The Neurosurgery Match: A Bibliometric Analysis of 206 First-Year Residents

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■ BACKGROUND AND OBJECTIVE: **An important component of the residency application for neurosurgery is research experience and the subsequent number of produced publications. Bibliometrics research has been developed to establish quantitative methods for the standardization of publishing impactful research. This study aims to quantify the research productivity of medical students who successfully matriculated into a Neurosurgery residency program.**

■ METHODS: **We initially identified first-year neurosurgery residents for the 2016–2017 academic year of all U.S. neurosurgical residency programs through departmental websites. The Scopus database was then queried for all articles published in the years 2006 to 2015 by first-year residents and bibliometric variables, such as publication count, journal impact factors, and author h-index, were extracted. The main outcome measured was residency program, tiered 1–5 by total departmental faculty research output.**

■ RESULTS: **Two hundred six (206) Scopus records for first-year neurosurgery residents were identified in 99 programs nationwide. Multivariate ordinal regression demonstrated that only h-index was independently associated with tier of matriculation ($P = 0.043$). H-index was observed to strongly correlate with the number of original research articles ($P = 0.005$), years since first publication ($P < 0.0001$), and journal impact factor ($P = 0.048$) as assessed by multiple linear regression. Notably, h-index was observed to increase by approximately 1 point with every 3 original research articles (B = 0.368) and 4 years since first publication (B = 0.257).**

■ CONCLUSIONS: **H-index is a powerful research predictor of matching into neurosurgical research institutions and can be improved by starting research early, targeting high impact journals, and participating in original clinical and laboratory investigations.**

INTRODUCTION

Matching into a neurosurgical residency program depends on multiple factors, including U.S. Medical Licensing Examination (USMLE) scores, medical school grades, and letters of recommendations. An important component of the residency application is research experience and the subsequent publications produced, and this is especially true in neurological surgery. According to 2016 National Resident Matching Program match data, U.S. allopathic seniors who matriculated into a Neurosurgery program were more academically productive than matriculants into programs of all other specialties, with a combined average of 13.4 abstracts, presentations, and publications.[1] Strong emphasis is placed on medical students to get involved with their institution's Neurosurgery department early during medical school, which facilitates exposure to the field and enables involvement in basic science and clinical research experiences.[2] Students interested in neurosurgery rely on advice from mentors. Very few standardized resources exist to guide medical students through the match process. Online forums do exist; however, anonymous posting and lack of oversight can lead to misleading and inaccurate information.

Bibliometrics research offers a unique opportunity to standardize publishing output by medical students who successfully match into a neurosurgery residency. This field of study is dedicated to establishing quantitative and statistical methods for the standardization of publishing impactful research. Bibliometrics has been used to predict National Institutes of Health (NIH) funding,[3-6] increased salary,[7] and academic career advancement.[8-11] Recently, the study of bibliometrics has gained considerable traction within neurosurgery in an attempt

Key words
- Bibliometrics
- Neurosurgery residency
- Research productivity

Abbreviations and Acronyms
ACGME: Accreditation Council for Graduate Medical Education
ERAS: Electronic Residency Application Service
USMLE: U.S. Medical Licensing Examination

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to quantify publication productivity in a standardized fashion, although research in this field is still young.[8-15] Perhaps the most well-studied metric of research productivity has been the h-index, which is a value that represents the number of publications, h, that are cited at least h times. This metric was recently used by Khan et al[8] and Taylor et al[12] to perform large, pooled analyses of neurosurgical training programs nationwide for the purpose of ranking each department by total and 5-year h-indices, respectively. The h-index is useful because it combines quantity of publications and impact of those publications, represented as citation count, to compare research output between authors.

