Publication Productivity for Academic Ophthalmologists and Academic Ophthalmology Departments in the United States: an Analytical Report

Craig R. Thiessen, BSc[1] Garrett T. Venable, BSc[1] Nick C. Ridenhour[2] Natalie C. Kerr, MD[3,4]

[1] College of Medicine, University of Tennessee Health Science Center (UTHSC), Memphis, Tennessee
[2] School of Health Professions, Samford University, Birmingham, Alabama
[3] Department of Ophthalmology, University of Tennessee Health Science Center (UTHSC), Memphis, Tennessee
[4] Le Bonheur Children's Hospital, Memphis, Tennessee

Address for correspondence Natalie C. Kerr, MD, FACS, Hamilton Eye Institute, 930 Madison Avenue, Suite 470, Memphis, TN 38103 (e-mail: nkerr@uthsc.edu).

J Clin Acad Ophthalmol 2016;8:e19–e29.

Abstract

Purpose Quantifying scholarly output for academic ophthalmologists and academic ophthalmology departments provides a benchmark for academic productivity, offering information about how well an academic department facilitates the scholarly activity of its faculty. Bibliometrics is a statistical method to analyze scientific literature. Among benchmarking methods, the h-index has been the most widely accepted. The h-index samples a researcher's publication quantity while controlling for quality through citation count. The m-quotient adjusts the h-index according to the number of years since the first peer-reviewed publication, allowing for productivity assessments independent of career length. This study utilizes bibliometrics to create profiles for academic ophthalmology in the United States.

Methods Bibliometric profiles were created for 2,824 ophthalmologists from 110 nonmilitary departments. Profiles included the h-index and m-quotient calculated from an online citation database. Comparisons between academic rank, gender, region, and subspecialty were performed. Departments were ranked by the summation as well as the mean of h-indices for each faculty member.

Results The mean h-index and m-quotient were 10.56 ± 11.96 and 0.52 ± 0.44, respectively. Both of these values exhibited a positive relationship with increasing academic rank ($p < 0.001$). Faculty with subspecialties in ocular oncology, pathology, vitreoretinal disease, neuro-ophthalmology, and uveitis had higher mean h-indices than those in cornea and external disease, glaucoma, pediatrics, oculoplastics, anterior segment, and comprehensive ophthalmology. Males ($n = 1,989$) demonstrated a significantly higher mean h-index than females ($n = 835$), 12.12 ± 12.66 versus 6.84 ± 9.07. This difference was still significant after correcting for academic rank ($p < 0.001$). However, there was no significant difference in m-quotients between genders ($p = 0.955$). Ranked by summed h-indices, the top five programs for publication productivity in the United States in descending order were Massachusetts Eye and

Keywords
- bibliometrics
- h-index
- m-quotient
- academic ophthalmology
- scholarly impact
- departmental rank
- Scopus

received November 2, 2015
accepted after revision January 29, 2016

DOI http://dx.doi.org/10.1055/s-0036-1581111.
ISSN 2379-0539.

Ear Infirmary, University of Miami, Thomas Jefferson University, Johns Hopkins University, and the University of Wisconsin.

Conclusion This report benchmarks the publication productivity of academic ophthalmologists and academic ophthalmology departments in the United States. These results may serve program development in academic ophthalmology departments and prospective trainees and faculty.

Bibliometrics is defined as the statistical and mathematical method used to quantitatively analyze scientific publications. Peer-reviewed publications are important for securing grant funding for academic ophthalmologists and their departments, career development and tenure/promotion for academic ophthalmologists, and judging the overall success of an academic department.[1–6] However, determining the output and impact of research for an individual or a department is often highly subjective and unduly driven by reputation without quantitative analysis and data.

Measures of productivity and the impact of scientific publications have been established, but none have been more widely accepted than the h-index.[7] First introduced in 2005 by physicist J. E. Hirsch, the h-index is defined as an author's number of papers, *h*, that have been cited at least *h* times in peer-reviewed literature.[8] The h-index measures publication quantity while accounting for quality through citation count. Hirsch also described another parameter, the m-quotient, defined as the h-index divided by the number of years since the author's first publication.[8] The m-quotient is useful when comparing younger researchers to their more seasoned counterparts.

The h-index is the point where the number of publications intersects the number of citations when ranked by decreasing order of citations. To illustrate how the h-index works, let us compare two researchers in the same field, X and Y. Suppose X has 100 peer-reviewed articles and 10 of those have been cited 10 or more times in the literature. X's h-index would be 10. Y has published 50 articles, and 20 of those have been cited 20 times or more, therefore yielding an h-index of 20. Who has the larger influence in that scientific field? The h-index would argue that Y has a greater impact despite having half the number of publications, because Y's work was considered significant to subsequent studies as measured by citations.

Since its description, the h-index has been applied to analyze the fields of several medical and surgical specialties, including anesthesiology,[9] hepatology,[10] neurosurgery,[11–15] otolaryngology,[16] radiation oncology,[17] radiology,[18] surgery,[19] and urology.[20] Academic ophthalmology has utilized the h-index with recent publications concerning National Institutes of Health (NIH) funding,[21] gender differences within NIH funding,[22] and fellowship training.[23] The purpose of this study was to describe academic productivity within ophthalmology by measuring the h-index and m-quotient for 2,824 ophthalmologists and all nonmilitary departments ($n = 110$).

