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# Using bibliometrics to analyze the state of academic productivity in US pediatric surgery training programs

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## ABSTRACT

*Background:* The Accreditation Council for Graduate Medical Education (ACGME) Common Program Requirements state that faculty must establish and maintain an environment of inquiry and scholarship. Bibliometrics, the statistical analysis of written publications, assesses scientific productivity and impact. The goal of this study was to understand the state of scholarship at Pediatric Surgery training programs.
*Methods:* Following IRB approval, Scopus was used to generate bibliometric profiles for US Pediatric Surgery training programs and faculty. Statistical analyses were performed.
*Results:* Information was obtained for 430 surgeons (105 female) from 48 US training programs. The mean lifetime h-index/surgeon for programs was 14.4 +/− 4.7 (6 programs above 1 SD, 9 programs below 1 SD). The mean 5-year h-index/surgeon for programs was 3.92 +/− 1.5 (7 programs above 1 SD, 8 programs below 1 SD). Programs accredited after 2000 had a lower lifetime h-index than those accredited before 2000 ($p = 0.0378$). Female surgeons had a lower lifetime h-index ($p < 0.0001$), 5-year h-index ($p = 0.0049$), and m-quotient ($p < 0.0001$) compared to males. Mean lifetime h-index increased with academic rank ($p < 0.0001$), with no gender differences beyond the assistant professor rank (p = NS).
*Conclusion:* Variability was identified based on institution, gender, and rank. This information can be used for benchmarking the academic productivity of faculty and programs and as an adjunct in promotion/tenure decisions.
*Type of Study:* Original Research.
*Level of Evidence:* n/a.

Bibliometrics, the statistical analysis of written publications, has become an important field in the digital age, with use both inside and outside of academia. Within medicine, the Accreditation Council for Medical Education (ACGME) publishes common program requirements by which all residencies and fellowships must abide. One of the requirements states “the faculty must establish and maintain an environment of inquiry and scholarship with an active research component”. In other words, research should be offered and encouraged in a residency program. Institutions can also utilize the data during their trainee and faculty recruitment process. Additionally, there is a push for the use of bibliometric data to objectively advance academic careers [1]. Bibliometric data can be used by policy makers and government agencies, such as the National Institutes of Health (NIH), to potentially set standards for achievement and disburse grants. The NIH recently announced that it was examining the potential use of bibliometrics to determine who would receive grants [2].

Pritchard coined the term ‘bibliometrics’ in 1969 and defined it as "application of mathematical and statistical methods to books and other media of communication" [3]. Since that time, the field of bibliometrics has been consistently evolving. A major development in the field took place in 2005 when Hirsch created the h-index [4]. This index was created as a simple way to demonstrate the scientific output of a researcher. It is defined as "the number of papers with citation number >/= h". Currently, there are multiple databases, such as those by Elsevier, Web of Science, Google Scholar and others, which allow the h-index to be accessed easily.

The application of bibliometric variables has been implemented in numerous nonscientific and scientific disciplines [5]. It is well established that pediatric surgery is one of the most competitive surgical subspecialty matches, with only a 45% match rate in 2017 [6]. Among the factors thought to be most predictive of matching in Pediatric Surgery is research productivity during General Surgery residency, leading many residents to dedicate 2–3 years to a focused research effort [7]. Additionally, for senior fellows seeking employment, there are little objective data available to gauge a prospective institution's commitment to research. The h-index has been shown to be predictive of future scientific productivity and may be a useful tool to guide these critical

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decisions [8]. However, there has been no detailed, bibliometric examination of Pediatric Surgery training programs.

The goal of this study was to understand the state of pediatric surgery scholarship at all ACGME-accredited Pediatric Surgery training programs in the United States. We hypothesized that there would be variability in the productivity of the institutions based on geographic distribution and age of the program, as well as variability in individual surgeon productivity based on gender and academic rank.

## 1. Methods

### *1.1. Ethics statement*

This study was approved by the Institutional Review Board of the University of Tennessee Health Science Center (Protocol #17–05178-XP).

### *1.2. Identification of academic pediatric surgery programs and surgeons*

Using the publicly accessible portions of the American Pediatric Surgical Association website (https://www.eapsa.org), a list of Pediatric Surgery fellowship training programs ($n = 48$) was obtained. From this list, each program's "Meet the Team" section or a similar heading was identified by Google search. Institutional affiliations of individual surgeons at the time of the search were verified by the senior author. Board-eligible/certified pediatric surgeons ($n = 434$), along with their academic rank and gender, were identified using institutional websites. Nonphysician members of Pediatric Surgery divisions/departments (e.g. PhD scientists) were not included in the analysis.

### *1.3. Bibliometric analysis and statistical methods*

The h-index is defined as an individual with *h* papers with at least *h* citations [4]. It corresponds to the point where the number of citations crosses the publications listed in decreasing order of citations (Fig. 1). The m-quotient is the h-index divided by the number of years since the author's first publication [8].

