Five-year institutional bibliometric profiles for 103 US neurosurgical residency programs

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OBJECT Various bibliometric indices based on the citations accumulated by scholarly articles, including the *h*-index, *g*-index, *e*-index, and Google's *i10*-index, may be used to evaluate academic productivity in neurological surgery. The present article provides a comprehensive assessment of recent academic publishing output from 103 US neurosurgical residency programs and investigates intradepartmental publishing equality among faculty members.

METHODS Each institution was considered a single entity, with the 5-year academic yield of every neurosurgical faculty member compiled to compute the following indices: *ih*(5), cumulative *h*, *ig*(5), *ie*(5), and *i10*(5) (based on publications and citations from 2009 through 2013). Intradepartmental comparison of productivity among faculty members yielded Gini coefficients for publications and citations. National and regional comparisons, institutional rankings, and intradepartmental publishing equality measures are presented.

RESULTS The median numbers of departmental faculty, total publications and citations, *ih*(5), summed *h*, *ig*(5), *ie*(5), *i10*(5), and Gini coefficients for publications and citations were 13, 82, 716, 12, 144, 23, 16, 17, 0.57, and 0.71, respectively. The top 5 most academically productive neurosurgical programs based on *ih*(5)-index were University of California, San Francisco, University of California, Los Angeles, University of Pittsburgh, Brigham & Women's Hospital, and Johns Hopkins University. The Western US region was most academically productive and displayed greater intradepartmental publishing equality (median *ih*[5]-index = 18, median Gini_{pub} = 0.56). In all regions, large departments with relative intradepartmental publishing equality tend to be the most academically productive. Multivariable logistic regression analysis identified the *ih*(5)-index as the only independent predictor of intradepartmental publishing equality (Gini_{pub} ≤ 0.5 [OR 1.20, 95% CI 1.20–1.40, *p* = 0.03]).

CONCLUSIONS The *ih*(5)-index is a novel, simple, and intuitive metric capable of accurately comparing the recent scholarly efforts of neurosurgical programs and accurately predicting intradepartmental publication equality. The *ih*(5)-index is relatively insensitive to factors such as isolated highly productive and/or no longer academically active senior faculty, which tend to distort other bibliometric indices and mask the accurate identification of currently productive academic environments. Institutional ranking by *ih*(5)-index may provide information of use to faculty and trainee applicants, research funding institutions, program leaders, and other stakeholders.

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KEY WORDS bibliometrics; *h*-index; institutional; neurosurgery; rank; Gini coefficient; *g*-index; *e*-index; *i10*-index; United States; regional

ABBREVIATION ACGME = Accreditation Council for Graduate Medical Education.

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THE quantification of academic publishing productivity, bibliometrics, or infometrics comprises the statistical analysis of the quality and quantity of research.¹⁹ The most common unit of bibliometric measurement assesses an individual researcher's personal achievements, although bibliometric measurements may also describe a group of researchers (e.g., academic department) or even a peer-reviewed publication (e.g., journal impact factor).

Many bibliometric indices are based on the citations accumulated by a scholarly article, including the *h*-index, *g*-index, *e*-index, and Google's *i10*-index. Varying combinations of these metrics have been applied to medical specialties, including anesthesiology,²⁰ hepatology,²² surgery,³⁰ otolaryngology,²⁶ radiation oncology,²³ radiology,²⁴ urology,⁴ psychiatry,¹⁴ and neurosurgery.^{2,17,18,21,25}

Recently, bibliometric researchers evaluating neurosurgical academic productivity have made efforts to extend and refine the use of bibliometric science in academic publishing.^{2,6,15–18,21,25,27,29,31} We previously created bibliometric profiles (*h*-index, *g*-index, *h_c*-index, *m*-quotient) for 1225 academic neurosurgeons from 99 programs in the United States, including comparisons among clinical subspecialties.¹⁷ We also ranked programs by totaling the *h*-indices of each individual program faculty member, yielding a cumulative, or summed *h*-index.¹⁷ However, because the *h*-index evaluates a researcher's entire publishing career and may increase with time based on the strengths of prior research successes, ranking programs by the department's cumulative *h*-index does not accurately depict more recent research achievements. The cumulative *h*-index is also overly sensitive to the contributions of individual, exceptionally productive faculty members, including those no longer academically active. Thus, the cumulative *h*-index may not provide a useful metric for program evaluation by faculty and resident applicants, funding bodies, and program leadership focused on contemporary academic opportunities and program improvement.

In 2010, Ponce and Lozano²¹ ranked 99 US and 14 Canadian neurosurgical programs using 3 different methods: all-time academic output, 10-year performance, and publication rates within 2 of the leading neurosurgical journals (*Journal of Neurosurgery* and *Neurosurgery*). Their rankings included publications by nonneurosurgical department members, making it difficult to determine the impact of specifically neurosurgeon-derived contributions to productivity rankings, and also depended on the *h*-index as a core measure.

To provide a more accurate assessment of neurosurgical program publishing productivity, the present report considers each department as an individual academic unit by creating a bibliometric profile based upon the department's cumulative publications and citations over a discrete 5-year period. The resulting 5-year institutional *h*-index—or *ih*(5)-index—avoids repeat counting of individual publications with multiple institutional authors and reliance on the academic productivity of individual department members remote in time or accumulated previously at other institutions. By comparing the *ih*(5)-index with other bibliometric indices, we provide a comprehensive assessment of the recent publishing productivity of 103

US neurosurgery residency programs accredited by the Accreditation Council for Graduate Medical Education (ACGME). We also investigated intradepartmental publishing equality with the use of Gini coefficients and Lorenz curves and describe the relationship between equality and overall productivity.

Methods

Selection of Programs

A list of the 2014 neurological surgery residency training programs was compiled according to the ACGME (<http://www.acgme.org/ads/Public/Reports/ReportRun?ReportId=1&CurrentYear=2013&SpecialtyId=35>). Departmental websites were consulted for faculty names, excluding all nonneurosurgical faculty members. Attempts were made by email and phone to obtain relevant information that was unclear or unavailable in the departmental websites. Two programs—Cleveland Clinic and the National Capital Consortium—were excluded from analysis due to insufficient or unavailable information, which left 103 of the total 105 programs listed with accredited status for the year ending on June 30, 2014. All calculations were carried out during the months of January and February of 2014.