Methods

A listing of the 2014 ophthalmology residency-training programs was obtained from the Accreditation Council for Graduate Medical Education (http://www.acgme.org/ads/Public/Reports/ReportRun?ReportId=1&CurrentYear=2014&SpecialtyId=41&IncludePreAccreditation=true&IncludePreAccreditation=false). A total of 110 nonmilitary departments were identified. Departmental Web sites were consulted for the names, academic ranks, gender, and subspecialties of each faculty member. Full- and part-time residency-trained academic ophthalmologists were included. Nonophthalmologist faculty such as opticians, optometrists, non-MD PhDs, neurologists, and pathologists were excluded. If detailed information could not be obtained from the department's Web site, the department was contacted via email or telephone. With one exception, the subspecialties included in this study were those with fellowships listed by the San Francisco Ophthalmology Fellowship Match: anterior segment, cornea and external disease, glaucoma, neuro-ophthalmology, ophthalmic pathology, ophthalmic plastic surgery, pediatric ophthalmology, uveitis and ocular immunology, and vitreoretinal diseases. Ocular oncology was not listed by the San Francisco Ophthalmology Fellowship Match, but was included in our study.

Programs were grouped by region according the U.S. Census Bureau (http://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf). These include the following: (1) northeast: CT, MA, ME, NH, NJ, NY, PA, RI, and VT; (2) midwest: IA, IL, IN, KS, MI, MN, MO, ND, NE, OH, SD, and WI; (3) south: AL, AR, DC, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, and WV; and (4) west: AK, AZ, CA, CO, HI, ID, MT, NM, NW, OR, UT, WA, and WY.

The h-index is defined as an individual's number of papers, *h*, with at least *h* citations. The m-quotient is the h-index divided by the number of years since the author's first publication. H-indices and m-quotients were obtained from the citation database Scopus (Elsevier, http://www.scopus.com). Scopus has previously been used in this manner and has strong correlation to other citations databases such as Google Scholar and Thomson Reuters' Web of Science.[11,15] Scopus also has unique identification capabilities, making it possible to cross-check departments and ophthalmological publications for further accuracy. In the event that a researcher was not easily identified in Scopus, efforts were made to identify him or her by analyzing all researchers of the same name.

Data collection took place between May 2015 and June 2015, and calculations were completed in June 2015.

Statistical Analysis

The Kruskal–Wallis one-way analysis of variance (ANOVA) was used for comparison of continuous variables. The Mann–Whitney statistical test was used when describing comparisons between two groups. Academic rank was corrected for gender using a two-tailed ANOVA. Statistical significance threshold was set at $p < 0.05$, and mean values are presented with ± SD. All data were analyzed using SPSS software (IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY).

Results

Bibliometric Profiles for Academic Ophthalmology

Data were obtained from 110 departmental Web sites, and included 2,824 academic ophthalmologists. The h-index and m-quotient were available for 2,491 (88.2%) of the 2,824 individuals. The mean h-index was 10.56 ± 11.96 with a median of 6 and a range from 0 to 127. The mean m-quotient was 0.52 ± 0.44 with a median of 0.40 and a range from 0 to 3.53. ►**Table 1** describes h-indices and m-quotients for academic rank, gender, fellowship training, subspecialties, and region. A total of 110 chairs, 607 professors, 494 associate

Table 1 Bibliometric profiles of academic ophthalmology including described subgroups

Variable	Frequency (%)	H-index[a]	*p*-Value	M-quotient[a]	*p*-Value
Overall	2,491 (88%)	10.56 ± 11.96 (6, [0–127])	–	0.52 ± 0.44 (0.40, [0–3.53])	–
Academic rank					
Chairman	110 (5%)	21.60 ± 13.7 (19, [0–74])	<0.001	0.78 ± 0.46 (0.72, [0–2.11])	<0.001
Professor	596 (27%)	21.2 ± 15.3 (19, [0–127])		0.72 ± 0.48 (0.62, [0–3.53])	
Associate	467 (21%)	9.70 ± 7.36 (8, [0–69])		0.54 ± 0.41 (0.54, [0–2.38])	
Assistant	828 (38%)	4.69 ± 4.82 (3, [0–45])		0.44 ± 0.38 (0.33, [0–2.83])	
Instructor	205 (9%)	4.43 ± 5.47 (3, [0–41])		0.37 ± 0.36 (0.25, [0–2.0])	
Gender					
Male	1,757 (71%)	12.12 ± 12.66 (8, [0–127])	<0.001[b]	0.54 ± 0.44 (0.43, [0–3.53])	<0.995[b]
Female	734 (29%)	6.84 ± 9.07 (4, [0–117])		0.48 ± 0.43 (0.35, [0–3.44])	
Fellowship training					
More than one	197 (8%)	14.47 ± 11.76 (11, [0–61])	<0.001	0.69 ± 0.41 (0.61, [0–2.20])	<0.001
One	2,011 (81%)	10.96 ± 12.20 (7, [0–127])		0.54 ± 0.44 (0.43, [0–3.53])	
None	283 (11%)	5.07 ± 7.92 (2.0, [0–56])		0.32 ± 0.41 (0.19, [0–3.44])	
Subspecialty					
Ocular oncology	20 (%)	19.95 ± 22.12 (10, [0–75])	<0.001	0.87 ± 0.66 (0.70, [0–2.31])	<0.001
Pathology	50 (%)	16.90 ± 14.06 (13, [0–66])		0.62 ± 0.44 (0.51, [0–1.73])	
Vitreoretinal	595 (%)	13.32 ± 13.90 (9, [0–127])		0.64 ± 0.49 (0.54, [0–3.53])	
Neuro-ophthalmology	126 (%)	13.13 ± 11.63 (9.5, [0–46])		0.53 ± 0.37 (0.49, [0–1.66])	
Uveitis	45 (%)	12.73 ± 13.58 (8, [0–51])		0.69 ± 0.46 (0.72, [0–1.75])	
Cornea and external	417 (%)	10.87 ± 11.05 (7, [0–65])		0.54 ± 0.43 (0.44, [0–2.33])	
Glaucoma	366 (%)	10.84 ± 13.25 (6, [0–117])		0.55 ± 0.46 (0.40, [0–3.00])	
Pediatrics	595 (%)	9.02 ± 9.45 (5, [0–62])		0.48 ± 0.34 (0.38, [0–2.83])	
Oculoplastics	221 (%)	7.91 ± 7.10 (6, [0–34])		0.44 ± 0.30 (0.39, [0–1.81])	
Anterior segment	41 (%)	7.61 ± 9.90 (4, [0–38])		0.48 ± 0.47 (0.27, [0–2.14])	
Comprehensive	284 (%)	5.05 ± 7.90 (2, [0–56])		0.32 ± 0.42 (0.19, [0–3.44])	
Region					
West	371 (15%)	12.49 ± 12.50 (8, [0–74])	0.001	0.61 ± 0.45 (0.50, [0–3.0])	<0.001
Midwest	616 (25%)	11.23 ± 13.0 (7, [0–127])		0.52 ± 0.44 (0.43, [0–3.53])	
Northeast	730 (29%)	9.92 ± 11.62 (5, [0–76])		0.50 ± 0.45 (0.37, [0–2.83])	
South	774 (31%)	9.72 ± 10.98 (6, [0–84])		0.50 ± 0.42 (0.37, [0–2.45])	