Between January and March 2017, individual names of surgeons were searched under the author tab of Elsevier's Scopus database. The following bibliometric information was collected and calculated: lifetime h-index, five-year h-index (2012–2016), lifetime number of citations, five-year number of citations (2012–2016), and the year the surgeon started publishing. Book citations were excluded. The author identity was verified using each author's educational profile on their institution's webpage. If there were multiple entries for the same surgeon on Scopus (e.g. with and without middle name), these data were verified to be the same surgeon and then combined. Additionally, individuals were excluded from the analysis if they were not found on Scopus or if there was uncertainty about which search result was the real author ($n = 4$). The use of publically accessible sources (APSA website, institutional websites, Scopus) is accompanied by limitations which are detailed in the Discussion below.

Each institution's h-index and m-quotient for the last five years and lifetime were calculated in Microsoft Excel (Microsoft Corporation, Redmond, WA). Exploratory analysis revealed these data to be normally distributed, so parametric statistics were employed. Data are presented as mean +/− standard deviation. Student's t-test and Analysis of Variance (ANOVA) with Bonferonni correction were used as appropriate. Statistical analyses were performed using SAS® version 9.3 (Cary, NC). A p-value less than 0.05 was considered statistically significant.

## 2. Results

### *2.1. Pediatric surgery training program institutional bibliometrics*

Information was obtained for 430 surgeons (105 female) from the 48 US training programs (Table 1). The mean lifetime h-index/surgeon (summative h-index for all surgeons at that institution divided by the total number of surgeons) for programs was 14.4 +/− 4.7, with six programs above one standard deviation, and nine programs below one standard deviation (Fig. 2A). The mean 5-year h-index/surgeon for programs was 3.92 +/− 1.5, with seven programs above one standard deviation and eight programs below one standard deviation (Fig. 2B). Institution ranks by lifetime h-index and 5-year h-index were determined by sorting data from highest to lowest (Table 1). In the case of a tie, standard competition ranking was employed. Programs with equal h-indices received the same ranking number, and then a gap is left in the ranking numbers. The number of ranking numbers that are left out in this gap is one less than the number of items that compared equal.

There were no differences in lifetime h-index, 5-year h-index or m-quotient for programs based on US Census Bureau geographic region (Fig. 2C). Programs accredited before the year 2000 had higher lifetime h-index (15.7 +/− 5.06 vs. 12.9 +/− 3.79, $p = 0.0378$), but there was no difference in 5-year h-index (4.24 +/− 1.5 vs. 3.54 +/− 1.33, $p = 0.0950$) or m-quotient (0.75 +/− 0.19 vs. 0.65 +/− 0.13, $p = 0.0507$) (Fig. 2D).

### *2.2. Individual pediatric surgeon bibliometrics*

The mean lifetime h-index for individual pediatric surgeons was 15.6 +/− 10.51, with 82 surgeons above one standard deviation and 94 surgeons below one standard deviation from the mean (Fig. 3A). For 5-year h-index, the mean for individual surgeons is 4.30 +/− 3.11, with 73 surgeons above one standard deviation and 86 below (Fig. 3B). The average m-quotient for all surgeons was 0.74 +/− 0.38. There was an increase in lifetime h-index with increasing rank increased with academic rank (Assistant professor: 10.35 +/− 6.60, Associate professor: 14.17 +/− 6.45, Professor: 25.55 +/− 11.04, $p < 0.05$, Fig. 3C). A similar trend was seen for 5-year h-index (Assistant professor: 3.37 +/− 2.32, Associate professor: 4.45 +/− 2.97, Professor: 5.73 +/− 3.67, $p < 0.05$). However, there was no significant difference in m-quotient between assistant (0.71 +/− 0.38) and associate professors (0.70 +/− 0.31), but both of these groups had a lower m-quotient than full professors (0.86 +/− 0.38, $p = 0.0007$, Fig. 3D).

### *2.3. Gender differences in pediatric surgeon bibliometrics*

Female surgeons had a lower lifetime h-index (11.5 +/− 7.6 vs. 16.9 +/− 10.99, $p < 0.0001$), 5-year h-index (3.5 +/− 2.7 vs. 4.5 +/− 3.2, $p = 0.0049$), and m-quotient (0.62 +/− 0.30 vs. 0.78 +/− 0.39, $p < 0.0001$) as compared to their male counterparts (Fig. 4A-C). However, when examining lifetime h-index by both gender and rank, the difference persisted at the level of assistant professors ($p < 0.0001$) but not at the associate or full professor levels (Fig. 4D).

