index score regardless of career choice. The majority of academic careers are produced from programs graduating at least three residents.

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1. Background

The Hirsch index (h-index) has been increasingly utilized to assess citation-based scholarly activity of physicians and has proven to be strongly associated in radiation oncology with the presence of pre-residency peer reviewed publications and post-residency choice of academic versus private practice career.^{1–4} However, the h-index has limited ability to recognize authors who publish a smaller number of manuscripts but with markedly higher citations.¹ The g-index has been introduced to address this limitation by assessing the largest number of manuscripts (g) by an author which have been cited at least (g × g) times.⁵ For example, an author with 25 citations could have a g-index no higher than the square root of 25, which is five (even if such author had published 15 manuscripts), but could have a g-index lower than five if such author had published fewer than five manuscripts associated with those 25 citations. While the g-index has been applied to other fields of medicine and science, it has yet to be applied to radiation oncology resident productivity.^{6,7}

2. Materials and methods

A list of radiation oncology residents comprising the 2016 graduating class and their initial post-residency career choice (academic versus private practice) was compiled from as previously described, after which the Scopus bibliometric citation database was searched eight months after graduation to collect and calculate g-index data for each resident.^{4,8} Demographics included and statistical analyses were performed as previously reported.⁴ IRB approval was not required for this study.

3. Results

For all resident graduates, the mean g-index score was 7.16 ± 6.38 (median = 6; range = 0–34); 71% of graduates had a g-index of at least 3, while 1/3 of graduates (54/163) had a g-index of at least 10; 14% (23/163) had a g-index of zero (Fig. 1). Gender-based analysis revealed no significant g-index score difference between men and women; on the other hand, residents with a PhD had significantly higher scores (Table 1). Residents choosing academic careers over private practice had significantly higher g-index scores (Table 1). No significant difference between male and female resident g-index scores was prevalent regardless of private practice (male = 68, female = 16) career choice (5.43 versus 3.12; $p = 0.12$) or academic (male = 59, female = 20) career choice (10.08 versus 7.65; $p = 0.15$). Of the

Table 1 – Radiation oncology resident characteristics stratified by g-index.

Resident characteristic	N	Mean g-index	p-Value
Men	127	7.59	0.11
Women	36	5.64	
PhD	36	11.97	<0.01
No PhD	127	5.80	
Academic career choice	79	9.47	<0.01
Private practice career choice	84	4.99	

Table 2 – Proportion of radiation oncology residents choosing academic careers stratified by g-index.

g-Index	Proportion of radiation oncology residents choosing academic careers
0–3	25.4%
4–7	45.7%
8–11	78.9%
12–15	52.6%
16–19	70.0%
20+	71.4%

30 residents with a g-index <2, 26 (86.7%) went into private practice (Fig. 1). Thirty-five of the 54 residents (64.8%) with a g-index of at least 10 went into academic radiation oncology. Of the 59 residents with a g-index <4, 75% went into private practice (Table 2).

Residency programs graduating at least three residents produced significantly higher mean g-index scores per resident than those graduating two residents, and trended toward significance versus programs graduating a single resident; there was no significant difference in g-index scores between programs graduating one versus two residents (Table 3). Programs graduating at least three residents were significantly more likely to produce academic careers than programs graduating either one or two residents; the total number of academic careers from programs graduating 3+ residents was more than from all other programs combined (Table 4).

4. Discussion

The goal of this study was to examine the g-index as a tool for measuring the citation-based scholarly activity of radiation oncology residents, just as the h-index has been for residents and faculty alike.^{3,4,9} Our findings indicate that increasing