Note: All *p*-values represent Kruskal–Wallis comparisons among each subgroup.
[a]All results reported as mean ± SD (median, [range]).
[b]Statistical test used Mann–Whitney with two-way ANOVA correcting for academic rank.

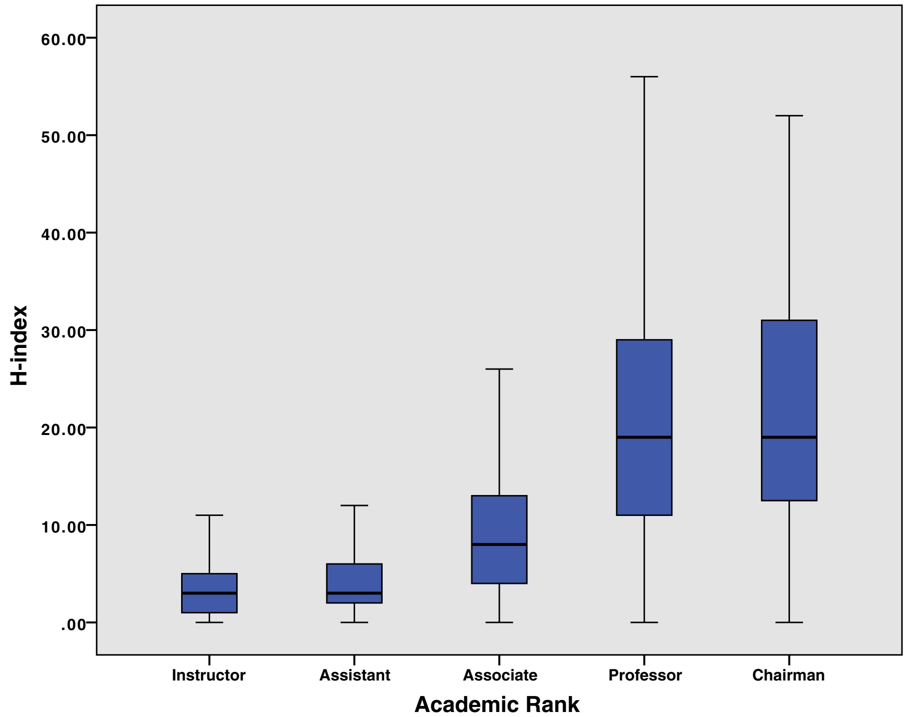

Fig. 1 Mean h-index for each academic rank.

professors, 960 assistant professors, and 265 instructors were reviewed. There was a significant increase in h-index and m-quotient with increasing academic rank (Kruskal–Wallis, $p < 0.001$) (►**Figs. 1** and **2**).

There were 1,989 males (70.4%) and 835 females (29.6%) represented. The mean h-index for males was 12.12 ± 12.66 with a median of 8.0 and a range from 0 to 127, and differed significantly from the mean female h-index of 6.84 ± 9.07 with a median of 4 and a range from 0 to 117 (Mann–Whitney, $p < 0.001$). When corrected for academic rank, the differing h-indices remained significant (two-way ANOVA, $p < 0.001$) (►**Fig. 3**). The mean m-quotient was 0.54 ± 0.44, with a median of 0.43 and a range from 0 to 3.53, and 0.48 ± 0.43, with a median of 3.5 and a range from 0 to 3.44 for males and

