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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