Research article

Using the H-index as a factor in the promotion of surgical faculty

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ABSTRACT

Introduction: Academic productivity is an important determinant for promotion. However, the measurement of academic productivity is ill-defined. The aim of this study is to demonstrate the academic productivity at the time of promotions at our institution.

Methods: We reviewed the data of 33 faculty from Department of Surgery at our institution who were promoted from 2006 to 2021. Gender, academic productivity at hiring, and each promotion were obtained. Academic productivity was assessed by bibliometric indices including total number of publications and citations, and H-index, which were obtained from Web of Science. T-test, Mann-Whitney U test, Fisher’s exact test and linear regression analysis were used to assess the association of H-index with length of promotion and gender. P < 0.050 were considered statistically significant.

Results: The medians (interquartile ranges) of indexes at hiring, at promotions from assistant professors to associate professors, and from associate professors to full professors were 6.0 (1.5–9.5), 11.0 (9.0–18.0) and 17.0 (9.0–23.0) respectively. A simple linear regression showed significant correlation between the length of promotion to associate professors and their H-indexes at hiring. (F (1, 27) = 10.55, p = 0.003, R² of 0.281.) There was no statistical significance in the difference of H-indexes at promotions between male and female faculty.

Conclusion: At our institution, the median H-indexes at the time of promotions from assistant professor to associate professor and from associate professor to full professor are 11.0 and 17.0. Using the H-index as an objective measure can be a useful tool to junior surgical faculty as reference for applying promotion.

1. Introduction

Academic promotion is vital to both surgical faculty and departments of surgery. Promotion recognizes and awards the excellence of surgical faculty, which further accelerates the development of faculty’s careers and influence in academic surgery. Additionally, promotion creates a “culture of excellence” and helps departments attract new faculty members [1].

Historically, successful academic surgeons were expected to function equally as educators, scientists and clinicians. This so-called “triple-threat” concept was created a hundred years ago, by Sir William Osler, the Father of Modern Medicine and co-founding physician of Johns Hopkins Hospital [2]. Teaching, research, and clinical productivity are still considered important determinants for academic promotion along with other new tenets such as administrative duty and community service [3].

At our institution, faculty who prepare for promotion should provide curriculum vitae, recommendation reports/letters, evidence of teaching effectiveness, evidence of research productivity, summary of service activity, external reviewer letters and annual reviews [4]. Appointments to associate professor requires evidence of scholarly achievement in areas of research, teaching, and/or service, as appropriate, documented by peer recognition at a national level. Appointments to professor requires evidence of sustained scholarly achievement and productivity in the areas of research, teaching, and/or service and demonstration of nationally recognized excellence in the conduct of academic duties. Departments/divisions will review proposals and make decisions for approval or denial before March. Departments then submit all faculty promotion to Dean’s office. The School of Medicine Faculty Council reviews the promotion packet and send to department chair with recommendations for approval/denial of promotion. After hearing appeals for denied promotion, final decision is made in August [5].

Academic productivity is one way to measure research effectiveness in the process of promotion. While there is no golden standard metric to quantify academic productivity, markers including total number of publications as well as total number of publication citations are

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frequently used. In 2005, the Hirsch index (H-index) was introduced to measure both quantity and quality of research. The complicated equations were explicitly explained in the original publication [6] given its consideration of both number of publications and number of citations for each publication, the H-index and number of publications are not in purely linear relation. The H-index is defined as h number of publications that have been cited at least h times [6]. For example, for researchers who have an H-index of 7, they must have 7 publications with at least 7 citations each. The advantage of the H-index is that it provides a single number to indicate surgeons’ productivity and mitigates the skewed appearance of academic productivity that occurs when a small number of publications have a large number of citations, and vice-versa. Multiple studies have proven that academic productivity is associated with academic promotion [7, 8, 9, 10, 11, 12, 13]. It has been shown that the H-index offers better validity than other bibliometric indices of research performance in the surgical field [12, 13]. However, to our knowledge, literature identifying benchmarks of academic productivity requirement for promotion is lacking. An objective benchmark of quantified academic productivity would provide a blueprint for junior faculty members who are seeking academic promotion. Additionally, it functions as an evidence-based metric to evaluate candidates for promotions.

The purpose of this study was to retrospectively review the academic productivity of faculty promoted from assistant professors to associate professor and associate professor to full professor at our institution using H-index as a bibliometric measure.