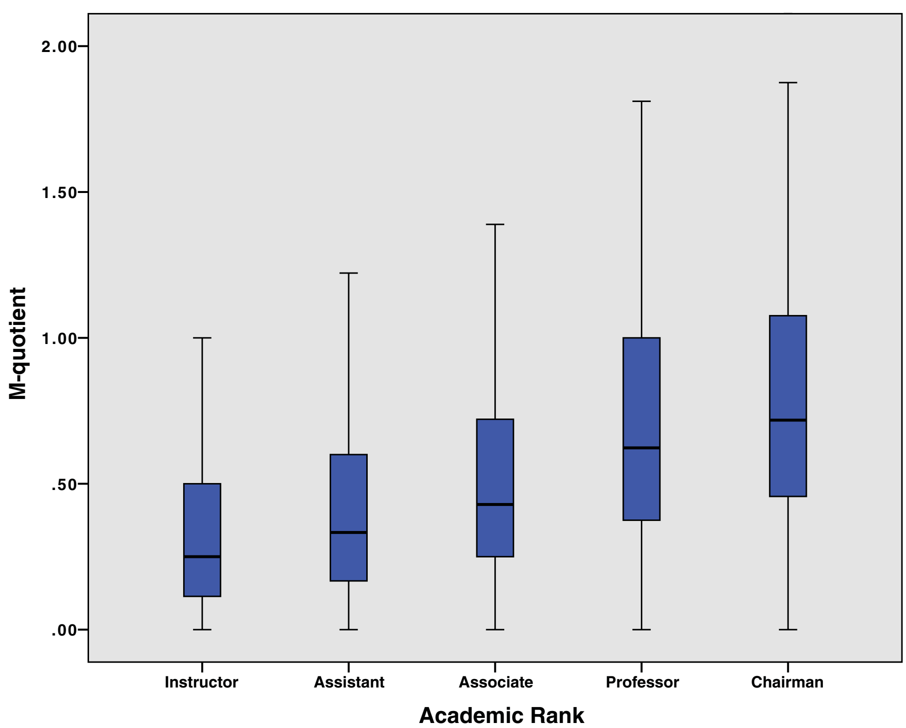

Fig. 2 Mean m-quotient for each academic rank.

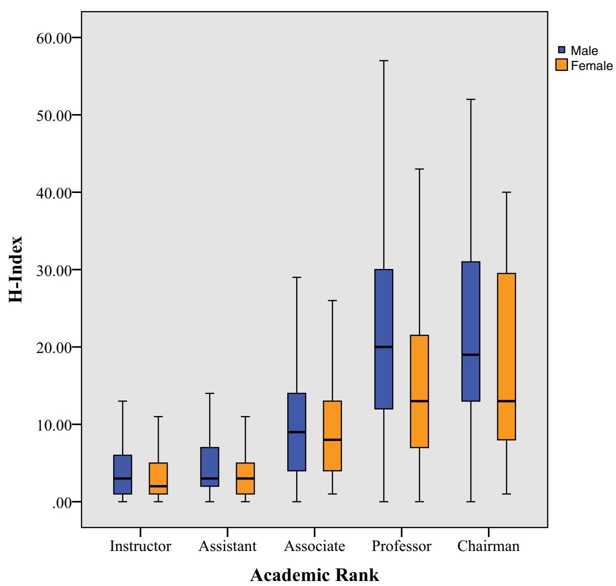

Fig. 3 Mean h-index for gender within each academic rank.

females, respectively, and while this appears significantly different (Mann–Whitney, $p = 0.001$), after correcting for academic rank, the difference was no longer significant (two-way ANOVA, $p = 0.955$). Females held fewer positions in each academic rank. Specifically, 8 of the 110 chair and 92 of the 607 professors positions were held by females (►**Table 2**).

There was a significant increase in h-index and m-quotient among those with fellowship training (Kruskal–Wallis, $p < 0.001$) (►**Table 1**). Those without fellowship training ($n = 283$) had a mean h-index of 5.07 ± 7.92 with a median of 2.0 and a range from 0 to 56 and a mean m-quotient of 0.32 ± 0.41 with a median of 0.19 and a range from 0 to 3.44. Ophthalmologists completing one fellowship ($n = 2{,}011$) had a mean h-index of 10.96 ± 12.20 with a median of 7 and a range from 0 to 127 and a mean m-quotient of 0.54 ± 0.44 with a median of 0.43 and a range from 0 to 3.53. Those completing more than one fellowship ($n = 197$) had a mean h-index of 14.47 ± 11.76 with a median of 11 and a range from 0 to 61, and a mean m-quotient of 0.69 ± 0.41 with a median of 0.61 and a range from 0 to 2.20. There was a significant difference between mean h-indices and m-quotients when comparing physicians with more than one fellowship to those completing only one fellowship (Mann–Whitney, $p < 0.001$).

Cornea and external disease and vitreoretinal disease had the largest number of faculty by subspecialty (►**Fig. 4**). There were significantly different h-indices and m-quotients among the various subspecialties in academic ophthalmology (Kruskal–Wallis, $p < 0.001$). Ocular oncology had the highest h-index, followed by ocular pathology, vitreoretinal disease, and neuro-ophthalmology, uveitis and immunology, cornea and external disease, glaucoma, pediatrics, oculoplastics, anterior segment, and comprehensive ophthalmology (►**Fig. 5**).

Departmental Rankings

The 110 departments were ranked based on the summation and the mean of h-indices within the department. The top five programs based on summed h-indices were the Massachusetts Eye and Ear Infirmary, University of Miami, Thomas Jefferson University, Johns Hopkins University, and the University of Wisconsin (►**Table 3**). The top five programs based on summed m-quotients were the same except for the University of Michigan replacing the University of Wisconsin in rank position 5. The top five programs based on mean h-indices were the University of Wisconsin, University of California San Diego, Johns Hopkins University, Mayo Clinic, and the University of Iowa.

When comparing the mean h-index and m-quotient within a region to other regions in the United States, the west had the highest mean h-index and m-quotient of 12.45 ± 12.50, with a median of 8 and a range from 0 to 74, and 0.61 ± 0.45, with a median of 0.50 and a range from 0 to 3.0, respectively (►**Table 1**). Both these parameters were significantly different when compared with other regions of the United States (Kruskal–Wallis, $p = 0.001$ and $p < 0.001$, respectively).