## 3. Discussion

In this study, we utilized bibliometrics to conduct the first, comprehensive analysis of academic productivity in US Pediatric Surgery fellowship training programs. We found no significant differences amongst programs based on geography but did note differences in programs based on year of accreditation. Additionally, we did note considerable variability in both lifetime and 5-year h-indices, with only six programs ranked in the top ten using both of these metrics. When adding in consideration of m-quotient, only four programs ranked in the top ten for all three metrics. In examining individual surgeon productivity, we noted that lifetime and five-year h-index increased with rank. Interestingly, we found a higher m-quotient for full professors as compared to assistant and associate professors. In examining gender differences in bibliometric measures, we noted lower lifetime h-index, five-year h-index, and m-quotient in female surgeons, but no

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**Table 1**

**Bibliometric profiles US Pediatric Surgery Training Programs.** Programs are ordered based on lifetime h-index ranking. Institution ranks by lifetime h-index, 5-year h-index and m-quotient were determined by sorting data from highest to lowest. In the case of a tie, standard competition ranking was employed. Programs with equal indices received the same ranking number, and then a gap is left in the ranking numbers. The number of ranking numbers that are left out in this gap is one less than the number of items that compared equal.

| State | Institution | Lifetime h-index | Rank | Five-Year h-index | Rank | m-Quotient | Rank |
|---|---|---|---|---|---|---|---|
| PA | Children's Hospital of Philadelphia | 28.67 | 1 | 6 | 4 | 1.101041 | 2 |
| MA | Harvard University-Boston Children's Hospital | 23.63 | 2 | 6.54 | 1 | 0.958254 | 3 |
| MO | UMKC-Children's Mercy | 22.75 | 3 | 5.88 | 5 | 1.102877 | 1 |
| CO | University of Colorado | 20.21 | 4 | 4.14 | 22 | 0.908177 | 5 |
| TX | University of Texas | 19.45 | 5 | 5.64 | 7 | 0.767373 | 17 |
| IN | Indiana University-JW Riley Hospital for Children | 19.22 | 6 | 3.78 | 28 | 0.944632 | 4 |
| CA | Stanford University Medical Center | 18.82 | 7 | 4.3 | 20 | 0.728958 | 22 |
| TN | University of Tennessee Health Science Center-Le Bonheur Children's Hospital | 17.77 | 8 | 5.31 | 9 | 0.873908 | 8 |
| AK | University of Arkansas For Medical Sciences | 17.75 | 9 | 3.25 | 34 | 0.694385 | 27 |
| OH | Cincinnati Children's Hospital Medical Center | 17.69 | 10 | 4.89 | 14 | 0.844256 | 9 |
| OH | Nationwide Children's Hospital | 17.47 | 11 | 6.06 | 3 | 0.805027 | 11 |
| TN | Vanderbilt University Medical Center-Monroe Carrell Jr. Children's Hospital | 17.4 | 12 | 4 | 24 | 0.669381 | 32 |
| TX | Baylor College of Medicine-Texas Children's Hospital | 17.14 | 13 | 5.86 | 6 | 0.830531 | 10 |
| CT | Yale-New Haven Hospital | 17.14 | 14 | 5.14 | 12 | 0.903911 | 6 |
| DC | George Washington University-Children's National Medical Center | 17.1 | 15 | 4 | 26 | 0.717942 | 25 |
| CA | University of Southern California-Children's Hospital of Los Angeles | 17.06 | 16 | 5.19 | 11 | 0.751057 | 19 |
| MO | Washington University | 16.6 | 17 | 5 | 13 | 0.730318 | 21 |
| WA | Seattle Children's Hospital | 16.55 | 18 | 5.36 | 8 | 0.742452 | 20 |
| RI | Brown University-Hasbro Children's Hospital | 16.5 | 19 | 2.75 | 38 | 0.762459 | 18 |
| MI | University of Michigan-Mott Children's Hospital of Michigan | 16.33 | 20 | 4.5 | 16 | 0.708381 | 26 |
| UT | University of Utah-Primary Children's Medical Center | 16 | 21 | 6.43 | 2 | 0.782075 | 16 |
| IL | University of Chicago-Comer Children's Hospital | 15.89 | 22 | 4.11 | 23 | 0.642128 | 34 |
| PA | University of Pittsburgh Medical Center-Children's Hospital of Pittsburgh | 15.5 | 23 | 4.46 | 18 | 0.875733 | 7 |
| WI | Children's Hospital of Wisconsin | 15.1 | 24 | 4.4 | 19 | 0.665559 | 33 |
| CA | Loma Linda University & Children's Hospital | 15 | 25 | 2.33 | 41 | 0.532452 | 39 |
| AL | University of Alabama-Birmingham | 13.5 | 26 | 4.63 | 15 | 0.591646 | 37 |
| KY | University of Louisville-Norton Children's Hospital | 13.5 | 27 | 3.17 | 36 | 0.788305 | 14 |
| IL | Ann & Robert Lurie Children's Hospital of Chicago | 13.36 | 28 | 3.93 | 27 | 0.789273 | 12 |
| MD | The Johns Hopkins Hospital-Bloomberg Children's Center | 13.29 | 29 | 5.29 | 10 | 0.788345 | 13 |
| CA | Rady Children's Hospital | 12.43 | 30 | 3.43 | 31 | 0.670198 | 31 |
| TX | University of Texas Southwestern-Dallas Children's Hospital | 12.1 | 31 | 3.3 | 32 | 0.693413 | 28 |
| NY | Morgan Stanley Children's Hospital of NY-Presbyterian | 12 | 32 | 3.56 | 30 | 0.691921 | 29 |
| FL | Johns Hopkins Medicine-All Children's Hospital | 11.86 | 33 | 3.29 | 33 | 0.612698 | 36 |
| DE | Thomas Jefferson/AI duPont Hospital for Children | 11.67 | 34 | 1.89 | 42 | 0.420071 | 45 |
| NY | Cohen Children's Medical Center | 11.38 | 35 | 2.63 | 39 | 0.675916 | 30 |
| FL | Miami Children's Hospital/Niklaus Children's Hospital | 11 | 36 | 4.5 | 17 | 0.526878 | 40 |
| OR | Oregon Health & Sciences University | 10.83 | 37 | 3.67 | 29 | 0.788005 | 15 |
| GA | Emory University-Children's Healthcare of Atlanta | 10.75 | 38 | 2.56 | 40 | 0.567475 | 38 |
| FL | University of Florida | 10 | 39 | 4.25 | 21 | 0.630723 | 35 |
| IA | University of Iowa Children's Hospital | 9.5 | 40 | 4 | 25 | 0.412039 | 46 |
| NY | SUNY at Buffalo-Women's and Children's Hospital of Buffalo | 8.8 | 41 | 3 | 37 | 0.474679 | 43 |
| NE | Children's Hospital of Omaha | 8.6 | 42 | 3.2 | 35 | 0.722738 | 24 |
| MI | Wayne State University-Children's Hospital of Michigan | 8.17 | 43 | 1.17 | 47 | 0.404284 | 47 |
| CT | University of Connecticut | 8 | 44 | 1.67 | 44 | 0.521102 | 41 |
| MI | University of Mississippi Medical Center | 7.67 | 45 | 1 | 48 | 0.507744 | 42 |
| PA | St. Christopher's | 7.5 | 46 | 1.7 | 43 | 0.297532 | 48 |
| MO | Saint Louis University-Cardinal Glennon Children's Medical Center | 7.25 | 47 | 1.5 | 45 | 0.723901 | 23 |
| OK | University of Oklahoma Health Sciences Center | 6.8 | 48 | 1.4 | 46 | 0.441372 | 44 |