Bibliometric Analysis

Each neurosurgical institution was converted into a single entity whereby each neurosurgical faculty member's 5-year academic yield—measured in publications and citations—was compiled to compute the various metrics as listed below. A protocol was defined (also detailed below) for acquiring publication and citation data, and it was rigorously followed to ensure the most accurate evaluation of an institution's 5-year scholarly contributions to the field of neurosurgery.

In order for an article to count toward an institution's contribution, it had to include a neurosurgeon from that institution among the listed authors. For example, if a paper had 10 authors, including 5 neurologists, 3 neuroradiologists, 1 pharmacist, and 1 neurosurgeon from a single institution, then this paper would be included in the analysis for that institution. Conversely if a paper's authorship consisted of only neurophysicists and neurologists (i.e., no neurosurgeons) then this paper would not count toward an institution's bibliometric index.

After composing a list of faculty for each institution, Scopus (Elsevier, www.scopus.com) was queried to obtain publication and citation data. The author search function was used to uniquely identify a faculty member, and each search was limited to only peer-reviewed articles published from 2009 to 2013. An author's contributions counted toward the total publication and citation number of the institution listed as his or her affiliation on the published paper. We accomplished this by scrutinizing article headings of individual publications to account for any change in institutional affiliation over the last 5 years. If multiple authors from the same institution were on the same paper, the following authorship assignment algorithm was used to ensure that each publication was counted only once: the paper was assigned in the order of first author, second au-

thor, last author, then third author, and so on. Conversely, if the publication was multiinstitutional, each institution would receive credit for the academic product attributed to that institution's respective faculty (no more than 1 author per institution).

Definition of Metrics

After identifying an institution's total publications and citations for the period 2009–2013 using Scopus, all data were entered into a Microsoft Excel spreadsheet, where publications were listed in decreasing order by number of citations. The following bibliometric measurements were calculated for each institution (*i*). Each metric is noted as “(5)” to indicate that the metric was calculated for a finite 5-year period and not for each individual member's entire career.

1. *ih*(5)-index: $ih(5) = h(\text{publications})$ with $\geq h(\text{citations})$; an institution's number of publications (*h*) with at least *h* citations.¹³ It is the point at which the number of citations intersects the number of publications listed in descending order by citation count. We also normalized the *ih*(5)-index for the 103 neurosurgical residency programs to account for each institution's respective faculty number (at the time of our analysis) by using a simple ratio: *ih*(5)-index/faculty number. This result can be viewed as the average, equal contribution that each neurosurgeon on faculty makes to the department's 5-year (2009–2013) *h*-index.
2. *ig*(5)-index: $ig(5) = g(\text{publications})$ with $\geq g^2(\text{citations})$; an institution's number of publications (*g*) that cumulatively have received at least g^2 citations.¹⁰ The *g*-index is designed to complement the *h*-index to more accurately capture highly cited publications.
3. *ie*(5)-index: $ie(5) = \sqrt{\text{total citations of } h \text{ papers} - h^2}$; calculated by determining the total number of citations from papers that make up the institution's *ih*(5)-index, then subtracting the minimum number of citations required to reach that *ih*(5)-index (h^2).³² The square root of this excess citation count is the *ie*(5)-index.³² Like the *g*-index, the *e*-index was designed for highly cited publications.
4. *i10*(5)-index: $i10(5) = n(\text{publications})$ with ≥ 10 citations; initially created by Google Scholar (<http://scholar.google.com>), the number of articles produced by an institution within the allotted 5-year span, acquiring 10 or more citations.

For additional comparison, the summed *h*-index was acquired from our previous publication by Khan et al.¹⁷ The summed *h*-index is the cumulative, life-long (i.e., not restricted to 5 years) *h*-indices of all members within a department. The summed *h*-index was manually calculated from Scopus during the months of April–May 2013 to include all of each individual's publications up to that point, including those before the year 1996.

Ranking of Programs

With the exception of the 2 programs noted above, all ACGME-accredited US neurosurgical training programs

(*n* = 103) were ranked by the defined metrics and by total number of publications and citations as well as Gini coefficients for publications and citations (see below).

Publication Equality

To assess academic equality within each department, Lorenz curves and Gini coefficients were generated for each program's publications and citations. The Lorenz curve is constructed with cumulative percent authors and cumulative percent publications or citations.⁵ Thus, equal contribution by each faculty member would construct a straight 45° line of equality. Each department's Lorenz curve was first calculated using publications from neurosurgeons who were part of a particular department during the specified time period. The Gini coefficient is a mathematical summary of inequality for author contribution to the department publication total based on the Lorenz curve. A Gini coefficient of 0 indicates equal contribution of department members to the overall publication rate; a value of 1 indicates complete inequality.

Statistical Analysis

After the various institution-specific metrics and Gini coefficients were calculated, pooled descriptive statistics were calculated for all 103 programs. Metrics were then compared based upon regional location of the institution as determined by the US Department of Commerce Economics and Statistics Administration, US Census Bureau (Fig. 1). Bivariate correlation was performed to assess relationship between the various indices and to determine if multicollinearity existed.

We also sought to identify whether any of the bibliometric indices discussed were predictors of intraprogram publication equality, which we defined as a publication Gini coefficient ($Gini_{pub} \leq 0.5$). Univariate analysis was performed between institutions having a Gini coefficient ≤ 0.5 and those who had a higher value, which was followed by multivariable logistic regression that included an adjustment for multicollinearity between metrics. Two-tailed statistical tests were used, and a *p* value of ≤ 0.05 was determined to represent statistical significance in the univariate and multivariable analysis. Results were reported as adjusted odds ratios with corresponding 95% confidence intervals. All data were analyzed using SPSS software (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0).

Results

Bibliometric Analysis and Regional Comparisons

The national and regional bibliometric characteristics of neurosurgical training programs with ACGME accreditation in the US and Puerto Rico (*n* = 103) are listed in Table 1. All distributions were positively skewed. The median number of faculty was 13. The median number of publications was 82, with a median of 716 citations. Other median indices were also found: *ih*(5)-index, 12; summed *h* index, 144; *ig*(5)-index, 122; *ie*(5)-index, 16; and *i10*(5)-index, 17. Finally, the median Gini coefficients for publications and citations for all analyzed departments were 0.57 and 0.71, respectively.

FIG. 1. Geographic subdivisions of the United States of America as defined by the US Census Bureau used for regional comparisons of neurosurgery departments.

