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CLINICAL INVESTIGATION

ESTIMATION OF CITATION-BASED SCHOLARLY ACTIVITY AMONG RADIATION ONCOLOGY FACULTY AT DOMESTIC RESIDENCY-TRAINING INSTITUTIONS: 1996–2007

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Purpose: Advancement in academic radiation oncology is largely contingent on research productivity and the perceived external influence of an individual's scholarly work. The purpose of this study was to use the Hirsch index (*h*-index) to estimate the research productivity of current radiation oncology faculty at U.S. academic institutions between 1996 and 2007.
Methods and Materials: We performed bibliometric citation database searches for available radiation oncology faculty at domestic residency-training institutions (*n* = 826). The outcomes analyzed included the total number of manuscripts, total number of citations, and the *h*-index between 1996 and 2007. Analysis of overall *h*-index rankings with stratification by academic ranking, junior vs. senior faculty status, and gender was performed.
Results: Of the 826 radiation oncologists, the mean *h*-index was 8.5. Of the individuals in the top 10% by the *h*-index, 34% were chairpersons, 88% were senior faculty, and 13% were women. A greater *h*-index was associated with a higher academic ranking and senior faculty status. Recursive partitioning analysis revealed an *h*-index threshold of 15 (p <0.0001) as an identified breakpoint between the senior and junior faculty. Overall, women had lower *h*-indexes compared with men (mean, 6.4 vs. 9.4); however, when stratified by academic ranking, the gender differential all but disappeared.
Conclusion: Using the *h*-index as a partial surrogate for research productivity, it appears that radiation oncologists in academia today comprise a prolific group, however, with a highly skewed distribution. According to the present analysis, the *h*-index correlated with academic ranking. Thus, it potentially has utility in the process of promotion decisions. Overall, women in radiation oncology were less academically productive than men; the possible reasons for the gender differential are discussed.

Academic productivity, Bibliometrics, Citations, Hirsch index, *H*-index.

INTRODUCTION

For institutions, departments, and individuals in academic radiation oncology, as in any scientific field in general, the relevance of research output is unquestionable. In a world of limited resources, the quantification of scholarly activity is often needed for evaluation and comparison purposes (*e.g.*, for university faculty recruitment and advancement, awarding of grants).

To our knowledge, no formal study has explored the relative research publication productivity of current U.S. radiation oncologists. We chose to use the Hirsch index (*h*-index) to estimate the scholarly activity of domestic radiation oncologists and to identify those who have been the most productive—defined as those individuals who have published more, both qualitatively and quantitatively, than most of their peers (1). As with other commonly used indicators, such as the number of reports published within a given period, number of citations per report, number of authors for each report, and impact factor of the journals in which the studies were published, the *h*-index can be implemented as a standardized measure of research productivity and also serves as a predictor of future scientific achievement (2). The purpose of this study was to use the *h*-index as a partial surrogate to estimate the research productivity of domestic radiation oncologists in academia between 1996 and 2007, as well as to define a quantitative benchmark for faculty achievement.

METHODS AND MATERIALS

Data selection criteria

All radiation oncologists who were members of the faculty of domestic residency-training institutions within the study period were included for analysis. A list of radiation oncology departments with active residency programs was compiled using the most recent release of the Association of Residents in Radiation Oncology

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Directory, January 2007–June 2007, as a guide (3). Departmental websites were individually accessed between October 29, 2007 and December 10, 2007 to provide a listing of the current faculty members. Only physicians (M.D./D.O.) and physician-scientists (M.D.-Ph.D.) were included. Faculty with Ph.D./other doctoral degrees alone were excluded from our analysis. When available, demographic parameters, including gender and academic ranking within the department, were collected and coded using a JMP spreadsheet (JMP, version 6.0, SAS Institute, Cary, NC).

Bibliometric analysis

For each faculty member, a custom search was performed using SCOPUS, a bibliometric citation database of research literature (Elsevier BV, Amsterdam, The Netherlands) (4). A search string was created using the Author Search function. Individual author results with the appropriate affiliation and subject area were selected, and the documents were examined as needed to select all publications attributable to an individual during the study period (1996–2007), regardless of the individual's affiliations at the time of initial article publication. The Citation Tracker function was used to generate the bibliographic database-derived total number of publications, total number of citations, and *h*-index for each individual. The searches were conducted in random order and performed by a single data collector to minimize temporal bias in data collection methods.