significant differences beyond the assistant professor rank when gender and rank were analyzed together.

Recently, Watson, et al., conducted a bibliometric analysis of Pediatric Surgeon-Scientists with the goal of defining factors associated with success [9]. In this study, the authors used publically accessible databases to identify NIH-funded Pediatric Surgeons, Scopus to determine h-indices and common journals, and deployed a survey to elicit scientists' perceptions of factors contributing to academic success. Similar to our results, they noted increasing h-index with academic rank. However, the mean h-index they determined for NIH-funded Pediatric Surgeon-Scientists (18 +/− 1.1) was higher than what we found when considering all Pediatric Surgeons at fellowship training programs (15.6 +/− 10.51). This suggests that NIH-funded scientists may have a broader impact on the scientific community than Pediatric Surgeons as a whole. However, the group of NIH-funded scientists is not simply a subset of those included in our study, as greater than half of Pediatric Surgeons in the US practice outside of a fellowship training program, and some of those surgeons are NIH-funded.

Another recent study, from Markel, et al., sought to examine the trajectory of academic productivity over a career in Pediatric Surgeons as compared to General Surgeons, hypothesizing that most Pediatric Surgeons do not pursue robust research careers and their academic productivity would decrease over time [10]. Congruent with our findings, they noted increased publication numbers and citations as academic rank increased. Interestingly, they noted higher productivity amongst Pediatric Surgeons at the assistant professor rank when compared to their General Surgery colleagues. However, these differences did not persist over the course of rising academic rank. They utilized an alternative approach to assess recent productivity by measuring "recentness," or citations within the last three years divided by total citations. Here, they showed stable "recentness" with increasing rank, which is in contradiction to our finding of increased five-year h-index and m-quotient at the full professor rank. This may simply be a reflection of the small numbers of individuals compared at each rank, resulting in an underpowered analysis.

No previous bibliometric analysis of Pediatric Surgeons has included gender considerations. Holliday et al., examined gender differences in bibliographic metrics for academic Radiation Oncologists [11]. They noted systematic differences in h-index, publication numbers, and NIH funding. However, they found that these differences disappear at the

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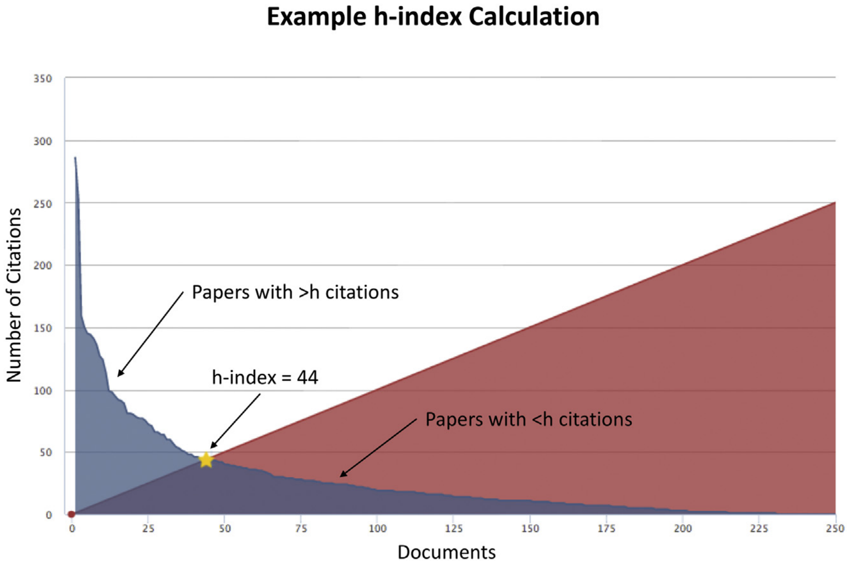