2. Material and methods

2.1. Data collection

This was a retrospective study using data from the Department of Surgery at the University of Alabama at Birmingham (UAB) from 2006 to 2021. All the information obtained for the use in this study was obtained from publicly available information sources. Therefore, no institutional review board approval was required.

A total of 33 surgical faculty who were promoted from assistant professors to associate professors and/or associate professors to full professors in the period of 2006–2021 were identified. Most junior faculty were hired as assistant professors as this is the entry level position in our institution. Some faculty came to our institution as associate after practicing at other institutions. Bibliometric indices were obtained from Web of Science (https://www.webofscience.com) by searching authors’ last names and first names. If similar author names existed in the database, categories and affiliations were used as cross-references. If the same author was listed under different authors’ records, all records were viewed as a combined record. Female faculty were searched by both maiden name and married name.

2.2. Study variables

Total number of publications, total times cited, H-index at the time of hiring, and promotions from assistant professors to associate professors and associate professors to full professors were collected to quantify research productivity. The length of promotion from assistant professors to associate professors and associate professors to full professors were calculated.

2.3. Statistical analyses

All descriptive statistics were tested for skewness. Continuous data with normal distribution was described as mean ± standard deviation. Continuous data with non-normal distribution was described as median and interquartile range (IQR). Normally distributed continuous data were compared using independent t-test and non-normally distributed continuous data were compared using the Mann-Whitney U test. Discrete variables were compared using Fisher’s exact test. Linear regression analysis was performed to the relationship between bibliometric indices and length of promotion from assistant professors to associate professors. IBM® SPSS® version 27.0 was used for data analyses. P < 0.050 was considered as statistically significant.

3. Results

Overall, 33 surgical faculty at our institution were promoted from 2006 to 2021. The majority of the faculty were male (73.5%), White (81.8%) and engaged in health service research (87.9%). This study is not powered to detect the differences between the group engaged in health service research and in basic science and the relationship between the type of research and H-index is beyond the scope of this study. There were 6 faculty specialized in gastrointestinal surgery, 5 in transplant surgery, 4 in pediatric surgery, 4 in surgical oncology, 4 in cardiothoracic surgery, 3 in trauma surgery, 3 in vascular surgery 2 in plastic surgery, 1 in breast surgery and 1 in endocrine surgery. There were 29 surgical faculty promoted from assistant professors to associate professors, 11 surgical faculty promoted from associate professors to full professors, and 7 surgical faculty promoted from assistant professors to associate professors and then associate professors to full professors. The award of tenure and promotion can be separate. In our study group, 8 out of 33 were not awarded tenure. Eight faculty were awarded tenure prior to promotion to associate professor, 12 were awarded tenure at the time of promotion to associate professor, and 5 faculty were awarded tenure after promotion to associate professor.

3.1. Productivity of surgical faculty

The academic productivity of surgical faculty at hiring, promotions from assistant professors to associate professors and associate professors to full professors are listed in Table 1.

At hiring, faculty had a median number of 10.0 (IQR 2.5, 16.0) publications, median number of 180.0 (IQR 38.5, 425.0) citations, and median H-index of 6.0 (IQR 1.5, 9.5).

At promotion from assistant professors to associate professors, faculty had a median number of 28.0 (IQR 17.5, 53.0) publications, median number of 503.0 (IQR 282.0, 1217.5) citations, and median H-index of 11.0 (IQR 9.0, 18.0). The median time required for promotion from assistant professors to associate professors was 5.0 (IQR 4.5, 7.0) years.

At promotion from associate professors to full professors, faculty had a median number of 41.0 (IQR 24.0, 73.0) publications, median number of 1132.0 (IQR 441.0, 1321.0) citations, and median H-index of 17.0 (9.0, 23.0). It took a median time of 6.0 (IQR 5.0, 9.0) years for surgical faculty in our institution to be promoted from associate professors to full professors.

3.2. Productivity versus length of promotion from assistant professors to associate professors

Based on the median length of time required for promotion from assistant professors to associate professors, promoted faculty were divided into two groups: promotion length ≤ 5 years and promotion length > 5 years. The academic productivity of the two groups are listed in Table 2. Surgical faculty who were promoted to associate professors in ≤ 5 years had more publications at hiring (12 (IQR 7, 26) versus 6.5 (IQR 1.8, 10.0) p = 0.003) and higher H-index scores at hiring (8.0 (IQR 5.0, 12.0) versus 4.5 (IQR 1.0, 8.0) p = 0.020). There were no differences in number of total citations at hiring, total publications at promotion, total citations at promotion or H-index at promotion between two groups.

