Impact of Fellowship Training on Research Productivity in Academic Neurological Surgery

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BACKGROUND: **An increasing number of neurological surgeons have sought fellowship training in recent years, and previous analyses have suggested these practitioners are more likely to pursue an academic career. Scholarly productivity is a key component in academic advancement.**

OBJECTIVE: **We used the *h-index* to evaluate whether fellowship training impacts research productivity and whether any differences exist in scholarly output among practitioners in the various neurosurgical subspecialties.**

METHODS: **Online listings from academic neurological surgery departments were used to organize faculty by academic rank and fellowship training. Using the Scopus database, we calculated the *h-index* for 869 full-time clinical faculty.**

RESULTS: **Mean *h-index* did not differ between fellowship- and nonfellowship-trained practitioners ($h = 12.6$ vs. 13.0, $P = 0.96$). When organized by academic rank, the difference between *h-indices* of those who completed fellowships was substantially greater at all ranks, with statistical significance at the associate professor rank ($P = 0.003$). Upon further examination by individual subspecialties, significant differences in relative research impact were noted ($P < 0.0001$). The stereotactic and functional fellowship was found to have the greatest mean *h*-index score, whereas the trauma/critical care fellowship had the lowest.**

CONCLUSION: **No significant difference existed between the mean *h-index* scores of neurological surgeons who completed fellowships and those who did not. However, when stratified by academic rank, a trend was observed showing greater mean *h*-index scores for those who completed fellowships. This trend persists across nearly all subspecialties. Overall, being a senior faculty member corresponds with a greater *h-index* score, regardless of whether a fellowship was completed.**

INTRODUCTION

Postresidency fellowship training in neurological surgery is a relatively recent phenomenon. Advocates of fellowship training in neurological surgery cite improved patient care and increased exposure to more complex health issues (18, 20, 28). One recent analysis reported that 84.6% of neurological surgery residents indicated an interest in pursuing fellowship training, with personal interest for additional knowledge, job market demand, and academic prestige as the reasons most frequently cited. In the same study the authors also noted that residents contemplating fellowship training were more likely to pursue an academic career path (18), mirroring previously described trends among academic neurological surgeons (2).

In addition to expanding a practitioner's therapeutic repertoire, fellowship training may potentially present an opportunity for additional structured research experiences. Research contributions are increasingly important factors in promotions and appointments in academic medicine (13, 22). In the past, metrics such as funding history, number of citations, and total number of publications have been used to measure research productivity (1). Although these measures are objective, they often do not indicate the influence of a practitioner's research upon scholarship within a field. For example, large funding awards do not

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necessarily translate into significant results. Similarly, total number of publications may not properly portray the impact that an author has had on their field. In addition, evaluation based merely on the total number of citations an author has may be disproportionately influenced by a single heavily cited paper (14, 15, 29).

The *h-index* is a previously described bibliometric-based criterion that rewards researchers with substantial productivity and high citation frequencies (7, 16, 19). Dr. J. E. Hirsch first described this metric in 2005 in an effort to address the limitations of other existing bibliometric indicators (14). Previous literature has shown that the *h-index* is a robust statistic that can be used within the field of neurosurgery to evaluate an individual's scholarly productivity (17, 36).

The *h-index* has repeatedly been shown to have a strong association with advancement, procurement of funding from the National Institutes of Health, and other measures of scholarly impact and expertise among academic practitioners in a wide variety of medical fields, including otolaryngology (6, 10, 11, 32, 34, 35), radiology (27, 29), urology (3), and anesthesiology (21-24). In otolaryngology, it has been found that fellowship-trained academic practitioners have considerably higher *h-indices* than their nonfellowship-trained colleagues (10). There have been no previous comparisons of whether postresidency fellowship training has a similar impact on scholarly influence among neurological surgeons.

Therefore, the primary objective of our current analysis was to characterize whether fellowship training has an influence on the scholarly impact of academic neurological surgeons, as measured by the *h-index*. We also were interested in further investigating whether differences in scholarly impact exist upon comparison of practitioners from the major neurological surgery subspecialties because any such differences can potentially provide insight into the degree that research is emphasized within these disciplines.