**Fig. 1. Example h-index calculation.** The h-index is defined as an individual with *h* papers with at least *h* citations [4]. It corresponds to the point where the number of citations crosses the publications listed in decreasing order of citations. In this example, the author has 44 documents (x-axis) that have been cited at least 44 times (y-axis). Documents #1–43 have been cited more often, with the initial few publications at well over 100 citations each. There are also a large number of documents (right side of the x-axis) with very few citations.

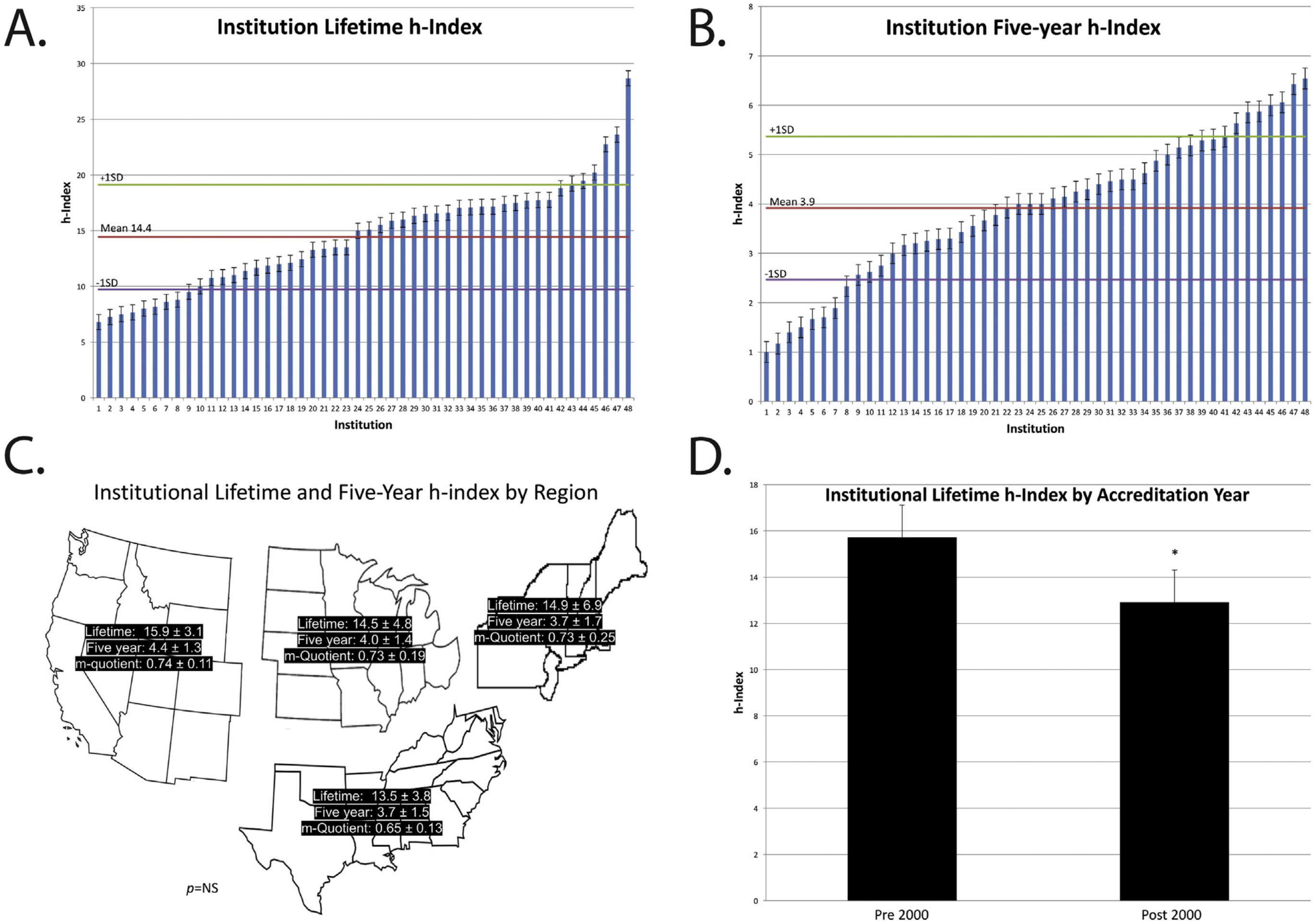

**Fig. 2. Bibliometric analysis of US Pediatric Surgery Training Programs.** (A) Institutional Lifetime h-index. Institutions were sorted in order of increasing lifetime h-index/surgeon. The mean