Neurosurgical programs from the Western region were found to be the most academically productive over the past 5 years (2009–2013), with a median *ih*(5)-index of 18. This region was also noted to have the smallest number of neurosurgical departments ($n = 16$) but the largest median number of faculty per institution ($n = 16.5$). The West was followed by the Midwest as second most productive region, with a median *ih*(5) of 14 and 24 departments. The Northeast—with a median *ih*(5) of 12 and 26 departments—and the South—with a median *ih*(5) of 12 and 37 departments—were tied for lowest median *ih*(5)-index. Overall, the West had the highest values for all remaining metrics—i.e., summed *h*, *ig*(5), *e*(5), *i10*(5), and total publications and citations—and the lowest Gini coefficients for publications.

All bibliometric indices—*ih*(5), summed *h*, *ig*(5), *ie*(5),

i10(5)—were found to be significantly positively correlated to number of faculty, total publications, total citations, and negatively correlated with publication and citation Gini coefficients (Table 2).

Institutional Rank

Rankings based on obtainable data for all US neurosurgical departments according to *ih*(5)-index, *ih*(5)-index corrected by faculty number, summed *h*-index, total publications, and total citations are listed in Table 3. The top 5 most academically productive neurosurgical programs over the past 5 years based on the *ih*(5)-index, ordered with the most productive listed first, are the University of California, San Francisco, University of California, Los Angeles, University of Pittsburgh, Brigham & Women's Hospital, and Johns Hopkins University. Alternatively, us-

TABLE 1. National and regional characteristics of neurosurgery training programs

Characteristic	Total ($n = 103$)	Midwest ($n = 24$)	Northeast ($n = 26$)	South ($n = 37$)	West ($n = 16$)
Faculty	13 [9.0–18.0]	12.0 [9.0–15.5]	14.0 [11.0–19.0]	12 [8.0–15.5]	16.5 [10.0–21.0]
Total publications	82 [37.5–172.0]	97.0 [64.0–142]	55 [41.0–178.0]	69 [30.0–125.0]	155.5 [49.5–248.0]
Total citations	716 [297–1504]	754 [470.0–1002]	468 [284–2043]	453 [230.5–1236]	1389 [558.5–2899]
<i>h</i> -index					
<i>ih</i> (5)	12 [8.5–19.0]	14 [10–17.0]	12 [8.0–22.0]	12 [8.0–17.5]	18 [10.5–23.5]
Summed	144 [79.5–231]	141 [85.0–202]	170 [98.0–263]	94 [69.0–194.5]	236.5 [98.5–319.5]
<i>ig</i> (5)-index	23 [14.5–32.5]	23 [17.0–27.0]	19 [14.0–39.0]	19 [13.0–30.5]	29.5 [22.0–45.5]
<i>ie</i> (5)-index	16 [10.0–24.5]	16 [11.0–18]	15 [10.0–26.0]	14 [9.0–23.5]	20.5 [14.5–34.5]
<i>i10</i> (5)-index	17 [8.0–42.0]	22 [10–32.5]	14 [8.0–50.0]	14 [7.0–28.5]	42 [11.0–63.0]
Gini coefficient					
Publications	0.57 [0.5–0.67]	0.58 [0.52–0.64]	0.57 [0.50–0.67]	0.62 [0.51–0.71]	0.56 [0.45–0.61]
Citations	0.71 [0.63–0.78]	0.66 [0.62–0.74]	0.71 [0.64–0.76]	0.75 [0.67–0.81]	0.69 [0.60–0.78]

* All data are presented as median [25%–75% interquartile range]. Regional assessment determined by US Department of Commerce Economics and Statistics Administration, US Census Bureau.

TABLE 2. Spearman's coefficient and significance values for bibliometric indices

Metric	Number of Faculty	Total Publications	Total Citations	Gini Coefficient for Publication	Gini Coefficient for Citations
<i>h</i> -index					
<i>ih</i> (5)	0.68; $p < 0.001$	0.93; $p < 0.001$	0.97; $p < 0.001$	-0.43; $p < 0.001$	-0.46; $p < 0.001$
Summed	0.84; $p < 0.001$	0.87; $p < 0.001$	0.84; $p < 0.001$	-0.29; $p = 0.002$	-0.30; $p = 0.003$
<i>ig</i> (5)-index	0.66; $p < 0.001$	0.89; $p < 0.001$	0.99; $p < 0.001$	-0.43; $p < 0.001$	-0.35; $p < 0.001$
<i>ie</i> (5)-index	0.61; $p < 0.001$	0.79; $p < 0.001$	0.93; $p < 0.001$	-0.37; $p < 0.001$	-0.22; $p = 0.02$
<i>il0</i> (5)-index	0.69; $p < 0.001$	0.94; $p < 0.001$	0.97; $p < 0.001$	-0.43; $p < 0.001$	-0.46; $p < 0.001$

ing the summed *h*-index resulted in a significantly different and variable ranking order. A positive change in ranking was observed in 54 programs, with a mean change of 13 (range 1–42). Forty-five programs had a negative change in ranking and fell an average of 14 spots (range 1–39). The ranking of 5 programs did not change. The 10 programs with the largest changes in rank between these 2 methods is shown in Fig. 2. A comparison of departmental ranks based on the *ig*(5)-index, *ie*(5)-index, *il0*(5)-index, as well as the intradepartmental Gini coefficients for publications and citations can be found in Appendix 1.

Predicting Intradepartmental Publishing Equality

Twenty-nine (28%) of 103 neurosurgical programs achieved the target $Gini_{pub} \leq 0.5$, signifying the top quartile of intradepartmental publication equality among programs. When institutions were stratified by $Gini_{pub} \leq 0.5$, we observed a statistically significant difference in all variables except for the number of faculty and summed *h*-index (Table 4). After adjustment for multicollinearity, the multivariable logistic regression analysis identified the *ih*(5)-index as an independent predictor of a $Gini_{pub} \leq 0.5$ (OR 1.20; 95% CI 0.20–1.40, $p = 0.03$) (Table 5). The logistic regression was adequately calibrated based on a nonsignificant Hosmer-Lemeshow goodness-of-fit p value of 0.45, and the model had good discrimination based on area under the receiver operator characteristic curve of 0.68.

Discussion

Validating the *ih*(5)-Index

There are many ways to assess research productivity, such as number of publications, grants awarded, professional reputation, professional leadership posts, and academic faculty retention rate of graduates.¹² Bibliometric indices, including the well-known *h*-index, are sometimes used as quantitative metrics in the evaluation of grant and fellowship applications and faculty employment, promotion, and tenure decisions.^{3,21}

A neurosurgical program's ability to attract the most innovative and productive resident and faculty applicants relies on the accurate and transparent display of program attributes, including the presence of an academically productive environment. The present analysis defines bibliometric benchmarks for academic productivity in US neurosurgical programs. Similar to Google Scholar journal rankings (http://scholar.google.com/citations?view_op=top_venues&hl=en), the *ih*(5)-index provides a simple

and accurate method of gauging a program's contemporary publication productivity and, indirectly, its academic impact and research potential. Additional bibliometric indices, such as total number of publications and citations, provide a more comprehensive description of the academic characteristics and ranking of any individual program.