Hirsch index

The bibliographic database outputs of the total number of publications (N_p), total number of citations, and the *h*-index were tabulated. Since its introduction by Jorge Hirsch, Ph.D.(University of California, San Diego), the *h*-index has become a widely implemented tool across academic disciplines and is readily available through bibliographic software packages (1). A scientist has index h if h of their papers published within n years has at least h citations each and the other ($N_p - h$) papers have $\leq h$ citations each. For example, the greatest h among radiation oncologists within this series is 48. Thus, this individual has written 48 papers with ≥48 citations each.

Statistical analysis

A descriptive analysis was performed to calculate the mean, median, and standard deviation for the N_p, total number of citations, and *h*-index of the individual radiation oncologists. A numeric ranking was performed of all included *h*-indexes and with stratification by academic rank (chair vs. non-chair professor vs. non-chair associate professor vs. assistant professor vs. instructor), junior vs. senior faculty status, and gender. Recursive partitioning analysis was performed to assess a nonparametrically derived *h*-index ''breakpoint'' associated with senior vs. junior faculty status.

RESULTS

A total of 78 U.S. academic radiation oncology departments were identified, and 826 radiation oncologists were included in the analysis.

Distribution of h-indexes

The *h*-index range was 0–48, with a highly skewed distribution. Figure 1 illustrates the distribution of *h*-indexes as a box plot. The mean *h*-index was 8.5 (95% confidence interval [CI], 7.9–9.1), and the 25th, 50th, 75th, and 100th percentiles were 2.0, 6.0, 13, and 48, respectively (Table 1).

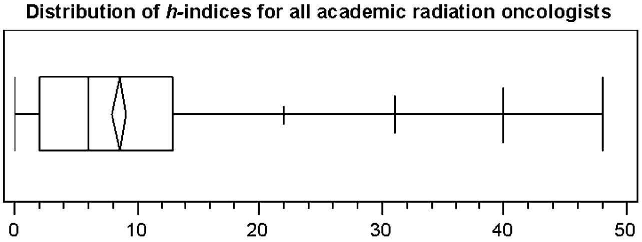

Fig. 1. Quartile box plot of Hirsch index distribution for U.S. academic radiation oncologists. Whiskers represent 0–100th percentile range. Ends of box indicate 25th and 75th percentiles. Central diamond represents mean. Width of diamond demonstrates 95% confidence interval (22).

The lower extreme of productivity was represented by those who had not published during the period evaluated ($n = 57$; 7%). Of these nonpublishing individuals, none were senior faculty, 25 (44%) were women, and 32 (56%) were men.

The greatest *h*-index was 48. The top 10% of *h*-indexes among the radiation oncologists are listed in Table 2. For the top 10%, the median *h*-index was 26 (range, 21–48). Chairpersons comprised 34%; 88% were senior faculty or the equivalent; and 13% were women. Of the 20 individuals ranking in the top 2%, nearly one-third (30%) were chairpersons; all were senior faculty or the equivalent; and only 1 (5%) was a woman, with *h*-index of 35.

H-index distribution by academic rank

For 123 individuals (15%), the academic position was not readily equated to the traditional hierarchical system of chairperson, professor, associate professor, assistant professor, or instructor. Of the remaining 703 individuals with traditional academic positions, 79 (11%) were chairpersons, 117 (17%) were non-chair professors, 177 (25%) were non-chair associate professors, 290 (41%) were assistant professors, and 40 (6%) were instructors. Table 3 lists the *h*-index distribution for each rank group. Chairpersons and non-chair professors had comparable *h*-indexes, with a slight trend toward greater values for chairpersons. The distribution for associate professors was markedly lower than for chairpersons or non-chair professors. The differences in distributions were less pronounced between associate and assistant professors and were further diminished between assistant professors and instructors.