lifetime h-index/surgeon for programs was 14.4 +/— 4.7. (B) Institutional 5-year h-index. Institutions were sorted in order of increasing 5-year h-index/surgeon. The mean 5-year h-index/surgeon for programs was 3.92 +/— 1.5. (C) Regional comparison of lifetime h-index, 5-year h-index and m-quotient by institution. US Census Bureau geographic region definitions were used to group training programs. No significant differences were noted (p = NS). (D) Comparison of lifetime h-index based on year of ACGME accreditation. Programs were grouped by year of accreditation (pre- and post-2000) and lifetime h-index compared. Programs accredited before the year 2000 had higher lifetime h-index (* p = 0.0378).

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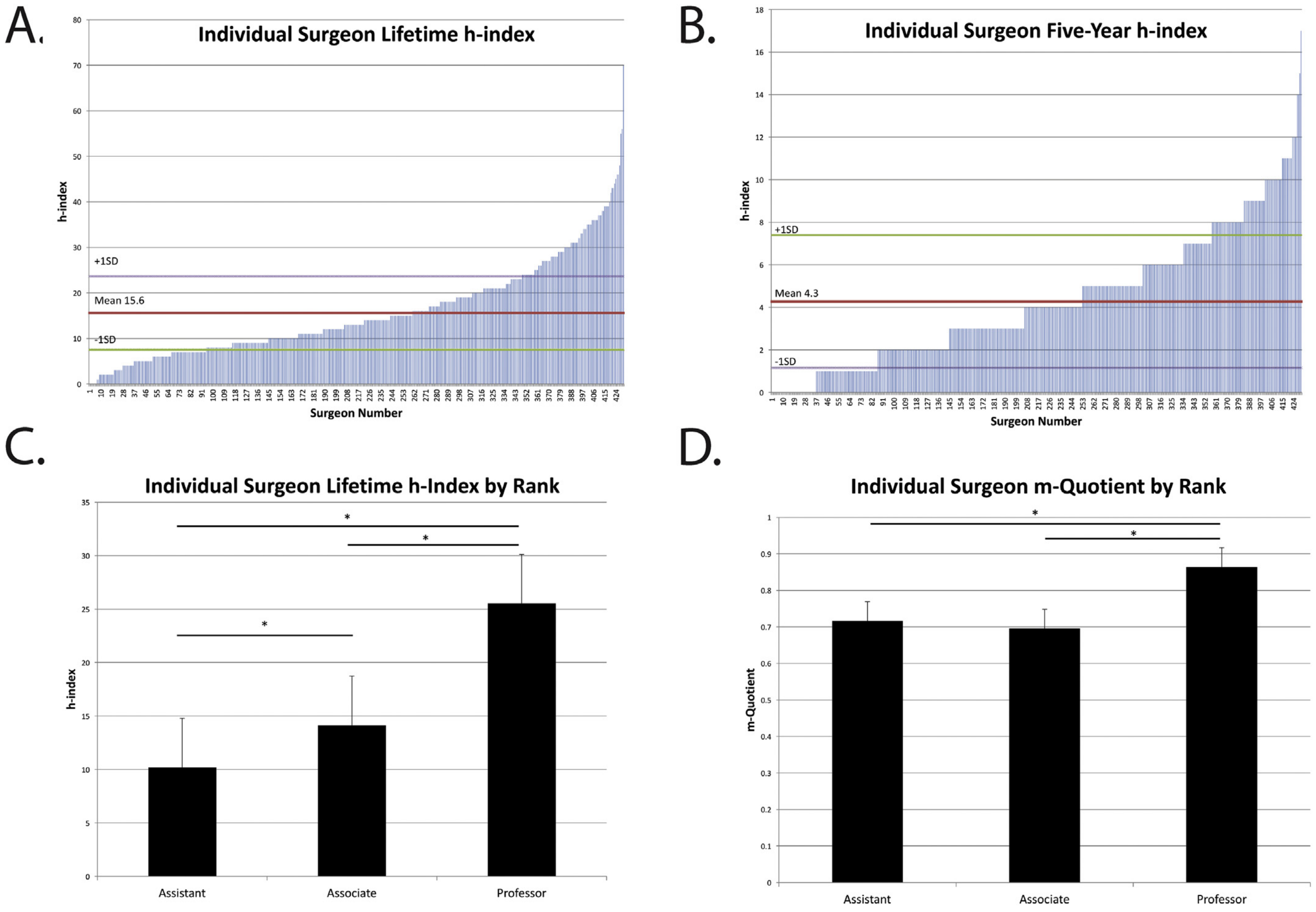