Discussion

Bibliometrics is a simple, yet powerful tool that can yield information about an individual or a department's scientific influence, which is an important measure of academic success. This approach has gained favor in several medical fields, and the h-index has been used in ophthalmology on a limited basis.[15,23]

In February 2013, Svider et al compared h-indices among different surgical specialties and found that ophthalmology had lower h-indices than general surgery, neurosurgery, orthopedics, and urology, but higher h-indices than obstetrics and gynecology, otolaryngology, and plastic surgery. The study was conducted from a sample of 20 randomly selected departments and included 2,429 surgeons of the various fields.[24]

In 2014, Svider et al found that a higher h-index is strongly associated with NIH funding within ophthalmology[21] and also found a statistical difference in NIH funding when comparing genders.[22] Lopez et al demonstrated gender differences in a review of 1,460 academic ophthalmologists. They found that females are underrepresented at higher academic positions and have significantly lower productivity than

Table 2 Comparison of gender distribution within each academic position

	Instructor	Assistant	Associate	Professor	Chairman
Male	158	570	343	515	102
Female	107	390	151	92	8

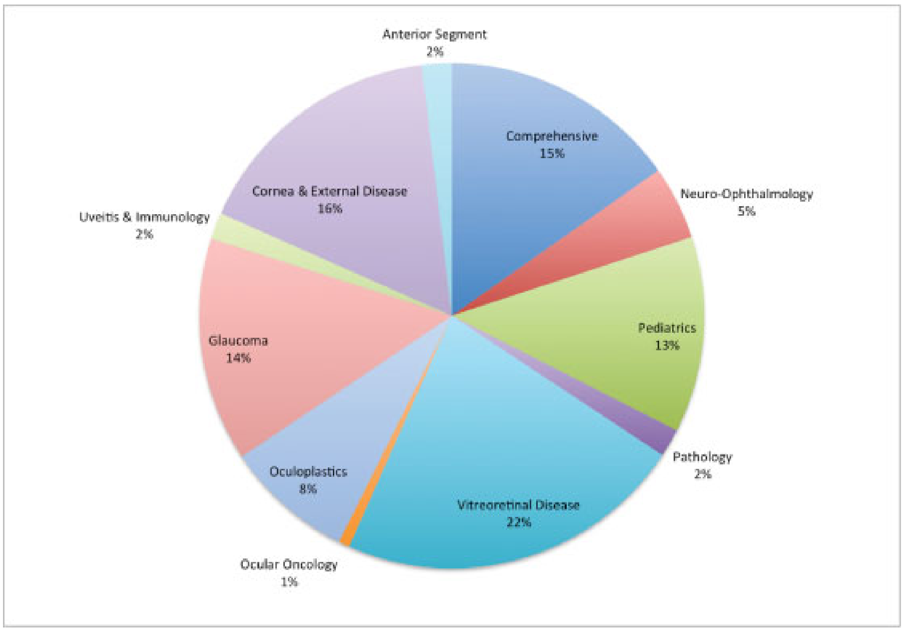

Fig. 4 Pie chart describing the frequency distribution of ophthalmological subspecialties.

males early in their careers. However, when comparing the publication productivity at the end of their careers, male and female scholarly output became equivalent, and females may have even surpassed their male counterparts.[25] Gender differences in our study were similar to those found by Lopez at al, with females making up to ~30% of academic ophthalmology and being underrepresented in higher academic ranks.[25]

Huang et al found that fellowship training correlated with higher publication productivity in 1,440 ophthalmologists.[23] Our study found comparable results, and showed that the h-indices of physicians with multiple fellowships were higher than those with one fellowship. Comparing the fellowship training report by Huang et al, we found similar results, although the order differed slightly.[23] Of note, in our results, there was a trend for smaller volume fields such as ocular oncology, pathology, and uveitis and ocular immunology to have higher h-indices. This may represent the effect of a few extremely productive ophthalmologists in a relatively small pool.

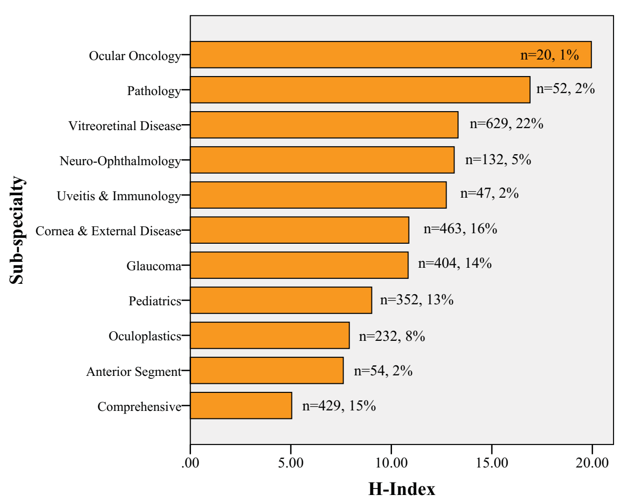

Fig. 5 Mean h-index of each ophthalmological subspecialty.