Combining the chairpersons and non-chair professors into one group and associate professors, assistant professors, and instructors into another group, 196 (28%) were senior faculty members and 507 (72%) were junior faculty members. The *h*-index of the senior faculty members was 0–48 (mean, 17.2; 95% CI, 15.9–18.6), and the 25th, 50th, 75th, and 100th percentile was 9.0, 17, 24, and 48, respectively. The *h*-index of the junior faculty members was 0–29 (mean, 5.7; 95% CI, 5.2–6.2), and the 25th, 50th, 75th, and 100th percentile was 1.0, 4.0, 9.0, and 29, respectively (Fig. 2). Recursive partitioning analysis revealed a statistically significant numeric *h*-index threshold of 15 (LogWorth, 54.7; $p < 0.0001$) between the two groups. The logistic fit of probability of senior vs. junior faculty status by *h*-index is represented in Fig. 3. Using

Table 1. Distribution of Hirsch index by gender

Gender	*n* (%)	*H*-index: Mean (95% CI)	Median (range)	Quartile 25%	50%	75%	100%
Male	592 (72)						
H-index		9.4 (8.7–10.1)	7 (0–48)	2	7	14	48
N_p		48 (42.7–53.3)	21 (0–527)	6	21	63	527
N_c		1,019 (878–1,161)	274 (0–18,476)	57	274	1,152	16,476
Female	234 (28)						
H-index		6.4 (5.5–7.4)	4 (0–35)	1	4	9	35
N_p		22.6 (17.8–27.3)	8 (0–242)	3	8	26	242
N_c		513 (357–669)	94 (0–12,222)	16	94	367	12,222
Total	826 (100)						
H-index		8.5 (7.9–9.1)	6 (0–48)	2	6	13	48
N_p		41 (37–45)	16 (0–527)	4	16	48	527
N_c		876 (764–987)	196 (0–16,476)	37	196	901	16,476

Abbreviations: H-index = Hirsch index; CI = confidence interval; N_p = number of papers; N_c = number of citations.

the recursive partitioning analysis-derived threshold, 73% of those with an *h*-index of ≥15 were senior faculty. In contrast, only 27% of those achieving this benchmark were junior faculty (Table 4). Of those with an *h*-index of <15, 85% were junior faculty and only 15% were senior faculty.

H-index distribution by gender

A total of 234 (28%) radiation oncologists were women and 592 (82%) were men. For women, the mean *h*-index was 6.4 (median 4.0; range, 0–35; 95% CI, 5.5–7.4). For the men, the mean *h*-index was 9.4 (median, 7.0; range, 0–48; 95% CI, 8.7–10.1). The gender differences in the *h*-index distribution are presented in Table 1. Compared with the *h*-index distributions, the distributions for the total number of reports and total number of citations showed a similar gender disparity. Despite the overall lower *h*-index for female radiation oncologists compared with their male counterparts as a group, when stratified by academic ranking, the gender differential all but disappeared (Table 3).

DISCUSSION

Advancement in academic radiation oncology is largely contingent on productivity and the measured external influence of an individual's scholarly work. Understanding academic productivity begins with understanding appropriate measures of publication; however, it must be more than a simple comparison of raw number of published papers. How the components of an individual's publication record are weighed and analyzed in practice becomes important since publication records are increasingly used in funding, appointment, and promotion decisions. This information is potentially of great interest to radiation oncologists, residents, fellows, and medical students seeking an academic mentor, because it measures the broad effect of an individual's work against others in the same field. In this study, we used the *h*-index as one measure of academic radiation oncologists' scholarly activity. Thus, we sought to compare the academic productivity among current radiation oncology faculty in U.S. academic institutions during an extended period (1996–2007).

Overall trends

As a group, radiation oncologists in academia today comprise a prolific group of individuals, with, however, a highly skewed distribution. Nearly 7% of individuals included in the analysis had had no publications during the period analyzed. Nonpublisher status correlated highly with junior faculty status. A lack of publications might represent at least three types of activity: an individual who normally publishes might have had a period during which no reports were submitted or accepted for publication; an individual might have been actively involved with research but not in a position in which publication was allowed or required; or an individual might no longer be active in research (*e.g.,* when raising a family or pursuing other types of work). Because the measure of nonpublishers was determined from counts spanning an 11-year period, the observed nonpublishers more likely reflects a long-term lack of research activity than a momentary fluctuation in a steady flow of publications.

The trends among individuals with the greatest *h*-indexes were remarkably different. Among the top 10%, the vast majority (88%) were senior faculty, approximately one-third were chairpersons, and a marked gender discrepancy was found, with just 13% being women. Female representation diminished further in the top 2%, with just 1 woman ranking in this select group.