**Fig. 3. Bibliometric analysis of US Pediatric Surgeons at fellowship training programs.** (A) Individual Surgeon Lifetime h-index. Surgeons were sorted in order of increasing lifetime h-index. The mean lifetime h-index for surgeons was 15.6 +/− 10.51. (B) Individual Surgeon 5-year h-index. Surgeons were sorted in order of increasing 5-year h-index. The mean 5-year h-index for surgeons was 4.30 +/− 3.11. (C) Comparison of lifetime h-index by rank. Lifetime h-index increased with increasing academic rank ($p < 0.0001$). (D) Comparison of m-quotient by rank. No significant difference was seen between assistant and associate professors, but both of these groups had a lower m-quotient than full professors ($^*p = 0.0007$).

rank of full professor. A separate study examined gender differences in h-index in the field of Psychology [12]. They found that, after controlling for professional age, gender accounted for 2.6% of the variance in h-index between male and female professors of Psychology. They further demonstrated the potential lifetime income differences that result from this difference based on time to promotion and average salaries. While the h-index is comparable only to the specific field being studied, and does not provide any significant information when comparing across two subjects, the underlying factors driving gender disparities may be relevant. In our study, female surgeons were found to have lower lifetime and five-year h-indices, which may be attributable to the fact that women represent <25% of the faculty in this study and fewer women currently hold full professorships within the field. However, when examining by gender and rank together, both genders appear to be on the same trajectory. As the Pediatric Surgery workforce grows to resemble the undergraduate, medical school and General Surgery residency pipeline, careful attention should be paid to ensure equal opportunities for mentorship, protected time for research and academic advancement.

There are several limitations to this study. We made the operational decision to represent institutional h-index (lifetime and 5-year) on a per-surgeon basis. This allowed for a fair comparison between institutions with markedly different numbers of faculty (e.g. 4 vs 20). However, this decision does not account for groups that are structured with wide variability amongst individuals in regards to time dedicated to clinical or research work. Additionally, we relied on the accuracy of institutional websites to list all of the affiliated surgeons and their academic ranks. We gathered data for each individual surgeon and grouped them by institution, thereby defining each institution as a collection of surgeons, rather than an academic entity in its own right. Because of this, all publications and citations for a given surgeon were credited to their current institution. This analysis does not account for academic mobility, and therefore institutions did not receive credit for publications from faculty that have moved. Additionally, this analysis only encompassed surgeons listed on the institutional websites, so it may have missed early career surgeons and may have included recently retired or emeritus surgeons. Institutional websites may also lag behind in listing new surgeons at that institution or removing surgeons that have moved. We performed this analysis in the middle of the academic year in order to best capture these career changes. It is interesting to note the findings in Table 1 with regards to five-year h-index and m-quotient. Both of these methods are utilized to mitigate some of the concerns regarding rank and time in practice. Indeed, these rankings identified many of the same programs in the top ten regardless of the bibliometric method employed. This suggests that, although we considered institutions to be defined by their component surgeons, there is an "institutional-identity" that this analysis captures.

There are limits to the bibliometric data source we chose to use. Elsevier's Scopus is one of multiple databases that can be used for bibliometric analysis. Other published studies have compared results

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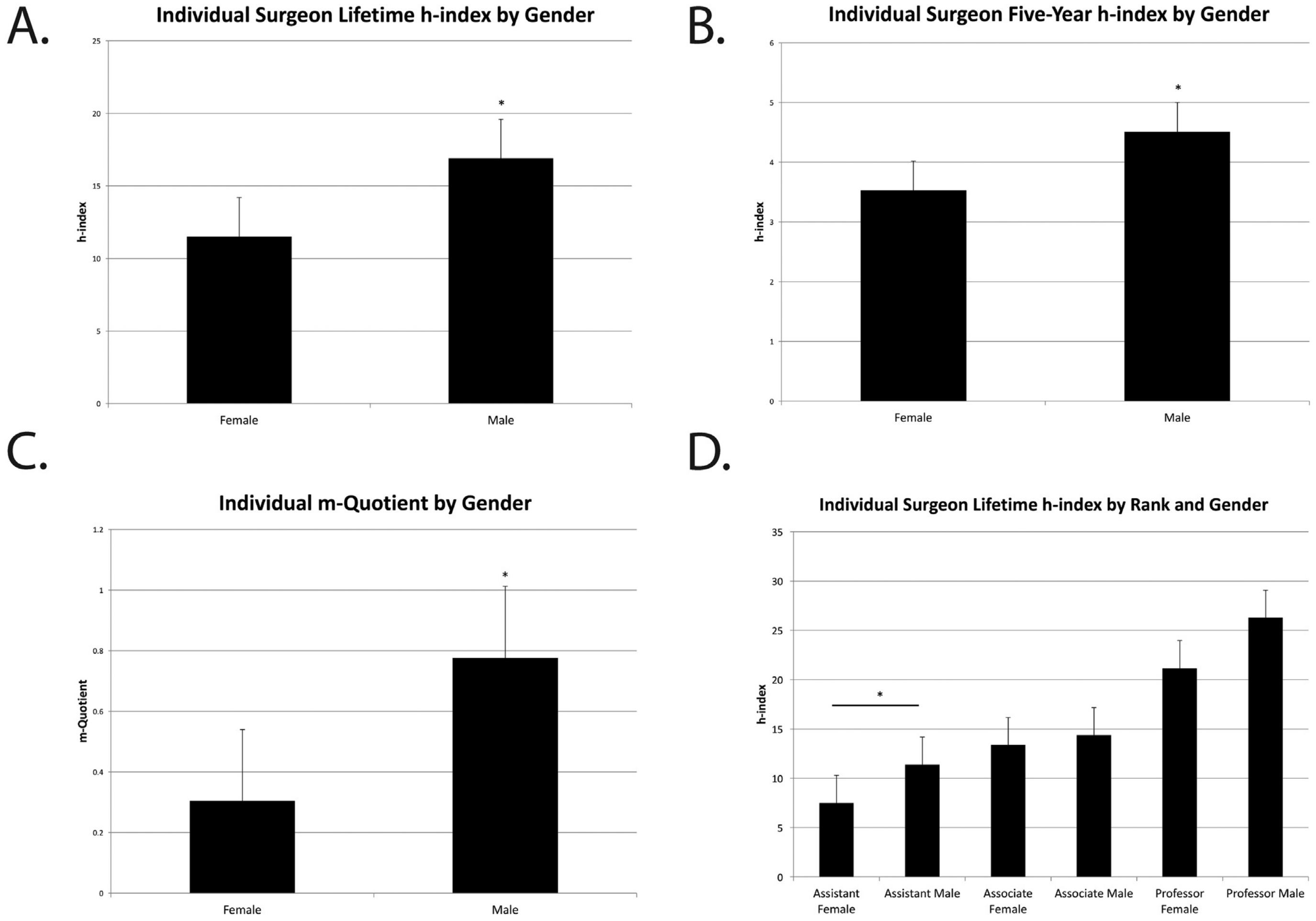