The present article aims to us a bibliometrics-based analysis to achieve several goals: 1) to highlight the research achievements of successful matriculants in the past year of applications, which may serve as benchmarking tools for current medical students; 2) to identify specific aspects of student research that may translate to success in the match, which may help to guide current students in making career decisions; and 3) to outline potential strategies for improving one's candidacy, which important, may translate to more qualified applicants and increased contributions to the neurosurgical literature. Prior neurosurgical studies regarding bibliometric analyses have evaluated associations between research productivity and career advancement; however, this is the first study to target a student population. Prospective neurosurgery applicants (i.e., medical students) make up the next generation of neurosurgeons. To continue to excel as a field, recruitment of the brightest students is paramount. Given the extremely limited standardized guidelines that exist for students, we hope to provide a valuable discussion of student research and residency recruitment.

METHODS

Data Extraction

The following data extraction process was similar to that previously reported in the literature.[8] We obtained a listing from the Accreditation Council for Graduate Medical Education (ACGME) of all U.S. neurosurgical residency programs (https://apps.acgme.org/ads/Public/Reports/Report/1).[16] For each program, we consulted institutional websites to find the names of postgraduate year residents. In cases of missing information, we consulted the 2016 Match List published on the American Association for Neurological Surgeons website (http://www.aans.org/Young%20Neurosurgeons/Medical%20Students/Residencymatch.aspx).[17]

After resident identification, we queried the Scopus database using the "Author Search" function for articles published before and including 2015. We only used publications before 2015 to ensure that search results were reflective of the original Electronic Residency Application Service (ERAS) submission for 2016 to 2017 first-year residents. In cases of multiple author search results, we cross-referenced the results with the applicant's medical school and graduation year. If there was still ambiguity, that author was excluded from further analysis. For each Scopus profile, we collected the following bibliometric variables: 1) total number of published or in-press articles; 2) number of original research articles; 3) number of case reports; 4) number of review articles; 5) number of neuroscience-related and non-neuroscience articles; 6) journal impact for each publication; 7) number of articles in neurosurgical journals; 8) h-index; and 9) m-quotient (defined as the h-index divided by the number of years since first publication). Applicant doctoral degrees and medical schools were collected from

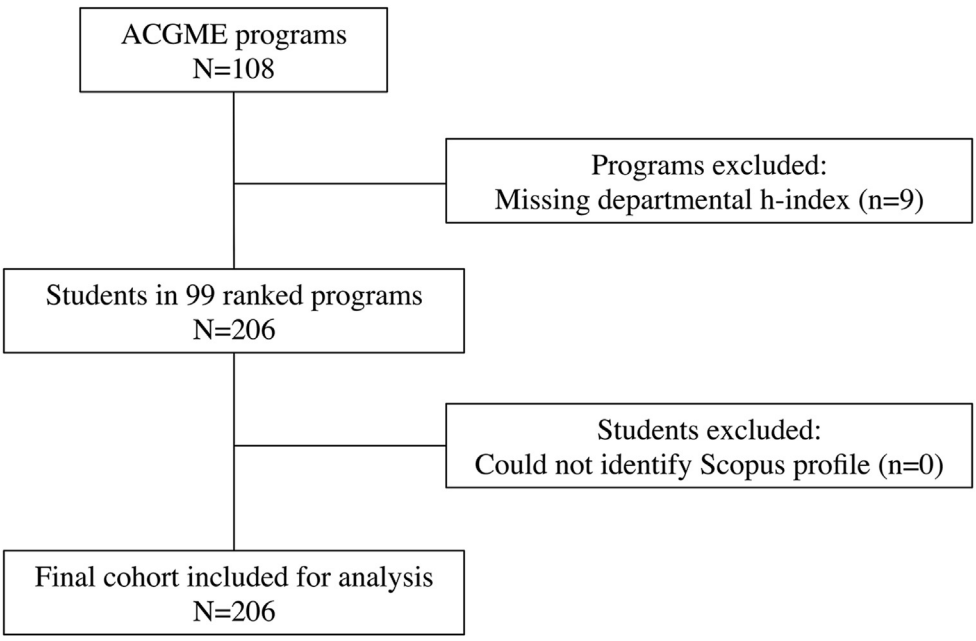

Figure 1. Flow chart of selection summary for final cohort of students included in our analysis. ACGME, Accreditation Council for Graduate Medical Education.

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