Academic ranking

When stratified by academic position, the *h*-indexes appeared to correlate with the academic hierarchy. Chairpersons and non-chair professors had similar academic productivity, with only minor differences across quartiles, suggesting that an appointment to a chair position is determined by factors other than academic productivity. When considering the rest of the academic appointment ladder, the *h*-index appeared to be fairly indicative of an individual's

Table 2. Top 10% of Hirsch indexes in radiation oncology during past 11 years

Rank	Gender	Position	Institution	*H*-index	Articles (*n*)	Citations (*n*)
1	Male	Senior faculty	University of Chicago	48	527	16,476
2	Male	Senior faculty	Memorial Sloan-Kettering Cancer Center	42	197	7,560
3	Male	Senior faculty	University of Washington	41	155	8,773
4	Male	Senior faculty	William Beaumont	40	196	5,424
5	Male	Senior faculty	Harvard	39	166	7,895
6	Male	NOS	William Beaumont	38	195	5,662
7	Male	Senior faculty	Fox Chase Cancer Center	36	259	5,591
8	Male	Senior faculty	Harvard	35	243	5,366
9	Male	Senior faculty	Harvard	35	262	7,645
10	Female	Senior faculty	M.D. Anderson Cancer Center	35	242	5,187
11	Male	Senior faculty	University of Michigan	34	215	5,188
12	Male	Senior faculty	University of California, San Francisco	34	188	4,377
13	Male	Senior faculty	M.D. Anderson Cancer Center	34	306	6,527
14	Male	Senior faculty	Yale-New Haven	33	104	3,783
15	Male	Senior faculty	University of Florida, Gainesville	33	371	6,777
16	Male	Senior faculty	University of Michigan	32	181	4,298
17	Male	Senior faculty	M.D. Anderson Cancer Center	32	309	7,274
18	Male	NOS	Fox Chase Cancer Center	31	161	3334
19	Male	Senior faculty	M.D. Anderson Cancer Center	31	200	3,305
20	Male	Senior faculty	Thomas Jefferson	31	171	5,088
21	Female	Senior faculty	M.D. Anderson Cancer Center	31	160	3,442
22	Male	Senior faculty	Harvard	31	221	6,379
23	Male	Senior faculty	M.D. Anderson Cancer Center	30	168	5,328
24	Male	Senior faculty	University of Wisconsin	30	207	3,939
25	Male	NOS	William Beaumont	29	98	2,347
26	Male	Senior faculty	Harvard	29	150	3,938
27	Male	Senior faculty	UMDNJ	29	187	3,900
28	Male	Senior faculty	Stanford	28	243	7,047
29	Male	Senior faculty	VCU	28	137	3,616
30	Male	Senior faculty	University of California, San Francisco	28	191	6,515
31	Male	Senior faculty	Mayo Clinic, Rochester	28	89	3,097
32	Female	Senior faculty	University of California, San Francisco	28	104	3,364
33	Male	Senior faculty	Harvard	27	172	6,415
34	Male	Senior faculty	Harvard	27	221	7,730
35	Male	Senior faculty	Mount Sinai	27	164	3,745
36	Female	Junior faculty	Stanford	26	83	1,760
37	Male	Junior faculty	University of Washington	26	214	4,352
38	Male	Senior faculty	University of Washington	26	139	2,936
39	Male	Senior faculty	University of Michigan	26	103	2,709
40	Male	Senior faculty	University of California, San Francisco	26	126	4,182
41	Male	Senior faculty	Mayo Clinic, Rochester	26	105	2,282
42	Male	Senior faculty	University of Pennsylvania	26	171	6,388
43	Female	Senior faculty	Stanford	26	227	4,700
44	Female	Senior faculty	Harvard	26	191	5,286
45	Female	Junior faculty	Stanford	25	97	2,466
46	Male	Senior faculty	University of Iowa	25	113	2,365
47	Male	Senior faculty	Vanderbilt	25	129	4,011
48	Male	Senior faculty	Henry Ford	25	119	2,218
49	Male	Senior faculty	Washington University	25	202	4,741
50	Male	Senior faculty	M.D. Anderson Cancer Center	25	103	2,178
51	Male	Senior faculty	Medical College of Wisconsin	25	125	5,429
52	Male	Junior faculty	University of Michigan	24	122	2,335
53	Female	Senior faculty	Mayo Clinic, Rochester	24	64	1,599
54	Male	Senior faculty	Georgetown	24	176	2,789
55	Male	Senior faculty	University of Pennsylvania	24	110	1,803
56	Male	Senior faculty	Rush University	24	91	3,978
57	Female	Senior faculty	Memorial Sloan-Kettering Cancer Center	24	111	2,637
58	Male	Senior faculty	University of California, San Francisco	24	276	5,524
59	Male	Senior faculty	M.D. Anderson Cancer Center	24	97	2,558
60	Male	Junior faculty	M.D. Anderson Cancer Center	23	48	10,097
61	Male	Junior faculty	M.D. Anderson Cancer Center	23	149	2,555
62	Male	Senior faculty	Johns Hopkins	23	66	1,701
63	Male	Senior faculty	Johns Hopkins	23	159	3,917
64	Male	Senior faculty	Case Western Reserve	23	270	5,065