**Fig. 4. Bibliometric analysis of Gender Differences in US Pediatric Surgeons at fellowship training programs.** (A) Individual Surgeon Lifetime h-index by Gender. Female surgeons had a lower lifetime h-index compared to their male colleagues (11.5 +/− 7.6 vs. 16.9 +/− 10.99, $p < 0.0001$). (B) Individual Surgeon 5-year h-index by Gender. Female surgeons had a lower 5-year h-index compared to their male colleagues (3.5 +/− 2.7 vs. 4.5 +/− 3.2, $p = 0.0049$). (C) Individual Surgeon m-quotient by Gender. Female surgeons had a lower m-quotient compared to their male colleagues (0.62 +/− 0.30 vs. 0.78 +/− 0.39, $p < 0.0001$). (D) Comparison of individual surgeon lifetime h-index by rank and gender. Differences persisted at the level of assistant professors ($p < 0.0001$) but not at the associate or full professor levels (p = NS).

from multiple databases (Scopus, Web of Science, Google Scholar) and noted variability in citation counts amongst the databases [13]. In these analyses, Scopus has generally been regarded as the best source for identifying an individual's productivity [14]. The greatest, previously noted shortcoming of Scopus was a lack of publication records prior to 1996. At the time of our analysis, the database had been expanded to include 1970–March 2017, and ongoing efforts will expand the database beyond this time period. For the purposes of our study, exclusion of publications prior to 1970 may have led to an artificially lower lifetime h-index for some senior authors and institutions in which those authors practice.

There are additional general limitations to the application of bibliometrics. First, it is important to recognize that h-index does not account for the quality of a publication (e.g. impact factor). Cited publications in both high- and low-impact journals make an equivalent contribution to the author's h-index. Additionally, the position of the author in the publication is not accounted for in the calculation of the h-index. For instance, a first authorship is equivalent to a sixth authorship, and the h-index would not be able to distinguish between the two. Furthermore, the lifetime h-index favors senior scientists as they have had more time to publish and have more readers cite their works. We attempted to address these limitations through the use of 5-year h-index and m-quotient. The 5-year h-index attempts to address recent productivity and citations, while the m-quotient normalizes for the length of career, thereby placing junior faculty on a level playing field with senior faculty. Use of the h-index for institutional rankings may also inadvertently punish institutions that are heavily weighted towards junior faculty. We attempted to account for this concern by including the 5-year h-index and m-quotient as alternative ranking methods. However, none of these metrics account for time away from training or practice (e.g. for the personal illness, parental leave, etc.). Unfortunately, no single bibliometric measure is perfect, and many other approaches exist [5], some of which may yield further insight into academic Pediatric Surgery.

## 4. Conclusions

This study represents the most detailed analysis of academic productivity in US Pediatric Surgery programs to date. Important variability was identified based on institution, gender and rank. Surgical residents who aspire to match into a pediatric fellowship program may utilize this data to identify a productive research fellowship mentor and institution. Further, once these residents are ready to apply for clinical fellowships, program directors can then use individual h-index information as an additional measure by which to rank applicants. Given the high quality of many applicants, it can be useful to consider an applicant's research productivity in a way that allows for a standardized comparison to other applicants. Finally, the findings of this study will be of use to institutions in benchmarking the academic productivity of faculty and programs and may be a useful, objective adjunct for decisions regarding promotion/tenure.

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