Is NIH Funding Predictive of Greater Research Productivity and Impact Among Academic Otolaryngologists?

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Objectives/Hypothesis: The h-index is an accurate and reliable indicator of scholarly productivity that takes into account relevance, significance, and influence of research contributions. As such, it is an effective, objective bibliometric that can be used to evaluate academic otolaryngologists for decisions regarding appointment and advancement. In this study, we evaluate the impact of NIH funding on scholarly productivity in otolaryngology.

Study Design: Analysis of bibliometric data of academic otolaryngologists.

Methods: Funding data for the 20 otolaryngology departments with the largest aggregate total of NIH grants for the fiscal years (FY) 2011 and 2012 was obtained using the National Institutes of Health Research Portfolio Online Reporting Tools Expenditures and Reports (RePORTER) Database. H-indices were calculated using the Scopus online database, and then compared to funding data at both the departmental and individual level.

Results: Faculty members in otolaryngology departments who received NIH funding had significantly greater research productivity and impact, as measured by the h-index, than their nonfunded peers. H-indices increased with greater NIH funding levels, and investigators with MD degrees tended to have higher mean NIH funding levels than those with PhDs. While there was no correlation between average h-index and NIH funding totals at the level of departments, there was greater correlation upon examination of NIH funding levels of individual investigators.

Conclusions: The h-index has a strong relationship with, and may be predictive of, grant awards of NIH-funded faculty members in otolaryngology departments. This bibliometric may be useful in decisions regarding appointment and advancement of faculty members within academic otolaryngology departments.

Key Words: NIH funding, h-index, academic promotion, academic productivity, faculty productivity, surgical faculty productivity, academic physician scientific productivity, academic rank determination, NIH funding and h-index, academic otolaryngologist research productivity.

Level of Evidence: N/A.

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INTRODUCTION

The evaluation process for advancement in academic medicine takes into account clinical performance, educational contributions, and administrative responsibilities, but is heavily focused on scholarly productivity as measured by research output.1–5 Several measures are frequently used to assess research output of individuals, including total number of publications, number of "significant" articles, and acquisition of academic grants.6,7 Additionally, extramural funding is often used to evaluate the research productivity of medical schools and individual departments. The U.S. News and World Report annually releases a listing of medical schools that includes research rankings based on funding totals from the National Institutes of Health (NIH). Many unofficial rankings with NIH funding totals are used within disciplines of medicine to analyze the research yield of individual hospitals and departments.8 Although proponents argue that these numbers allow for an objective analysis of the degree to which departments emphasize and produce results in research, these metrics can have questionable utility when discussing the relevance and significance of scholarly output.9,10

Parameters traditionally used to judge research productivity have their limitations. Although total number of publications is an easily quantifiable measure, this metric indicates little about the meaningfulness of these articles or the author’s value toward the academic discourse within a field.6,11,12 Many would agree that an individual who publishes few projects with significant impact on clinical practice has had more of an effect than a faculty member with many obscure articles; this same conclusion can be reached for aggregate research
productivity at the departmental level. Additionally, the number of publications does not indicate the order that an author is listed within these projects; an author with minimal or partial contributions to many projects can easily have a higher number of publications than an individual who has taken active, leading roles in scholarship.

The number of citations by others has also been proposed and used as a measure of scholarly productivity. The limitation with this is that if an individual has participated in a single widely cited study, this number can be disproportionately inflated and indicates nothing about the relative dearth of citations from the individual’s other articles. The same issues with order of authorship can also be attributed here; if the person is an author with partial or minimal contributions on a single or handful of significant studies, credit for citations still is received by this metric. Additionally, if an article is repeatedly cited as an example of a poorly performed study, a higher value in this regard incorrectly posits that this individual has produced successful research.

First proposed in 2005 by Dr. Jorge E. Hirsch, a physicist from the University of California–San Diego, the h-index is an objective and easily calculable assessment of scholarly productivity while taking into account significance of research contributions. An author has an h-index of 25 after publishing 25 publications that have been cited at least 25 times each. Even if they have far more than 25 total publications in peer-reviewed journals, any publication cited < h times (less than 25 in this case) are not accounted for in this measure. This ensures that every publication counted has been impactful enough to have been cited in the literature a significant amount of times.

The h-index is calculated using several available online databases, including those from Google Scholar and Scopus. Although results may vary between these databases and others depending on the number of years counted, as well as whether abstracts and presentations are included, one analysis of the h-index among academic neurosurgeons found a high degree of correlation between results from Google Scholar and Scopus.

Since its inception, the h-index has been examined to characterize academic productivity in a wide variety of scientific disciplines, both medical and nonmedical. One recent analysis found this value to be predictive of academic rank among otolaryngologists, although no analyses have examined how h-index values relate to NIH funding status in our field. Awards from the NIH demand rigorous justification of proposals, objectives, and endpoints, and are considered the gold standard in funding sources within biomedical research.