(*Continued*)

Table 2. Top 10% of Hirsch indexes in radiation oncology during past 11 years (*Continued*)

Rank	Gender	Position	Institution	*H*-index	Articles (*n*)	Citations (*n*)
65	Male	Senior faculty	University of Alabama	23	96	2,099
66	Female	Senior faculty	M.D. Anderson Cancer Center	23	125	2,593
67	Male	Senior faculty	Johns Hopkins	23	135	3,316
68	Male	Senior faculty	Harvard	23	222	5,196
69	Male	Junior faculty	University of Chicago	22	127	2,596
70	Male	Junior faculty	Mayo Clinic, Rochester	22	53	1,534
71	Male	Junior faculty	Baylor College of Medicine	22	85	1,506
72	Male	Junior faculty	M.D. Anderson Cancer Center	22	91	1,347
73	Male	Senior faculty	SUNY Downstate	22	102	4,235
74	Male	Senior faculty	University of Southern California	22	126	3,554
75	Male	Senior faculty	Albert Einstein	22	127	3,877
76	Male	Senior faculty	Duke University	22	84	3,581
77	Male	Senior faculty	M.D. Anderson Cancer Center	22	79	1,571
78	Female	Senior faculty	University of California, San Francisco	22	101	3,617
79	Male	Senior faculty	Washington University	22	90	1,654
80	Male	Senior faculty	University of Michigan	21	150	4,872
81	Male	NOS	Memorial Sloan-Kettering Cancer Center	21	130	3,418
82	Male	Senior faculty	Thomas Jefferson	21	82	1,632
83	Male	Senior faculty	Washington University	21	78	1,902

Abbreviations: NOS = position not otherwise specified; UMDNJ = University of Medicine and Dentistry New Jersey; VCU = Virginia Commonwealth University; SUNY = State University of New York.

research caliber and, hence, the appropriate academic position for that individual.

Insofar as the *h*-index values of the junior faculty were lower than those of the senior faculty, our results further emphasize that academic productivity strongly correlates with an individual's academic rank. According to the present analysis, the breakpoint *h*-index value for promotion to senior faculty rank appears to be 15.

Women in radiation oncology

In 2003, it was reported that only approximately one-quarter (23%) of radiation oncology trainees and post-training, professionally active, radiation oncologists were women, a statistic far behind the approximately 40% of trainees in all physician fields who were women (5). In our study, we found that women comprised 28% of active radiation oncologists in academia, a proportion only slightly greater than the reported 23% overall (both academia and private practice).

Gender differences in scholarly activity are well-documented across the spectrum of scientific disciplines (5–9). The trend appears to also hold true in academic radiation oncology, as evidenced by the significantly lower mean and quartile *h*-index values for female radiation oncologists overall compared with their male counterparts (Table 1) (10). Jagsi *et al.* (11) have offered one possible explanation for the gender gap, that the pool of female faculty members in