A simple linear regression was calculated for length of promotion to associate professors based on their H-index at hiring. A significant regression equation was found (F (1, 27) = 10.55, p = 0.003), with an R2 of 0.281. When the H index at hiring is zero, the mean length of promotion to associate professor is 7.0 years. Based on these findings, 28.1% of the time to promotion to associate professor is explained by the H-
H-index at hiring 8.0 (IQR 5.0–9.0)

Total publication at hiring 12 (IQR 7.0–16.0)

Time for promotion (Years)

Promotion length from assistant professors to associate professors (n = 29)

At promotion from assistant professors to associate professors

28.0 (IQR 17.5–53.0)

503.0 (IQR 282.0–1217.5)

11.0 (IQR 9.0–18.0)

5.0 (IQR 4.5–7.0)

Promotion length from associate professors to full professors (n = 11)

41.0 (IQR 24.0–73.0)

1132.0 (IQR 441.0–1321.0)

17.0 (IQR 9.0–23.0)

6.0 (IQR 5.0–9.0)

Table 1. Productivity at hiring and promotions.

| Event                      | Total publication | Total citations | H-index | Time for promotion (Years) |
|----------------------------|-------------------|-----------------|---------|--------------------------|
| At hiring                  | 10.0 (IQR 2.5–16.0) | 180.0 (IQR 38.5–425.0) | 6.0 (IQR 1.5–9.5) | -                        |
| At promotion from assistant professors to associate professors | 28.0 (IQR 17.5–53.0) | 503.0 (IQR 282.0–1217.5) | 11.0 (IQR 9.0–18.0) | 5.0 (IQR 4.5–7.0) |
| At promotion from associate professors to full professors | 41.0 (IQR 24.0–73.0) | 1132.0 (IQR 441.0–1321.0) | 17.0 (IQR 9.0–23.0) | 6.0 (IQR 5.0–9.0) |

Table 2. Productivity versus Promotion length from assistant professors to associate professors.

| Event                      | Promotion length ≤ 5 years (n = 15) | Promotion length > 5 years (n = 14) | Mann-Whitney U test |
|----------------------------|--------------------------------------|--------------------------------------|---------------------|
| Total publication at hiring| 12.0 (IQR 7.0–26.0)                  | 6.5 (IQR 1.8–10.0)                   | P = 0.003*          |
| Total citation at hiring   | 256.0 (IQR 172.0–1486.0)             | 155.0 (IQR 16.5–350.8)               | P = 0.134           |
| H-index at hiring          | 8.0 (IQR 5.0–12.0)                   | 4.5 (IQR 1.0–8.0)                    | P = 0.020           |
| Total publication at promotion | 38.0 (IQR 17.0–68.0)                | 27.5 (IQR 16.5–42.0)                 | P = 0.400           |
| Total citation at promotion| 503.0 (IQR 273.0–1487.0)            | 501.5 (IQR 282.0–1047.0)             | P = 0.983           |
| H-index at promotion       | 11.0 (IQR 9.0–20.0)                  | 11.5 (IQR 8.25–18.0)                 | P = 0.983           |

* Indicates statistically significant.
productivity between different genders across all academic ranks in urology. Carnevale et al. (2020) [25] found that female faculty had higher average H-index per year than male faculty in vascular surgery. Several factors could explain the discrepancies in H-index when comparing genders including length of practice as well as other factors of the academic promotion process including teaching and clinical expertise. By capturing the H-indexes of surgical faculty at promotion, we reduced the confounding factor of time since starting practice in our study. We did not identify a difference in H-index at time of promotions or promotion between male and female faculty within our study. (Tables 3 and 4). Based on our findings, we believe that H-index serves as a suitable measure of academic productivity for both male and female faculty applying for academic promotion.