There is little to suggest, however, that the NIH or other organizations take into account the relevance or significance of scholarship in an objective manner when judging the past performance of Primary Investigators (PI). The objectives of this analysis were to examine whether NIH funding is predictive of scholarly productivity and relevance, as measured by the h-index. These relationships were evaluated at both the departmental and PI level.

MATERIALS AND METHODS

Funding data was obtained using the NIHs Research Portfolio Online Reporting Tools Expenditures and Reports (RePORTER). Funding for the 20 departments with the highest aggregate dollar total of NIH grants for the fiscal year (FY) 2011 and 2012 was recorded.

Faculty listings from each of these 20 otolaryngology departments were obtained through individual departmental Web sites. Additionally, each faculty member’s terminal degree was classified into the categories of MD (or MD equivalent), or PhD (or other doctorate). Each faculty’s h-index was calculated using the online calculator available on the Scopus Database (www.scopus.com). Adjunct, visiting, part-time, and nonacademic clinical faculty were excluded from this analysis. The h-index value of faculty (regardless of NIH funding status) was calculated for each of the 20 departments included in this analysis. The 2011 to 2012 FY NIH funding totals of each individual faculty who received funding was obtained. One-way ANOVAs and student t tests were used for statistical analyses, with a threshold for significance set at P < 0.05.

RESULTS

Out of the 477 faculty members included from these 20 otolaryngology departments, 158 received NIH funding for the 2011 to 2012 FYs. These 158 individuals had a significantly higher h-index than those without NIH funding (Fig. 1) (student’s t test, P < 0.005). Of the 158 NIH-funded faculty, 111 were not physicians and held doctorate degrees (either PhDs, EDDs, ScDs, or AuDs) (Fig. 2). The mean h-indices and NIH funding awards of these faculty members, organized by terminal degree, indicate that the mean h-index of the 35 faculty members whose terminal degree was an MD was statistically higher than NIH-funded investigators with MD/PhDs and PhDs (Fig. 2) (t tests, P < 0.005). The NIH funding totals of MDs trended higher than those of MD/PhDs or PhDs (one-way ANOVA, P > 0.05) (Fig. 2). NIH-funded investigators at higher academic ranks had statistically
higher $h$-indices and funding levels (one-way ANOVAs, $P < 0.05$) (Fig. 3).

There was no correlation between departmental $h$-index and NIH funding (Fig. 4). Looking at funding totals for the 158 individuals in this analysis that received NIH grants, there was a stronger correlation between individual $h$-index and NIH funding awards (Fig. 5).

The 158 faculty members receiving funding were organized into five categories by the size of their NIH awards. There was significant variance among these groups (one-way ANOVA, $P < 0.05$). There was an increase in average $h$-index with increasing funding totals (Fig. 6).

**DISCUSSION**

The NIH is the leading governmental supporter of funding for biomedical research in the United States.\cite{25}

NIH grants are considered the gold standard for funding support throughout many scientific disciplines. As such, NIH funding totals have been utilized as an easily calculable metric for comparison of research productivity among departments, and have often been a component in the process of evaluating individuals' research contributions.

The relationship between academic productivity, as measured by the $h$-index, and NIH funding status has been examined in other specialties. One recent analysis evaluating these metrics among academic radiologists found that faculty members that were funded by NIH grants possessed higher $h$-indices than those not NIH funded; however, they noted that higher funding totals did not predict higher $h$-indices.\cite{26} Another group assessing $h$-indices in academic anesthesiology found higher $h$-indices among NIH-funded departments, also noting that these departments had a higher proportion of associate and full professors relative to departments that did not have NIH-funded research, although there was no comment of a correlation when examining individual faculty members.\cite{15}

Previous studies have found a relationship between academic rank and research productivity as measured by the $h$-index. Articles focusing on academic

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**Fig. 2.** Mean (A) $H$-indices (B) NIH Awards of NIH-funded faculty members organized by terminal degree. Error bars represent standard error of measurement ($n =$ sample size). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

**Fig. 3.** Mean (A) $H$-indices (B) NIH Awards of NIH-funded faculty members organized by academic rank. Error bars represent standard error of measurement ($n =$ sample size). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

**Fig. 4.** Mean departmental $h$-index and aggregate NIH funding of the top 20 NIH-funded Otolaryngology departments in 2011 and 2012. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]
neurosurgeons, radiologists, and anesthesiologists found a reliable increase in this metric, with increasing seniority from the level of assistant professor to full professor. One recent assessment specific to academic otolaryngologists from 50 departments found a similar pattern, with assistant professors possessing a mean h-index of 4.62, associate professors a mean h-index of 8.13, and professors a mean h-index of 15.6. There was no significant increase in h-index upon comparison of full professors to departmental chairpersons in that analysis.