Table 3. Distribution of Hirsch index by academic position

		H-index					
				Quartile			
Position	*n* (%)	Mean (95% CI)	Median (range)	25%	50%	75%	100%
Instructor	40 (6)	2.8 (2.0–3.6)	2 (0–9)	1	2	5	9
Male	27 (68)	3 (2.0–4.0)	2 (0–9)	1	2	5	9
Female	13 (32)	2.5 (1.2–3.8)	2 (0–7)	1	2	4	7
Assistant Professor	290 (41)	4 (3.5–4.5)	2 (0–29)	1	2	6	29
Male	188 (65)	4 (3.4–4.6)	3 (0–23)	1	3	6	23
Female	102 (35)	4 (3.0–4.9)	2 (0–29)	1	2	5	29
Associate Professor	177 (25)	9.3 (8.3–10.2)	8 (0–26)	4	8	14	26
Male	131 (74)	9.7 (8.6–10.8)	9 (0–26)	4	9	14	26
Female	46 (26)	8 (6.2–9.8)	6 (0–26)	4	6	12	26
Professor	117 (17)	17 (15.3–18.8)	16 (0–41)	9	16	24	41
Male	94 (80)	17 (14.7–18.7)	15 (0–41)	9	15	23	41
Female	23 (20)	17 (12.3–20.1)	17 (1–35)	7	17	25	35
Chairperson	79 (11)	18 (15.7–20.2)	18 (0–48)	10	18	24	48
Male	68 (86)	18 (15.7–20.8)	19 (0–48)	9	19	25	48
Female	11 (14)	16 (12.7–19.8)	15 (7–24)	13	15	20	24

Abbreviation as in Table 1.

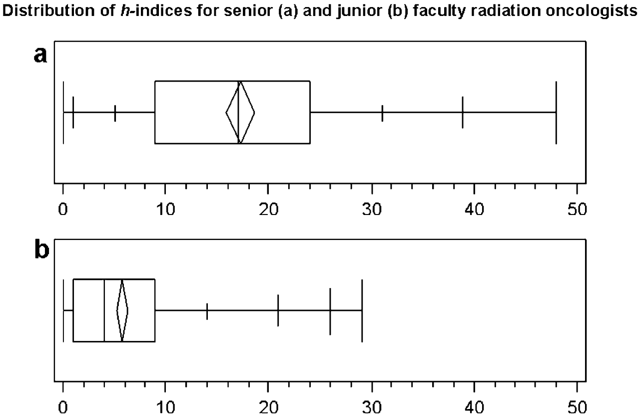

Fig. 2. Quartile box plots of Hirsch index distributions for U.S. academic radiation oncologists with (a) senior and (b) junior faculty appointments.

academic radiation oncology is simply limited. Our findings certainly corroborate this possibility. Going one step further, our results suggest that the women's lower *h*-indexes resulted from overrepresentation among nonpublishers and underrepresentation among the extremely productive, rather than of the quality of publications. In fact, using another popular measure of academic productivity, the mean citation count per paper, n_c,($n_c = N_c/N_p$), it is difficult to discriminate between the two groups' academic achievement, because reports by female radiation oncologists on average received citations per paper comparable to those by males (data not shown) (12).

Other explanations for the gender differences that have been proposed include differences in personal characteristics (*e.g.,* ability, motivation, and dedication) or educational background; however, a satisfactory explanation for the disparity

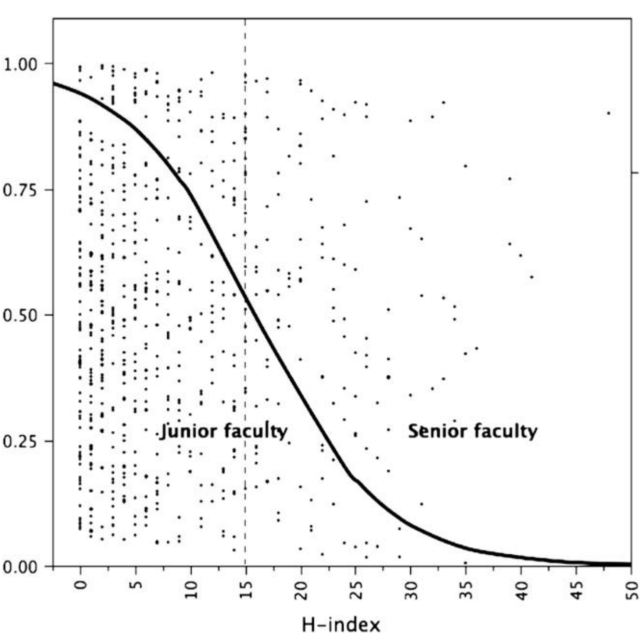

Fig. 3. Logistic fit of probability of senior vs. junior faculty status by Hirsch index (*h*-index).