METHODS

The American Medical Association's Fellowship and Residency Interactive Electronic Database (i.e., FREIDA) was used to access a list of academic neurological surgery departments. Faculty listings from each individual departmental website were used to compile a list of academic neurological surgeons organized by academic rank and fellowship training, including assistant professors, associate professors, and professors. Instructors, adjunct, voluntary, nonclinical, and nonacademic faculty were excluded from this analysis. In addition, departments that did not provide complete faculty listings with the relevant information were excluded. Faculty who had nonclinical, nonsubspecialty, or research fellowships also were excluded because we aimed to examine the clinical subspecialties of neurosurgery.

Faculty were organized by fellowship training into the following specialties: neurotrauma and critical care, pediatric, spine, skull base, endovascular, epilepsy, interventional neuroradiology, cerebrovascular, vascular (all), peripheral nerve, no fellowship, oncology, and stereotactic and functional. Faculty with listings indicating fellowship training in multiple categories, such as cerebrovascular and skull base surgery, were included in multiple categories for the purposes of this analysis. The "endovascular" category included faculty listed with interventional neuroradiology training as well as those having completed endovascular fellowships. Any faculty with fellowships that contained the term "vascular," such as cerebrovascular, cerebrovascular/skull base, endovascular, cerebrovascular/endovascular, and interventional neuroradiology, were included in the vascular (all) category.

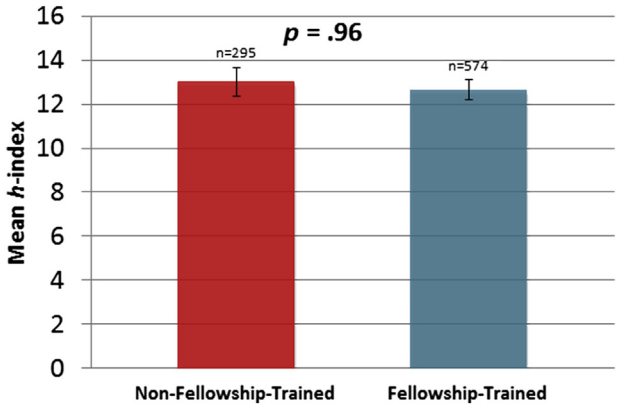

Figure 1. Mean *h-indices* of nonfellowship-trained and fellowship-trained neurological surgeons. Error bars represent standard error of the mean. N represents the cohort size.

The Scopus database (www.scopus.com) was used to determine the *h-index* of included faculty members. Although databases such as Scopus and Web of Science may vary slightly in their *h-index* calculation techniques, an analysis of the *h*-index in academic neurosurgery found a high degree of correlation between results from these two sources (17). Frequently encountered names, for example "Williams" or "Brown," may yield multiple authors with similar names among search results in this database. Departmental affiliations (both current and previous), as well as journals in which faculty members published as listed on Scopus, were used to confirm the reliability of search results for such searches. All data was collected in October 2012.

Statistical Analyses

Nonparametric statistical methods were used, including Mann-Whitney *U* tests and Kruskal-Wallis tests for continuous data, and

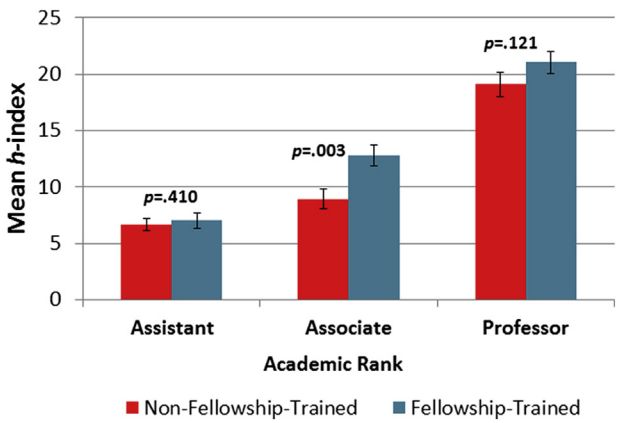

Figure 2. Mean *h-indices* of nonfellowship-trained and fellowship-trained neurological surgeons stratified by academic rank.