As in several studies, we found productivity positively correlated with academic rank.[11,15,16,20,21,23–25] There were significant differences between h-indices and m-quotients when comparing academic rank, supporting previous studies linking higher productivity to promotion and tenure.[1,2]

Ranking departments was done to benchmark the publishing record of each department as has been done in other specialties.[15] By measuring the success of the individuals within a department, we can gauge the accomplishment of the department as a whole. Summing the h-indices of each member favored those departments with large volumes of faculty. As such, using the mean of the h-index may be a better benchmark for smaller departments. However, within smaller departments, the mean h-index can be unduly influenced by one or a few outliers, and thus, ranking by mean h-index may not accurately reflect the overall productivity or general support for scholarly activity within a department. Thus, we decided to include both the sum and the mean into the rank lists to allow for meaningful use of the analysis. Furthermore, while the h-index only shows how much activity a researcher has produced in a lifetime, the m-quotient helps illicit those producing consistent literature independent of age. Departments with a high m-quotient ranking could be viewed as supporting the newer academic ophthalmologist and encouraging those advanced in the field to maintain productivity.

This list can be used by deans and chairmen to evaluate their programs since those with higher scholarly impact may be more able to recruit and retain high-quality faculty and residents, as well as procure NIH funding.[3,6,21] Also, prospective faculty and trainees who desire a scholarly program can view this list for comparison purposes when making career choices.

Table 3 Academic rankings of 110 nonmilitary departments in the United States based on summation of h-indices and mean of h-indices for each department

Program	Rank by Σ	Σ h-index	Rank by mean	Mean h-index	No. of faculty
Massachusetts Eye and Ear Infirmary	1	995	17	15.076	66
University of Miami	2	979	12	16.317	61
Thomas Jefferson University	3	963	16	15.787	69
Johns Hopkins University	4	882	3	20.512	43
University of Wisconsin	5	707	1	22.094	35
University of Michigan	6	706	23	13.321	57
University of California, San Francisco	7	666	9	18.000	37
University of Pennsylvania	8	622	6	18.848	34
UCLA Medical Center	9	616	8	18.118	36
Duke University	10	589	30	12.020	50
University of Illinois, Chicago	11	531	26	12.951	41
Northwestern University	12	512	70	7.529	81
New York University	13	507	57	8.311	67
Mayo Clinic	14	491	4	20.458	26
Cleveland Clinic Foundation	15	491	7	18.185	29
University of Iowa	16	473	5	19.708	24
Baylor College of Medicine	17	462	14	15.931	29
California Pacific Medical Center	18	440	62	8.148	68
Emory University	19	437	33	11.205	43
Tufts Medical Center	20	426	22	14.200	37
Oregon Health and Science University	21	414	10	17.250	24
University of California, San Diego	22	404	2	21.263	21
Icahn School of Medicine, Mount Sinai	23	376	42	10.162	40
Washington University	24	371	24	13.250	28
Stanford University	25	368	31	11.500	32
University of Alabama, Birmingham	26	361	63	8.022	50
New York Presbyterian, Columbia	27	344	11	17.200	23
University of Southern California	28	337	13	16.048	21
University of Cincinnati	29	335	38	10.469	40
University of Utah	30	330	19	14.348	25
University of Texas Southwestern	31	313	21	14.227	22
Hofstra North Shore-LIJ School of Medicine	32	304	68	7.600	51
Rush University	33	278	71	7.514	45
Georgetown University	34	268	88	5.956	58
University of Colorado	35	255	79	6.892	42
Detroit Medical Center/Wayne State	36	248	39	10.333	27
University of Pittsburgh	37	241	37	10.478	26
Medical College of Wisconsin	38	237	29	12.474	19
University of North Carolina	39	234	36	10.636	22
Rutgers New Jersey Medical School	40	218	18	14.533	15
University of California, Davis	41	213	28	12.529	18
Albany Medical Center	42	209	74	7.207	37
University of Washington	43	208	72	7.429	30

(*Continued*)

Table 3 (*Continued*)

Program	Rank by Σ	Σ h-index	Rank by mean	Mean h-index	No. of faculty
University of California, Irvine	44	203	27	12.688	16
University of Oklahoma	45	199	67	7.654	29
Vanderbilt University	46	196	65	7.840	31
Medical University of South Carolina	47	184	41	10.222	18
Tulane University	48	184	46	9.684	28
Brown University	49	179	95	4.972	45
Indiana University	50	171	35	10.688	16
University of Tennessee	51	165	60	8.250	24
University of Louisville	52	159	15	15.900	10
University of Minnesota	53	155	45	9.688	17
Ohio State University	54	154	90	5.704	29
University of Texas, Houston	55	152	55	8.444	19
University of Rochester	55	152	55	8.444	19
Summa Health System	57	150	49	8.824	31
New York Eye and Ear Infirmary, Mount Sinai	58	149	58	8.278	19
University of Virginia	59	149	58	8.278	22
Nassau University	60	147	52	8.647	24
Penn State Milton S. Hershey	61	133	40	10.231	15
University of Kentucky	62	131	61	8.188	16
Albert Einstein College of Medicine	62	131	51	8.733	15
New York Presbyterian, Cornell	64	125	78	6.944	19
University of Nebraska	65	123	50	8.786	15
University of Maryland	66	121	86	6.050	20
University of South Florida Morsani	67	119	47	9.154	15
Geisinger Health System	68	118	34	10.727	13
Boston University Medical Center	69	115	89	5.750	20
University of Arizona	70	111	53	8.538	14
SUNY Health Science Center at Brooklyn	71	108	82	6.353	19
George Washington University	72	108	87	6.000	19
William Beaumont Hospital	73	105	25	13.125	11
West Virginia University	74	105	77	7.000	15
Wake Forest University	75	103	73	7.357	15
SUNY Upstate	76	103	108	3.433	47
Eastern Virginia Medical School	77	99	106	3.960	39
Drexel University College of Medicine	78	94	80	6.714	17
Yale University	79	93	83	6.200	15
Loyola University	80	93	92	5.471	26
St. Louis University	81	92	66	7.667	12
Case Western Reserve University	82	91	48	9.100	10
University of Buffalo	83	90	44	10.000	11
New York Medical College, Westchester	84	87	93	5.118	32
University of Florida	85	83	69	7.545	12
University of Missouri, Kansas City	86	83	96	4.882	17