In our analysis, we noted that individual otolaryngology faculty members’ h-indices generally increased with higher NIH awards, a finding not previously reported (Fig. 6). Additionally, otolaryngology faculty members receiving NIH funding had a statistically higher h-index than their non-NIH funded peers (Fig. 1). This is consistent with previous findings from other specialties: faculty who received funding from the NIH likely dedicate more of their time to research activities rather than clinical activities and are expected to be more productive in this realm. An unexpected finding was that NIH-funded MDs had higher h-indices and NIH awards than colleagues with PhDs (Fig. 2), even though faculty with PhD degrees would have been expected to spend a higher proportion of their time toward research than their MD colleagues, most of whom dedicate at least some time to clinical care. This may suggest the possibility that having an MD degree confers an advantage towards successful grant applications, although this would not explain why MDs had statistically higher research productivity and NIH awards than their MD/PhD colleagues.

Surprisingly, there was no significant correlation between average departmental h-indices and level of NIH funding (Fig. 3). Part of this may be explained by the fact that two-thirds of the faculty members in these departments received no NIH funding during this time period. Further examination including only the 158 funded individuals revealed a far stronger correlation (Fig. 4).

The h-index is a robust and objective indicator of scholarly productivity; it takes into account relevance and influence of contributions in a way that no other commonly used metric does. It has been previously demonstrated as a powerful predictor of future academic productivity in several settings, and it has been shown to have a consistent and reliable relationship with academic rank. Consideration of several limitations of this metric, however, is warranted.

Individuals at the beginning of their careers are clearly at a disadvantage upon comparison of h-indices. Authors later in their careers have been publishing long enough to have their work judged and cited by others, while those early in their career have not had enough years of research experience to produce an appropriate number of research articles to allow for comparison. In his original work describing this metric, Hirsch suggested dividing an author’s h-index by the numbers of years active to address this issue, creating a rate of scholarly productivity. This proposed measure, , has not been widely used, and although the h-index is an objective and powerful predictor of academic productivity, it should be kept in mind that a low value in younger faculty member does not indicate poor productivity.

Another noted limitation is the potential for self-citation to promote h-index inflation. If an author has several articles near their h-index citation threshold (articles with h-1 or h-2 citations), they can conceivably self-cite their way to a slightly higher h-index, but the repeated and sustained self-citation needed to significantly increase this metric would be tedious and likely difficult to accomplish, except for an author with a low h-index.

One other weakness of the h-index is its insensitivity to overall quantity of publications in some situations. For example, an author with an h of 10 and 20 total

![Fig. 5. Individual h-indices and NIH funding levels among faculty members at the top 20 NIH-funded Otolaryngology departments. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]](image)

![Fig. 6. Mean H-indices of faculty members by NIH funding range. Error bars represent standard error of measurement. Asterisks (*) represent statistically significant difference between the two groups on either side (t test, P < 0.05); (n = number of faculty members with funding in that range). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]](image)
publications is regarded as equally productive as another individual with an h of 10 and 40 total publications. It is important to stress that the h-index is effective in quantifying scholarly productivity in regard to academic relevance, which ultimately is what most researchers strive for; however, there may need to be a correction factor introduced to take into account sheer quantity of scholarship in circumstances such as this.

This analysis reveals important trends regarding how NIH funding status relates to scholarly productivity as measured by the h-index. It is important to note that even though NIH funding is considered the gold standard for biomedical research support, there are myriad otolaryngologic research opportunities supported through other programs not accounted for in this examination, including but certainly not limited to oncology research foundations, the American Academy of Otolaryngology–Head and Neck Surgery's Centralized Otolaryngology Research Efforts (CORE) program, and grants through other otolaryngology subspecialty organizations. Of note, CORE supports some of the NIH funding grants awarded to PIs.

CONCLUSION

The h-index has a strong relationship with funding amounts of NIH-funded faculty members in otolaryngology departments. Individuals with higher funding totals tended to have higher h-indices, and NIH-funded faculty members had higher overall research productivity and impact, as measured by this parameter compared to non-funded otolaryngologists. In light of this data, the bibliometric can be used more often in evaluating decisions regarding hiring and advancement of faculty members within academic otolaryngology departments as it may be associated with, and may in fact be predictive of, NIH funding potential. Further prospective studies are necessary to confirm these findings.

BIBLIOGRAPHY

7. von Bohlen Und, Hallbach O. How to judge a book by its cover? How useful are bibliometric indices for the evaluation of "scientific quality" or "scientific productivity"? Ann Anat 2011;183:191–196.

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Svidar et al.: NIH Funding and H-index in Otolaryngology