There have been few attempts to accurately quantify and rank institutions' contemporary academic productivity.^{12,17,21,30} Such efforts require sound methodology that incorporates easily accessible data over a discrete and reasonable time period, accounting for the hetero- or homogeneity that may occur from year to year. Adequate time to accumulate citations is also required. Turaga et al.³⁰ used the *h*-index to evaluate the academic productivity of general surgery programs from the top 10 research medical schools, according to *U.S. News and World Report*. They analyzed the productivity between each school in 1, 2, and 3-year increments. Only the 3-year increment significantly discriminated between programs.³⁰

Ranking 78 US radiation oncology departments¹² and 99 US and Canadian neurosurgical departments²¹ using a 10-year time span was limited by the inability of departmental search strings to distinguish clinical from nonclinical or affiliated faculty contributions. This method overestimates the *h*-indices of institutions with large affiliate clinical and basic science divisions.^{12,21} To focus on neurosurgical content and author productivity, Ponce and Lozano²¹ calculated the 10-year *h*-index of each institution, using only those articles found within the 2 most highly referenced neurosurgical journals (*Journal of Neurosurgery* and *Neurosurgery*). This approach, however, ignores important research produced by neurosurgeons but published in journals other than these specific neurosurgical journals. By contrast, the *ih*(5)-index summarizes data relevant only to the publications of active clinical neurosurgeons over a manageable time period that should reasonably reflect current productivity.

We believe the *ih*(5)-index is superior to the cumulative or summed *h*-index for several reasons. When trying to assess a department's present research potential, it is more appropriate to analyze the institution's more recent body of work. The summed *h*-index inherently favors the past efforts of individual, seasoned researchers irrespective of the quality or volume of ongoing research. Moreover, of all bibliometric indices, the summed *h*-index is most closely associated with number of faculty, arbitrarily favoring larger departments.

By contrast, the *ih*(5)-index limits the influence of highly productive individual outliers and instead empha-

TABLE 3. Comparison of departmental rankings based upon institutional and summed *h*-index, total publications, and total citations

Department	<i>ih</i> (5)-index		Summed <i>h</i> -index		Total Publications		Total Citations		Faculty Number
	Rank*	Number†	Rank	Number	Rank	Number	Rank	Number	
University of California, San Francisco	1 [30]	42 {1.273}	1	625	1	680	1	9048	33
University of California, Los Angeles	2 [15]	36 {1.565}	5	467	5	360	2	6038	23
University of Pittsburgh	3 [58]	31 {0.912}	4	471	3	388	5	4065	34
Brigham & Women's Hospital	3 [5]	31 {1.938}	16	289	10	263	4	4250	16
Johns Hopkins University	5 [55]	29 {0.936}	3	509	2	557	3	4795	31
University of Virginia	6 [2]	28 {2.000}	8	361	6	328	7	3552	14
Duke University Hospital	7 [7]	27 {1.800}	13	298	10	263	6	3783	15
Ohio State University	7 [35]	27 {1.227}	22	258	12	261	11	3013	22
St. Joseph's Hospital and Medical Center/Barrow Neurological Institute	9 [60]	26 {0.897}	2	513	4	365	8	3547	29
Stanford University	9 [48]	26 {1.000}	9	342	8	279	9	3534	26
Northwestern University	11 [43]	26 {1.130}	21	261	12	261	15	2468	23
Columbia University	12 [27]	25 {1.316}	6	410	7	291	12	2843	19
University of Florida	12 [24]	25 {1.389}	27	229	14	246	10	3236	18
University of Pennsylvania	14 [18]	24 {1.500}	11	302	25	178	14	2757	16
Cornell University	14 [2]	24 {2.000}	43	179	20	204	19	2043	12
Massachusetts General Hospital	16 [40]	23 {1.150}	7	386	9	271	16	2401	20
Emory University	17 [39]	22 {1.158}	26	230	19	207	18	2212	19
University at Buffalo	17 [12]	22 {1.692}	41	185	32	146	13	2812	13
Washington University	19 [28]	21 {1.313}	12	299	22	189	26	1441	16
University of Washington	19 [37]	21 {1.167}	15	291	23	187	20	1847	18
University of Miami	19 [37]	21 {1.167}	19	272	28	153	30	1338	18
Cedars-Sinai Medical Center	19 [18]	21 {1.500}	25	232	29	152	23	1692	14
Oregon Health & Science University	23 [17]	20 {1.539}	24	241	26	166	17	2264	13
Case Western Reserve University	23 [22]	20 {1.429}	50	144	31	147	29	1363	14
University of Utah	25 [47]	19 {1.056}	17	278	16	217	25	1568	18
Yale University	25 [26]	19 {1.357}	23	243	39	127	22	1697	14
Baylor College of Medicine	25 [31]	19 {1.267}	37	190	24	182	28	1422	15
Thomas Jefferson University	28 [66]	18 {0.818}	20	263	17	216	24	1608	22
University of Alabama, Birmingham	28 [29]	18 {1.286}	34	196	21	202	26	1441	14
Virginia Commonwealth University	28 [14]	18 {1.636}	49	148	56	69	31	1315	11
Mayfield Clinic/University of Cincinnati	31 [73]	17 {0.739}	28	225	34	137	36	1046	23
University of South Florida	31 [79]	17 {0.680}	28	225	40	112	38	946	25
University of Michigan	31 [64]	17 {0.850}	32	202	15	241	21	1791	20
New York University	31 [36]	17 {1.214}	35	195	35	134	34	1120	14
University of Texas Southwestern	31 [68]	17 {0.810}	36	193	56	69	47	759	21
Colorado University	31 [61]	17 {0.895}	40	187	30	151	32	1210	19
University of Chicago	31 [70]	17 {0.769}	60	113	48	87	39	925	10
University of California, San Diego	38 [62]	16 {0.889}	28	225	37	129	43	843	18
University of Wisconsin	38 [46]	16 {1.067}	37	190	41	111	37	958	15
Henry Ford Hospital	40 [8]	16 {1.778}	45	157	50	82	40	921	9
University of Southern California	41 [48]	15 {1.000}	14	297	27	159	35	1062	15
Methodist Houston	41 [48]	15 {1.000}	46	154	49	83	33	1157	15
University of Maryland	41 [25]	15 {1.364}	48	149	51	80	50	716	11
Medical University of South Carolina	41 [18]	15 {1.500}	75	79	42	110	45	832	10
Wayne State University	41 [13]	15 {1.667}	83	65	45	97	50	716	9
University of Iowa	46 [16]	14 {1.556}	56	129	37	129	43	843	9
University of Illinois, Peoria	46 [9]	14 {1.750}	73	83	55	71	53	571	8