Table 3 (*Continued*)

Program	Rank by Σ	Σ h-index	Rank by mean	Mean h-index	No. of faculty
Kansas University	87	81	43	10.125	9
Bronx Lebanon Hospital Center	88	81	98	4.765	18
University of Texas Medical Branch	89	80	64	8.000	12
Henry Ford Hospital	90	80	94	5.000	17
Sinai Hospital of Baltimore	91	74	84	6.167	12
Medical College of Georgia	92	72	91	5.538	14
Louisiana State University, Ochsner	93	71	76	7.100	19
Loma Linda University	94	67	104	4.188	21
University of Missouri, Columbia	95	64	75	7.111	11
University of Arkansas Medical School	96	63	97	4.846	14
University of Chicago	97	57	20	14.250	4
University of Florida Jacksonville	98	57	32	11.400	7
University of Texas, San Antonio	99	53	107	3.533	17
SUNY at Stony Brook	100	52	101	4.333	13
New York Medical College, Jamaica Hospital	101	47	109	3.357	16
Virginia Commonwealth University	102	45	81	6.429	9
Texas A&M	103	43	85	6.143	7
Louisiana State University, Shreveport	104	42	103	4.200	12
John H. Stroger Hospital of Cook County	105	41	110	2.563	20
University of Mississippi	106	39	101	4.333	11
Howard University	107	37	100	4.625	8
Temple University	108	34	54	8.500	4
Texas Tech University	109	33	99	4.714	9
University of South Carolina, Palmetto	110	33	105	4.125	9

Bibliometric studies assessing productivity in academic medicine are becoming more common. Future reports could be repeated in series to determine trends in academic activity and scholarly impact. Also, in future studies, departments could be evaluated for a specific subspecialty instead of the entire department itself. This information might be useful for residency and fellowship applicants.

As new metrics and reports are developed, caution must be warranted when interpreting those parameters. Hirsch himself stated, "… a single number can never give more than a rough approximation to an individual's multifaceted profile, and many other factors should be considered in combination in evaluating an individual."[8] We look forward to future assessments utilizing robust bibliometric models, such as the h-index, fostering and improving scholarly activity in academic departments.

Limitations

While the h-index is the most recognized parameter, it is not without limitations. First, the size of the studied field greatly influences the h-index.[11,15] Since ophthalmology is relatively small compared with, for example, general surgery, h-indices will tend to be lower for ophthalmology on the basis of its smaller pool of researchers and potential readership. Thus, caution must be used when applying the h-index to compare different specialties, as in the study previously mentioned.[24] This limitation also accounts for some of the differing h-indices in the ophthalmological subspecialties found in our results. For instance, the higher h-indices of ocular pathology and neuro-ophthalmology could be influenced by wider readership (beyond ophthalmology) of pathology and neurology journals. Differences between subspecialties may also be explained by the relative number of ophthalmologists within a subspecialty.

A major criticism of the h-index is that it can be falsely inflated by self-citation.[26] An author might self-cite papers to increase his or her h-index, especially in the beginning of a publishing career, because fewer citations are needed to increase the h-index. Engqvist and Frommen analyzed this problem in a study of 40 evolutionary biologists and ecologists by removing all self-citation counts, and they found the impact of self-citation to be minimal.[26]

Another drawback of the h-index is positively correlated with time spent publishing within a field secondary to the continually maturing citation count.[11] Additionally, some argue that it favors quantity over quality, as very highly cited papers are not adequately accounted for. Other parameters such as the g-index[27] and e-index[28] reward those publications that are very highly cited, something the h-index lacks. However, in prior studies analyzing the productivity of neurosurgery departments, the g-index and e-index were found to be multicollinear with the h-index, resulting in a similar ranking regardless of the citation metric.[15,29]

Our methodology follows protocols utilized in several previous studies.[15,21,23] The database Scopus was chosen because of its unique identification and search capabilities.[15] For example, common names are difficult to identify, but Scopus assigns departments and specialties to each author, making analysis more accurate. Despite these advantages, our study is only as accurate as the accessible data. Data obtained from department Web sites and Scopus may produce erroneous results if outdated, and Scopus itself does not count citations prior to 1996. One might assume this limitation would affect all departments' analyses equally, but that assumption may not be true, and we have no way of determining the effect of this limitation. Our data collection period was 2 months and could have minimally influenced results, as those at the end of the collection period potentially had as much as two additional months to publish or acquire additional citations. Furthermore, as important as it is to review the most actively productive members of the field, benefits can also be gleaned from evaluating idleness. Individuals without h-indices ($n = 333$) were sought out. If found, their publications were then searched in Scopus to ensure internal validity. However, if the individuals could not be located in Scopus, they were considered to be inactive members of the community. These assumptions may have resulted in unintentional, unquantifiable errors in analysis.

Conclusion

This report includes detailed information about publication productivity in academic ophthalmology across academic rank, departmental rankings, gender, region, and subspecialty. This analysis can be used for comparing effectiveness in promoting scholarly activity among academic departments of ophthalmology. We hope that this information provides data that will guide program development and be useful to prospective or current trainees and faculty interested in scholarly productivity. Benchmarks generated by robust bibliometric profiling have the potential to drive improvements needed for the growth of scholarly output within academic departments and the advancement of ophthalmology.