Table 4. RPA-derived Hirsch index breakpoint analysis

Hirsch index	Junior faculty (*n*)	Senior faculty (*n*)
≥15	44 (6)	118 (17)
<15	463 (66)	77 (11)
Total	507 (72)	196 (28)

Abbreviation: RPA = recursive partitioning analysis.
Data in parentheses are percentages of total number of faculty.

remains elusive (6, 11). We strongly believe that the lack of female role models is one of the most, if not the most, important factors in the disconcordance of academically productive female faculty and the proportion of women enrolled in North American medical schools (13). The obligations of family and children may differentially affect one's career path. Overt, but more commonly, such as is the case with ethnicity, subtle discrimination according to gender could make resources more difficult for women to obtain, which in turn would limit their ability to publish. Such prejudice can come in the form of low expectations that are conveyed to nascent female faculty members (13, 14). Although we did not analyze the trends in academic productivity by career year or stage in our study, a longitudinal component could also contribute to the discrepancy we observed (*i.e.,* gender differences in scholarly activity might increase during the first decade of the career when women tend to have lower productivity but are reversed later in the career) (7, 14).

Study strengths and limitations

The principal strength of our study was that the data were from a large, carefully conducted search with good quality assurance procedures. A small team, using a single database to ensure homogeneity, acquired the data. The bibliometric citation software used, which tracks and analyzes research and trends for approximately 14,200 journals from >4,000 publishers, supplying 27-plus million abstracted citations, is one of the largest citation databases of peer-reviewed studies. Its citation analysis features reach back to 1996 for the nonlife sciences, including radiation oncology. Given the high quality of data and the objective, systematic manner in which the numbers were assigned, the citation-based measures we analyzed, including the *h*-index, can be applied with relatively high confidence.

Study limitations include time sensitivity of the SCOPUS-derived citation numbers. Although the citation database allowed us to make reasonable, up-to-date estimates of the *h*-index and other measures of scientific productivity that are generally applicable at a given point, citation numbers are dynamic. The publication records extracted for the individuals in our study do not necessarily reflect synchronous data among individuals, because ≤5 weeks elapsed between searches during which minor changes might have occurred. During the interval from when the data were gathered and the time of publication, the data will have changed. Thus, the *h*-indexes presented in the present study should be considered reliable estimates of productivity, rather than precise values.

For some analyses, entries were necessarily omitted; however, the cohort size remained large, compensating for the incomplete demographic parameters. In the academic ranking analysis, for example, although a small number of individuals with faculty appointments not readily converted to traditional academic hierarchy were omitted, this was unlikely to skew the analysis, because the excluded faculty appointments tended to be institutional phenomena.

Because the bibliometric citation software data does not include information on book chapters and does not readily yield information on author order or collaborative networks, we were unable to offer a more comprehensive assessment of scholarly activity that reflects some potentially important factors such as non-journal publications, an individual's relative contribution, or patterns of collaboration (15). For example, the shocking prevalence of honorary co-authorships and the influence of self-citation will skew the results considerably (16–18). Consequently, one reason chairpersons and professors might be overrepresented in publications is ''ghost'' authoring or honorary co-authorships. We found some indication that, at least within the radiologic sciences literature, the first two listed authors of a publication undertake the vast majority of the effort required for manuscript preparation (19). Additionally, authors who loosely cite themselves or their co-authors might artificially inflate their listed *h*-index. As increasing emphasis has been placed on the publications for promotion in academic medicine, a trend has occurred toward increasing the mean number of authors per publication, editorial authorship, collaborative groups, and multicenter trials with fewer solo authors now publishing original research or case reports (20). As such, it is imperative for faculty-hiring committees and candidates to be aware of the changing value and definition of authorship and, more specifically, to characterize academic competitiveness as accurately as possible (21).

CONCLUSION

We have demonstrated that the *h*-index is a simple and easily implemented method of quantifying one aspect of an individual's scientific productivity and used the *h*-index to set a quantitative benchmark for scholarly activity among domestic radiation oncologists in academia. These new results contribute to a long-standing field: the study of scientific publication rates and citations. They might thus have relevance well beyond the radiation oncology community surveyed. Future questions of interest include whether these differences in productivity vary over time as individuals enter different stages of their career; and whether it is uniform across other measures of productivity that, for example, account for the number of co-authors, author position, or author networks. Without more complete answers to these questions, attempts to systematize and guide academicians/committees involved in the appointment process, as well as to model and combat the processes generating gender differences in productivity, will necessarily be limited (23).

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