(continued)

TABLE 3. Comparison of departmental rankings based upon institutional and summed *h*-index, total publications, and total citations
(continued)

Department	<i>ih</i> (5)-index		Summed <i>h</i> -index		Total Publications		Total Citations		Faculty Number
	Rank*	Number†	Rank	Number	Rank	Number	Rank	Number	
Vanderbilt University	48 [71]	13 {0.765}	31	222	33	138	49	726	17
Mayo Clinic, Rochester	49 [48]	12 {1.000}	10	317	35	134	56	523	12
Mount Sinai School of Medicine	49 [92]	12 {0.462}	18	276	63	55	60	468	26
Semmes-Murphey Clinic/University of Tennessee, Memphis	49 [72]	12 {0.750}	42	181	52	76	42	846	16
Medical College of Wisconsin	49 [56]	12 {0.923}	53	141	53	72	52	699	13
Tufts Medical Center	49 [10]	12 {1.714}	62	98	44	99	61	460	7
Dartmouth University	49 [2]	12 {2.000}	68	90	58	64	58	485	6
George Washington University	49 [56]	12 {0.923}	72	85	60	61	67	356	13
National Institutes of Health (NIH)	49 [1]	12 {2.400}	89	55	71	41	41	917	5
NSLIJ/Hofstra University	57 [78]	11 {0.688}	44	170	68	45	75	292	16
University of Kentucky	57 [6]	11 {1.833}	76	76	84	29	66	361	6
Loma Linda University	57 [48]	11 {1.000}	81	67	75	37	68	336	11
Indiana University	60 [94]	10 {0.417}	32	202	18	214	46	802	24
Allegheny General Hospital	60 [84]	10 {0.526}	39	188	66	49	76	284	19
University of Illinois, Chicago	60 [11]	10 {1.700}	50	144	47	90	63	448	13
University of California, Davis	60 [45]	10 {1.111}	61	107	61	60	55	549	9
University of Minnesota	60 [32]	10 {1.250}	64	96	64	53	73	302	8
Wake Forest University	60 [48]	10 {1.000}	67	92	58	64	62	453	10
University of Rochester	60 [65]	10 {0.833}	68	90	69	45	59	477	12
University of New Mexico	60 [32]	10 {1.250}	68	90	73	39	54	568	8
University of Kansas	60 [32]	10 {1.250}	90	54	62	57	57	492	8
University of Texas, Houston	69 [91]	9 {0.474}	47	153	76	34	71	306	19
Rush University Medical Center	69 [66]	9 {0.818}	57	123	43	104	65	379	11
Georgia Regents University	69 [59]	9 {0.900}	74	80	74	38	82	218	10
Mayo Clinic, Florida	69 [44]	9 {1.125}	77	75	53	72	73	302	8
Albany Medical Center	69 [48]	9 {1.000}	83	65	70	44	64	385	9
Louisiana State University, New Orleans	69 [18]	9 {1.500}	91	50	80	31	77	278	6
New York Medical College	75 [95]	8 {0.400}	52	142	82	30	79	261	20
Brown University School of Medicine	75 [74]	8 {0.727}	54	139	65	52	69	325	11
Louisiana State University Shreveport	75 [41]	8 {1.143}	65	94	45	97	78	264	7
West Virginia University	75 [82]	8 {0.571}	65	94	79	32	83	207	14
University of Texas, San Antonio	75 [62]	8 {0.889}	79	69	85	27	84	189	9
University of North Carolina	75 [41]	8 {1.143}	87	56	89	19	85	174	7
Georgetown University	75 [80]	8 {0.667}	96	41	67	48	80	243	12
SUNY/Upstate Medical University	82 [81]	7 {0.636}	58	122	71	41	91	114	11
University of Nebraska	82 [85]	7 {0.500}	71	87	80	31	48	754	14
University of California, Irvine	82 [69]	7 {0.778}	82	66	87	23	86	157	9
University of Vermont	82 [23]	7 {1.400}	87	56	89	19	92	109	5
Penn State University	86 [96]	6 {0.375}	59	119	76	34	90	115	16
Albert Einstein College of Medicine	87 [93]	5 {0.455}	55	135	82	30	70	321	11
Saint Louis University	87 [75]	5 {0.714}	86	58	92	18	87	129	7
Loyola University	87 [85]	5 {0.500}	92	48	96	12	96	65	10
University of Arizona	87 [75]	5 {0.714}	94	42	94	14	94	85	7
Carolinas Medical Center‡	87 [85]	5 {0.500}	N/A	N/A	89	19	81	238	10
University of Texas, Galveston‡	87 [75]	5 {0.714}	N/A	N/A	86	26	93	86	7
University of Medicine and Dentistry of New Jersey	93 [82]	4 {0.571}	78	70	76	34	95	77	7

(continued)

TABLE 3. Comparison of departmental rankings based upon institutional and summed *h*-index, total publications, and total citations (continued)

Department	<i>ih</i> (5)-index		Summed <i>h</i> -index		Total Publications		Total Citations		Faculty Number
	Rank*	Number†	Rank	Number	Rank	Number	Rank	Number	
University of Mississippi	93 [85]	4 {0.500}	94	42	92	18	98	32	8
Geisinger Health System‡	93 [85]	4 {0.500}	N/A	N/A	99	8	89	123	8
University of Arkansas	96 [103]	3 {0.231}	62	98	96	12	97	34	13
University of Louisville	96 [96]	3 {0.375}	79	69	88	22	88	126	8
University of Oklahoma	96 [96]	3 {0.375}	85	62	94	14	72	303	8
Tulane University	96 [100]	3 {0.250}	96	41	98	9	99	31	12
University of Puerto Rico	96 [96]	3 {0.375}	98	23	101	6	100	18	8
Temple University	101 [85]	2 {0.500}	99	22	102	4	101	12	4
University of Missouri	102 [100]	1 {0.250}	92	48	99	8	102	9	4
Southern Illinois University‡	102 [100]	1 {0.250}	N/A	N/A	103	1	103	5	4

N/A = not available.