Financial Support

This study was supported in part by an unrestricted grant by the Research to Prevent Blindness.

Note

This article was presented in part as a poster at the American Academy of Ophthalmology Annual Meeting, November 14 to 17, 2015.

References

1 Atasoylu AA, Wright SM, Beasley BW, et al. Promotion criteria for clinician-educators. J Gen Intern Med 2003;18(9):711–716
2 Bligh J, Brice J. Further insights into the roles of the medical educator: the importance of scholarly management. Acad Med 2009;84(8):1161–1165
3 Rezek I, McDonald RJ, Kallmes DF. Is the h-index predictive of greater NIH funding success among academic radiologists? Acad Radiol 2011;18(11):1337–1340
4 Svider PF, Mauro KM, Sanghvi S, Setzen M, Baredes S, Eloy JA. Is NIH funding predictive of greater research productivity and impact among academic otolaryngologists? Laryngoscope 2013;123(1): 118–122
5 Carpenter CR, Cone DC, Sarli CC. Using publication metrics to highlight academic productivity and research impact. Acad Emerg Med 2014;21(10):1160–1172
6 Venable GT, Khan NR, Taylor DR, Thompson CJ, Michael LM, Klimo P Jr. A correlation between National Institutes of Health funding and bibliometrics in neurosurgery. World Neurosurg 2014;81(3–4):468–472
7 Ball P. Achievement index climbs the ranks. Nature 2007; 448(7155):737
8 Hirsch JE. An index to quantify an individual's scientific research output. Proc Natl Acad Sci U S A 2005;102(46): 16569–16572
9 Pagel PS, Hudetz JA. An analysis of scholarly productivity in United States academic anaesthesiologists by citation bibliometrics. Anaesthesia 2011;66(10):873–878
10 Poynard T, Thabut D, Munteanu M, Ratziu V, Benhamou Y, Deckmyn O. Hirsch index and truth survival in clinical research. PLoS ONE 2010;5(8):e12044
11 Lee J, Kraus KL, Couldwell WT. Use of the h index in neurosurgery. Clinical article. J Neurosurg 2009;111(2):387–392
12 Ponce FA, Lozano AM. Academic impact and rankings of American and Canadian neurosurgical departments as assessed using the h index. J Neurosurg 2010;113(3):447–457
13 Spearman CM, Quigley MJ, Quigley MR, Wilberger JE. Survey of the h index for all of academic neurosurgery: another power-law phenomenon? J Neurosurg 2010;113(5):929–933
14 Aoun SG, Bendok BR, Rahme RJ, Dacey RG Jr, Batjer HH. Standardizing the evaluation of scientific and academic performance in neurosurgery—critical review of the "h" index and its variants. World Neurosurg 2013;80(5):e85–e90
15 Khan NR, Thompson CJ, Taylor DR, et al. An analysis of publication productivity for 1225 academic neurosurgeons and 99 departments in the United States. J Neurosurg 2014;120(3): 746–755
16 Svider PF, Choudhry ZA, Choudhry OJ, Baredes S, Liu JK, Eloy JA. The use of the h-index in academic otolaryngology. Laryngoscope 2013;123(1):103–106
17 Quigley MR, Holliday EB, Fuller CD, Choi M, Thomas CR Jr. Distribution of the h-index in radiation oncology conforms to a variation of power law: implications for assessing academic productivity. J Cancer Educ 2012;27(3):463–466
18 Bakkalbasi N, Bauer K, Glover J, Wang L. Three options for citation tracking: Google Scholar, Scopus and Web of Science. Biomed Digit Libr 2006;3:7
19 Turaga KK, Gamblin TC. Measuring the surgical academic output of an institution: the "institutional" H-index. J Surg Educ 2012;69(4): 499–503
20 Benway BM, Kalidas P, Cabello JM, Bhayani SB. Does citation analysis reveal association between h-index and academic rank in urology? Urology 2009;74(1):30–33
21 Svider PF, Lopez SA, Husain Q, Bhagat N, Eloy JA, Langer PD. The association between scholarly impact and National Institutes of Health funding in ophthalmology. Ophthalmology 2014;121(1): 423–428

22 Svider PF, D'Aguillo CM, White PE, et al. Gender differences in successful National Institutes of Health funding in ophthalmology. J Surg Educ 2014;71(5):680–688
23 Huang G, Fang CH, Lopez SA, Bhagat N, Langer PD, Eloy JA. Impact of fellowship training on research productivity in academic ophthalmology. J Surg Educ 2015;72(3):410–417
24 Svider PF, Pashkova AA, Choudhry Z, et al. Comparison of scholarly impact among surgical specialties: an examination of 2429 academic surgeons. Laryngoscope 2013;123(4):884–889
25 Lopez SA, Svider PF, Misra P, Bhagat N, Langer PD, Eloy JA. Gender differences in promotion and scholarly impact: an analysis of 1460 academic ophthalmologists. J Surg Educ 2014;71(6): 851–859
26 Engqvist L, Frommen JG. The h-index and self-citations. Trends Ecol Evol 2008;23(5):250–252
27 Egghe L. Theory and practise of the g-index. Scientometrics 2006; 69:131–152
28 Zhang CT. The e-index, complementing the h-index for excess citations. PLoS ONE 2009;4(5):e5429
29 Taylor DR, Venable GT, Jones GM, et al. Five-year institutional bibliometric profiles for 103 US neurosurgical residency programs. J Neurosurg 2015;123(3):547–560