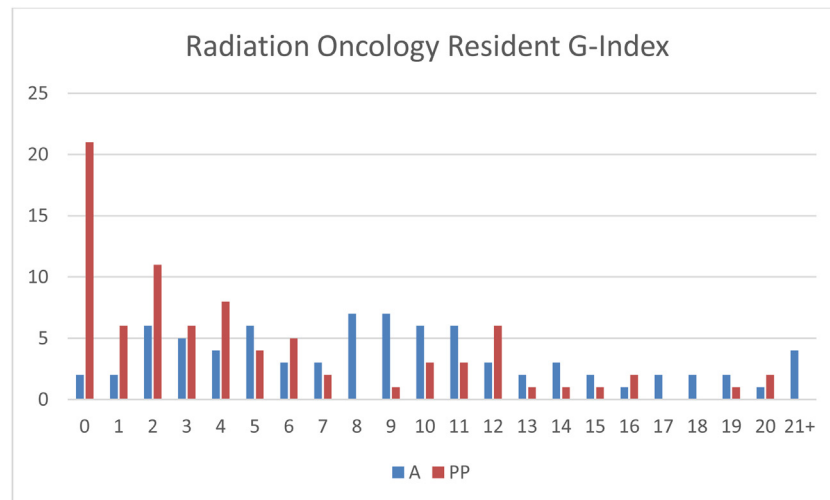


Fig. 1 – Depiction of relationship between radiation oncology resident g-index and choice of academic versus private practice career. The mean g-index score for all resident graduates was 7.2 (median = 6) (A = academic; PP = private practice).

Table 3 – Radiation oncology residency graduate volume stratified by g-index.

Residency graduate volume	Number of programs	Total residents	Mean g-index per resident	p-Value
One resident	24	24	5.67	1 vs. 2: $p=0.7371$ 1 vs. 3+: $p=0.0795$
Two residents	33	66	6.17	2 vs. 3+: $p=0.0181$
3+ residents	19	73	8.54	

Table 4 – Radiation oncology residency graduate volume stratified by career choice.

Residency graduate volume	Number of programs	Total residents	Residents choosing academic careers	Proportion of residents choosing academic careers	p-Value
One resident	24	24	8	33.3%	1 vs. 2: $p=0.6332$ 1 vs. 3+: $p=0.0192$
Two residents	33	66	26	39.4%	2 vs. 3+: $p=0.0109$
3+ residents	19	73	45	61.6%	

g-index is associated with post-residency choice of academic over private practice career (Table 2), and that no significant gender difference in g-index exists regardless of career choice; these are findings similar to those published for the h-index.⁴ These results, the first to examine the g-index in radiation oncology, establish the g-index as an additional tool for measuring citation-based scholarly activity to be used in concert with the more established h-index. For residents with a comparably smaller number of publications yet each cited in great quantity, the g-index may be more representative of the impact of their scholarly activity than the h-index as it is superior in rewarding an author's most highly cited articles. Our findings also demonstrate that residency programs graduating at least three residents produce significantly higher g-index scores per resident than programs graduating two residents, which has implications for department

chairs, program directors, and residency applicants regarding the academic reputation of specific programs (Table 3). Even more interesting is that despite representing only 25% of the residency programs and 45% of graduates in this analysis, programs graduating 3+ residents produced more academic career choices than all other residencies combined, comprising 60% of academic careers (Table 4).

The limitations of this study are similar to those involving analyses of academic versus private practice resident career choice as previously reported; these include its retrospective nature, the organic nature of the g-index (measurements even weeks apart could produce different scores for the same resident; to decrease the impact of this limitation, all information was accessed from Scopus over a short time period), and the focus of this study on United States programs, which may minimize the applicability of these findings worldwide.^{4,8} Another

limitation is the possible change in resident surname resulting from marriage, although all graduates were researched back to their pre-medical school careers in order to minimize this limitation, as previously described.^{4,8} Since the g-index (as the h-index) is impacted by academic career duration, graduates with PhDs will often have a higher g-index due to their comparably lengthened pre-residency scholarly activity time period.

5. Conclusion

Radiation oncology resident graduates published on average a minimum of seven manuscripts cited at least 49 times. PhD-degree graduates had significantly higher g-index scores, as did residents choosing academic over private practice careers. There was no significant gender-related difference in g-index score regardless of career choice. One-third of graduates had a g-index of at least 10 (at least 10 manuscripts cited at least 100 times), of whom 65% chose academic careers. Fewer than one-fifth of graduates had a g-index <2, of whom 87% chose private practice careers. Finally, residency programs graduating at least three residents produced significantly higher g-index scores per resident than those graduating two residents, and were significantly more likely to produce residents choosing academic careers. These results indicate that the g-index offers comparable citation-based benchmark information to the h-index, and may be a useful alternative for assessing radiation oncology resident productivity, post-residency career choices, and radiation oncology program academic reputation.

Conflict of interest

None declared.

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