* [] indicates program rank corrected by faculty number.

† { } indicates mean *h*-index per faculty during the five year period from 2009–2013.‡ Summed *h*-index data not available at time of original publication.

sizes the academic productivity of the institution as a whole. The *ih*(5)-index is also notably less well correlated to number of faculty. Nonetheless, larger departments will continue to have some advantage over smaller ones, using any metric.

There is significant variability between neurosurgical department rankings by cumulative *h*-index versus *ih*(5)-index. For example, Wayne State University ranks 42 places higher using the *ih*(5)-index (41st vs 83rd; Fig. 2). Two major characteristics are likely present in programs ranking substantially higher using the *ih*(5)-index: 1) relatively strong contemporary academic productivity and 2) contribution to productivity by a relatively high percentage of department faculty. Each of these factors is likely to be indicative of a promising research environment for resident and faculty development or funding investment.

In an attempt to further explore the effect of faculty number on academic productivity, a ratio of *ih*(5)-index to faculty number was calculated for each institution, thus assigning a mean *h*-index per faculty within a department. When ranked by this method, as one might expect, the results tended to favor smaller departments with 6 of the top 10 ranked programs having a faculty number less than 10 (range 5–16). For example, the top-ranked program, National Institutes of Health (NIH), has only 5 members. Correcting the *ih*(5) by faculty number shifts the focus back to the individual level rather than the institutional level. The corrected and uncorrected *ih*(5) each provide a unique metric for analyzing departmental academic output; however, we leave it to the reader to choose which focus (i.e., emphasizing individual vs institutional output) is the best measure.

The *ig*(5)-index, *ie*(5)-index, and *ilo*(5)-index, which in part reflect the generation of additional citations in particularly high impact publications, provide one quantitative bibliometric estimation of research publication quality. The top 10 ranked programs according to the *ih*(5)-index, are almost all in the top 10 rank using these additional “publication quality” bibliometric indices: 8/10 for the *ig*(5)-in-

dex; 7/10 for the *ie*(5)-index; and 10/10 for the *ilo*(5)-index (Appendix Table 1). This finding implies that top 10 *ih*(5)-index ranking is associated with both volume and quality in academic publishing (at least to the extent that quality is measured by citation frequency, a controversial assumption).¹ Although a profile of balanced bibliometric indices may most accurately reflect true departmental academic productivity, many of these indices are not independent of one another. In isolation, the *ih*(5)-index may most accurately assess both research quality and quantity.

Intradepartmental Publishing Equality

Relatively equitable research contributions by departmental faculty members may contribute to a productive academic environment. Gini coefficients are a quantitative bibliometric measurement of intradepartmental publishing inequality. Since there is no uniformly accepted Gini coefficient that represents ideal publication equality, we stratified programs into 2 categories using a threshold Gini coefficient ($\text{Gini}_{\text{pub}} \leq 0.5$) that represents the top quartile of US programs. Using this goal, our analysis identified the *ih*(5)-index as an independent predictor of achieving a Ginipub of ≤ 0.5 (OR 1.2; Table 5). These results indicate that for every 1 point increase in *ih*(5)-index, there is a 20% increased odds of achieving a Ginipub value corresponding to the top 25% of all neurosurgery programs nationwide. In other words, an increase in *ih*(5)-index may increase the odds of achieving publication equality among the faculty within a department. When analyzing regions, the Western neurosurgery programs appear to be the most academically productive, with a median *ih*(5) of 18 and a median Ginipub of 0.56. Nevertheless, only 3 of the top 10 programs ranked by *ih*(5)-index demonstrated a Ginipub coefficient of ≤ 0.5 : Brigham and Women's Hospital; Johns Hopkins University; and Duke University. Although publication equality likely plays a role in the success of any institution's academic enterprise, other factors such as faculty professional priorities, compensation

FIG. 2. Neurosurgery programs with the largest change in academic productivity ranked by the *ih*(5)-index versus the summed *h*-index.

incentives, and departmental leadership undoubtedly also play determinative roles.

Limitations

While every effort to achieve accurate data collection was made with rigorous adherence to the study protocol, the accuracy of the data presented here is limited by information available on departmental websites and publication databases.⁸ As mentioned previously, publishing output tends to favor larger departments, which in turn are more likely to have greater funding, ancillary support, access to research networks, and Internet presence. Other crucial scholarly efforts, such as teaching, conference presentations, grant funding, and professional society leadership, are not reflected by bibliometric indices.¹² Moreover, the

effectiveness of teaching and clinical care cannot be derived from bibliometrics.¹² Nevertheless, the *ih*(5)-index is a valuable indicator of the professional impact of the single most visible, marketable, and measurable result of academic productivity: peer-reviewed publications.

Future Applications

The present data provide the most accurate available snapshot of the departmental scholarly efforts of 103 US neurosurgical programs to date. Measuring academic output allows institutions to reflect and develop strategies to enhance the quality of their research environment. Neurosurgical programs in the Western region achieved the highest rankings on various bibliometric indices with similar intradepartmental faculty publication productivity to other regions in the US.

Publication productivity has various implications for the success of both academic departments and individual faculty members. After controlling for specialty, institution, and rank, among neurosurgeons, ophthalmologists, otolaryngologists, and neurologists in the University of California Health System, Fijalkowsky et al.¹¹ found a significant association between the number of publications

TABLE 4. Academic productivity measures stratified by Gini coefficient for publication*

Variable	Gini Coefficient ≤ 0.5	Gini Coefficient > 0.5	p Value
Faculty	14.0 [9.0–16.0]	13.0 [9.0–19.0]	0.9
Publications	134.0 [72.0–202.0]	62.5 [32.0–146.0]	0.003
Citations	1120.0 [571.0–1791.0]	481.0 [218.0–1315.0]	0.002
<i>h</i> -index			
<i>ih</i> (5)	17.0 [12.0–21.0]	10.0 [8.0–18.0]	0.002
Summed	196.0 [83.0–278.0]	137.0 [70.0–222.0]	0.08
<i>ig</i> (5)-index	27.0 [19.0–36.0]	20.0 [13.0–28.0]	0.003
<i>ie</i> (5)-index	18.0 [14.0–28.0]	14.5 [9.0–21.0]	0.02
<i>i10</i> -index	32.0 [15.0–15.0]	11.0 [7.0–33.0]	0.001

* All data are presented as median [25%–75% interquartile range].