There are limitations to the use of H-index as a measure of scholarly effectiveness in the process of promotion evaluation. One concern is that H-index remains the same or is most likely to increase over time as surgical faculty who stay in academia longer. Even if the faculty do not publish any new papers, their total number of publications will remain the same and the number of citations of each paper will either remain the same or increase. The increasing number of citations over time will cause the H-index to grow even if the number of publications remains the same. Additionally, the H-index does not take into account orders of authorship despite the fact that first authors and senior authors usually have more academic input than second authors. Another limitation is that some citations are used with no real significance to the publication or may even be used in a negative context. Other confounding factors such as the “Matthew effect”, whereby well-established researchers and projects are cited more often than those that are less known [33]. Furthermore, there are different bibliometric search engines available and the results of H-index can vary in different search engines. We chose Web of Science, which has a more extensive coverage of publications and their citations from 1990 to present. In our study, 28.1% of the faculty were cited by journals other than Web of Science, such as Elsevier Journals or Google Scholar. Another limitation is that some papers are cited more often than others, and these citations are not always related to the quality of the paper. Additionally, the H-index does not take into account orders of authorship, as first authors and senior authors usually have more academic input than second authors. Another limitation is that some citations are used with no real significance to the publication or may even be used in a negative context.

To our knowledge, this is the first study examining H-index as an objective measurement of academic productivity by capturing bibliometric index at the time of promotions. As we mentioned, the process of

| Author                  | Year | Specialty             | Number of faculty in the study | H-index (Assistant Professor) | H-index (Associate Professor) | H-index (Full Professor) |
|-------------------------|------|-----------------------|-------------------------------|-------------------------------|-------------------------------|--------------------------|
| Ashfaq et al. [14]      | 2018 | General surgery       | 3712                          | Mean ± SD 6.8 ± 64            | 12.9 ± 9.3                    | 27.9 ± 17.4              |
| Lopez et al. [15]       | 2015 | Hand Surgery          | 366                           | Mean ± SD 5 ± 4               | 10 ± 7                        | 18 ± 9                   |
| Radford et al. [16]     | 2021 | Breast Surgery        | 209                           | Median (Range) 6 (1–37)       | 17 (4–48)                     | 37 (6–114)               |
| Ence et al. [8]         | 2016 | Orthopedic Surgery    | 4663                          | Median (IQR) 2 (1–6)          | 8 (3–14)                      | 17 (10–27)               |
| Gast et al. [9]         | 2014 | Plastic Surgery       | 127                           | Mean ± SD 8.2 ± 5.8           | 15.4 ± 6.9                    | 25.0 ± 13.5              |
| LaRocca et al. [11]     | 2018 | Surgical Oncology     | 319                           | Median (Range) 7 (1–30)       | 17 (3–44)                     | 39 (6–138)               |
| Desai et al. [17]       | 2018 | Pediatric Surgery     | 430                           | Mean ± SD 10.35 ± 6.60        | 14.17 ± 6.45                  | 25.55 ± 11.04            |
| Lafaro et al.           | 2020 | Hepatopancreatobiliary Surgery | 111 | Median (Range) 11.5 (0–26) | 22.0 (3–40) | 48.0 (12–97) |
| Han et al. [18]         | 2018 | Oral and Maxillofacial Surgery | 299 | Mean ± SD 3.9 ± 3.5 | 7.7 ± 5.4 | 15.5 ± 16.4 |
| Tomei et al. [19]       | 2014 | Neurological Surgery  | 1052                          | Median (IQR) Male: 6 (3–10) Female: 4 (2–9) | Male: 10 (6–16) Female: 9 (6–15) | Male: 17 (10–27) Female: 15 (12–23) |
evaluating academic promotion involves different routes and multiple aspects. The study results showed that H-index was not perfect indicator of academic promotion. However, it still provides junior surgical faculty a useful reference for academic promotion.

5. Conclusion

There are multiple components to achieving promotion in the field of academic surgery. Currently, an objective standard to measure academic productivity as a determinant of promotion is lacking. At our institution, the median H-indexes at the time of promotions from assistant professor and from associate professor to full professor are 11.0 and 17.0. Using the H-index as an objective measure can be a useful tool to junior surgical faculty as a reference for promotion application.

Declarations

Author contribution statement

Rongzhi Wang: Performed the experiments; Analyzed and interpreted the data; Wrote the paper.
Marshall Lewis: Performed the experiments; Analyzed and interpreted the data.
Rui Zheng-Pywell, Janet Julson, Mary Smithson: Analyzed and interpreted the data.
Herbert Chen: Conceived and designed the experiments.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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