TABLE 5. Multivariable analyses for predictors of intra-program publication equality amongst neurosurgery programs*

Variable	Adjusted OR	95% CI	p Value
<i>ih</i> (5)-index	1.20	1.02–1.40	0.03
Summed <i>h</i> -index	0.99	0.99–1.01	0.66
<i>i10</i> -index	0.98	0.94–1.01	0.23

* Hosmer and Lemeshow test $p = 0.45$; receiver operator characteristic area under the curve = 0.68 (95% CI 0.58–0.78).

and individual salary ($p < 0.000001$), resulting in a 2.4% salary increase for every 10 publications ($p < 0.000001$). Similarly, NIH funding is highly associated with scholarly impact, reflected in bibliometric indices.^{7,26,28,31} Six of the top 10 NIH-funded neurosurgical programs³¹ are also ranked in the top 10 most academically productive institutions based on *ih(5)*-index (present results), suggesting that successful grant funding is strongly associated with the creation of impactful, high-quality research.³⁰

Publication rates and institutional *h*-indices have surged over the last decade, likely due to the presence of more medical journals, enhanced online access to the journal editorial process, an enlarged medical research workforce, and greater professional pressure to publish.^{21,30} Comparison of the *ih(5)*-index and other bibliometric rankings will allow programs to gauge individual and global progress in academic productivity. These data will also be useful in departmental, decanal, and hospital academic benchmarking; program review; and possibly in the creation and award of compensation incentives.⁹ Educational organizations, including the Society of Neurological Surgeons, which serves as the residency program directors' society for the US, and the American Board of Neurological Surgery, may also benefit from longitudinal tracking of program academic productivity using data from sequential 5-year periods. Finally, these data should be useful to prospective neurosurgical residents and faculty members who wish to assess and compare long-term research opportunities in various programs.

Recognizing the mission of academic health care centers to deliver high-quality and innovative health care to current and future patients, it may be possible to combine indices of academic and clinical productivity (such as the *ih(5)*-index and the work component of the relative value unit [wRVU]) to yield an objective measure of overall neurosurgical faculty productivity. Such a combined index might allow more equitable valuation of individuals and departments who have varying compositions of clinical and research duties. Finally, we recommend repeating the national *ih(5)*-index analysis in 5 years to follow the evolution and development of academic productivity within neurosurgery broadly.

Conclusions

This study comprises the most comprehensive 5-year bibliometric evaluation of nearly all academic neurosurgical programs in the US. This analysis demonstrated surprising regional differences in academic productivity and intradepartmental academic productivity equality. The *ih(5)*-index is a simple, intuitive metric capable of accurately summarizing a department's recent scholarly efforts carried out by active neurosurgeons. The *ih(5)*-index limits the influence of variable individual productivity to reflect the academic impact of entire neurosurgical programs, as a reflection of the current quality of the institutional research environment. Of the bibliometric indices studied, only *ih(5)*-index predicts intradepartmental publication equality, which is itself associated with overall departmental research productivity. By ranking institutions using the *ih(5)*-index, we hope to promote attention to objective

academic outcomes and discussion of strategies that might lead to enhanced research productivity in the specialty of neurosurgery as a whole. Future 5-year cycle evaluations should be undertaken using the *ih(5)*-index to assess changes in neurosurgical research productivity over time.

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Supplemental Information

Companion Paper

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Appendix

APPENDIX TABLE 1. Comparison of departmental rankings based upon remaining bibliometric indices

Department	<i>ig</i> (5)-index		<i>ie</i> (5)-index		<i>i10</i> (5)-Index		Publication Gini Coefficient		Citation Gini Coefficient	
	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number
University of California, San Francisco	2	66	2	43	1	243	32	0.52	22	0.62
University of California, Los Angeles	1	69	1	52	5	104	48	0.57	57	0.74
University of Pittsburgh	10	48	13	31	3	119	73	0.66	57	0.74
Brigham & Women's Hospital	3	58	2	43	8	84	25	0.50	13	0.59
Johns Hopkins University	5	50	10	34	2	135	20	0.48	15	0.60
University of Virginia	13	44	16	28	4	107	34	0.53	3	0.42
Duke University Hospital	4	54	4	41	9	83	6	0.41	45	0.70
Ohio State University	12	46	12	32	10	76	70	0.65	57	0.74
St. Joseph's Hospital and Medical Center/Barrow Neurological Institute	8	49	7	37	10	76	59	0.61	32	0.65
Stanford University	8	49	8	36	7	86	59	0.61	57	0.74
Northwestern University	18	39	26	24	16	62	51	0.58	15	0.60
Columbia University	16	40	20	26	6	87	48	0.57	49	0.71
University of Florida	5	50	6	38	12	66	62	0.62	70	0.77
University of Pennsylvania	11	47	9	35	16	62	7	0.42	28	0.64
Cornell University	20	36	28	23	16	62	20	0.48	10	0.55
Massachusetts General Hospital	16	40	16	28	16	62	25	0.50	35	0.66
Emory University	14	42	13	31	17	51	44	0.56	45	0.70
University at Buffalo	5	50	4	41	28	41	83	0.72	78	0.79
Washington University	39	26	61	13	24	45	42	0.55	22	0.62
University of Washington	20	36	23	25	22	49	44	0.56	53	0.72
University of Miami	31	29	47	16	23	47	20	0.48	25	0.63
Cedars-Sinai Medical Center	20	36	23	25	18	50	14	0.45	35	0.66
Oregon Health & Science University	14	42	11	33	18	50	10	0.43	32	0.65
Case Western Reserve University	32	28	47	16	22	49	56	0.59	45	0.70
University of Utah	26	32	30	21	26	42	20	0.48	9	0.54
Yale University	18	39	15	30	29	37	10	0.43	28	0.64
Baylor College of Medicine	28	31	30	21	29	37	51	0.58	55	0.73
Thomas Jefferson University	29	30	32	20	18	50	76	0.68	55	0.73
University of Alabama, Birmingham	25	33	26	24	31	34	7	0.42	13	0.59
Virginia Commonwealth University	24	35	16	28	44	25	42	0.55	43	0.69
Mayfield Clinic/University of Cincinnati	39	26	40	17	34	32	62	0.62	28	0.64
University of South Florida	39	26	40	17	36	29	86	0.74	78	0.79
University of Michigan	20	36	16	28	28	41	16	0.46	35	0.66
New York University	35	27	36	18	33	32	19	0.47	25	0.63
University of Texas Southwestern	43	25	47	16	46	22	56	0.59	87	0.81
Colorado University	35	27	40	17	26	42	14	0.45	4	0.49
University of Chicago	35	27	36	18	42	26	59	0.61	87	0.81
University of California, San Diego	44	24	53	15	47	21	12	0.44	12	0.57
University of Wisconsin	32	28	32	20	36	29	38	0.54	49	0.71
Henry Ford Hospital	39	26	40	17	32	33	30	0.51	22	0.62
University of Southern California	51	22	57	14	35	30	12	0.44	11	0.56
Methodist Houston	26	32	23	25	42	26	77	0.69	87	0.81

(continued)

APPENDIX TABLE 1. Comparison of departmental rankings based upon remaining bibliometric indices (*continued*)

Department	<i>ig</i> (5)-index		<i>ie</i> (5)-index		<i>i10</i> (5)-Index		Publication Gini Coefficient		Citation Gini Coefficient	
	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number
University of Maryland	51	22	57	14	38	28	81	0.71	53	0.72
Medical University of South Carolina	44	24	47	16	38	28	4	0.37	1	0.31
Wayne State University	47	23	53	15	46	22	68	0.64	32	0.65
University of Iowa	47	23	53	15	44	25	7	0.42	5	0.50
University of Illinois, Peoria	64	17	87	8	38	28	25	0.50	18	0.61
Vanderbilt University	51	22	47	16	51	17	65	0.63	70	0.77
Mayo Clinic, Rochester	62	18	72	11	66	10	1	0.32	2	0.39
Mount Sinai School of Medicine	57	19	65	12	49	18	74	0.67	70	0.77
Semmes-Murphey Clinic/University of Tennessee, Memphis	32	28	28	23	51	17	62	0.62	90	0.83
University of Wisconsin	44	24	36	18	48	19	16	0.46	35	0.66
Tufts Medical Center	62	18	65	12	55	14	25	0.50	8	0.52
Dartmouth University	57	19	65	12	55	14	51	0.58	18	0.61
George Washington University	70	16	78	9	55	14	38	0.54	43	0.69
National Institutes of Health	29	30	20	26	52	15	5	0.40	15	0.60
NSLIJ/Hofstra University	73	15	74	10	61	11	34	0.53	62	0.75
University of Kentucky	57	19	61	13	55	14	25	0.50	40	0.67
Loma Linda University	64	17	65	12	61	11	87	0.75	98	0.88
Indiana University	47	23	36	18	57	13	103	0.91	101	0.91
Allegheny General Hospital	76	14	78	9	66	10	95	0.78	103	0.92
University of Illinois, Chicago	64	17	72	11	61	11	70	0.65	18	0.61
University of California, Davis	51	22	35	19	61	11	56	0.59	68	0.76
University of Minnesota	76	14	87	8	66	10	51	0.58	18	0.61
Wake Forest University	57	19	57	14	66	10	65	0.63	75	0.78
University of Rochester	55	21	40	17	66	10	51	0.58	49	0.71
University of New Mexico	47	23	32	20	66	10	44	0.56	78	0.79
University of Kansas	55	21	40	17	61	11	98	0.79	82	0.80
University of Texas, Houston	64	17	61	13	71	9	93	0.76	101	0.91
Rush University Medical Center	64	17	65	12	71	9	38	0.54	28	0.64
Georgia Regents University	80	13	78	9	75	8	79	0.70	62	0.75
Mayo Clinic, Florida	76	14	78	9	75	8	3	0.36	6	0.51
Albany Medical Center	57	19	53	15	75	8	20	0.48	68	0.76
Louisiana State University, New Orleans	70	16	65	12	71	9	16	0.46	25	0.63
New York Medical College	73	15	65	12	75	8	81	0.71	75	0.78
Brown University School of Medicine	70	16	61	13	75	8	38	0.54	42	0.68
Louisiana State University, Shreveport	80	13	78	9	82	7	95	0.78	70	0.77
West Virginia University	80	13	78	9	75	8	100	0.84	95	0.85
University of Texas, San Antonio	80	13	78	9	85	5	74	0.67	82	0.80
University of North Carolina	80	13	74	10	83	6	99	0.80	95	0.85
Georgetown University	76	14	74	10	82	7	32	0.52	40	0.67
SUNY/Upstate Medical University	90	9	93	5	90	4	48	0.57	35	0.66
University of Nebraska	35	27	20	26	82	7	34	0.53	100	0.89
University of California, Irvine	86	12	87	8	82	7	94	0.77	97	0.87
University of Vermont	89	10	91	6	82	7	2	0.34	6	0.51

(continued)

APPENDIX TABLE 1. Comparison of departmental rankings based upon remaining bibliometric indices (continued)

Department	<i>ig(5)</i> -index		<i>ie(5)</i> -index		<i>i10(5)</i> -Index		Publication Gini Coefficient		Citation Gini Coefficient	
	Rank	Number	Rank	Number	Rank	Number	Rank	Number	Rank	Number
Penn State University	90	9	91	6	85	5	68	0.64	78	0.79
Albert Einstein College of Medicine	64	17	47	16	90	4	30	0.51	82	0.80
Saint Louis University	87	11	78	9	95	2	44	0.56	57	0.74
Loyola University	93	8	93	5	95	2	65	0.63	49	0.71
University of Arizona	90	9	87	8	90	4	84	0.73	90	0.83
Carolinas Medical Center	73	15	57	14	90	4	87	0.75	98	0.88
University of Texas, Galveston	93	8	93	5	95	2	95	0.78	82	0.80
University of Medicine and Dentistry of New Jersey	96	7	93	5	91	3	84	0.73	62	0.75
University of Mississippi	97	5	99	3	99	0	70	0.65	45	0.70
Geisinger Health System	93	8	74	10	90	4	87	0.75	70	0.77
University of Arkansas	97	5	93	5	97	1	34	0.53	90	0.83
University of Louisville	87	11	78	9	95	2	102	0.86	82	0.80
University of Oklahoma	80	13	40	17	95	2	79	0.70	90	0.83
Tulane University	97	5	98	4	97	1	100	0.84	90	0.83
University of Puerto Rico	100	4	101	2	99	0	87	0.75	75	0.78
Temple University	101	3	101	2	99	0	87	0.75	62	0.75
University of Missouri	101	3	99	3	99	0	77	0.69	62	0.75
Southern Illinois University	103	1	101	2	99	0	87	0.75	62	0.75