Academic Productivity of Neurosurgeons Working in the United Kingdom: Insights from the H-Index and Its Variants

Aimun A. B. Jamjoom[1], A. N. Wiggins[1], J. J. M. Loan[2], J. Emelifeoneu[1], I. P. Fouyas[1], P. M. Brennan[1]

■ OBJECTIVES: **Academic metrics can be used to compare the productivity of researchers. We aimed to use a variety of bibliometric parameters to assess the productivity of neurosurgeons working in the United Kingdom.**

■ METHODS: **Neurosurgical consultants working in the United Kingdom were identified using the Society of British Neurosurgeons' Audit Programme website. Baseline data collected included year of entry to specialist register, academic position and award of higher degree. Google Scholar was used to compute a range of academic metrics for each consultant including the h-index, hi-norm, e-index and g-index. Non-parametric tests were used to compare median results.**

■ RESULTS: **Median metrics for the whole cohort were: h-index (5), hi-norm (3), g-index (10.4) and e-index (9). The top 3 units based on h-index were Addenbrookes (13), Great Ormond Street (12.5) and Queen's Square (11.5). The h-index correlated with academic position [Prof (17.5), Senior Lecturer (10.5) and non-academic (5); $P < 0.0001$], higher degree [PhD (10), MD (6) and none (4.5); $P < 0.0001$] and consultant experience [> 10 year (7), < 10 years (4); $P < 0.0001$]. No difference was found based on gender [male (5), female (4); $P = 0.12$]. The same trends were seen across the following other metrics: hi-norm, e-index and g-index.**

■ DISCUSSION: **This study details the academic impact of United Kingdom-based neurosurgeons through the analysis of a number of citation metrics. It provides a benchmark bibliometric profile and we advocate future comparative assessments as a means to assess impact of and guide academic policy.**

INTRODUCTION

Publications are widely regarded as a key indicator of academic performance. Analysis of citation trends is playing an increasingly important role in assessing the impact of individual academics. These analyses are being used to facilitate funding allocation and comparison between individuals and institutions.[1,2] The most common metric is the Hirsch index (h-index), which was devised in 2005.[3] It is calculated where "h publications received at least h citations or more," so an academic with 20 publications with at least 20 citations each would have an h-index of 20. The h-index is one of the most widely used metrics; however, it has a number of weaknesses. In particular, it is weighted toward older researchers who have had more time to accumulate citations throughout their career. Furthermore, it does not take into account highly cited articles and has therefore been suggested as favoring quantity over quality. It may also lose reliability for researchers with common names or fields of high coauthorship.[1] To compensate for these methodological issues, various modifications of the h-index have been developed. These include the m-quotient[3] and hi-annual, which aim to provide a temporal profile to the h-index and are meant to level the playing field between researchers with differing years of experience. Similarly, the hc-index provides an age-related weight to articles, which favors more recent publications.[4] While the g-index[5] provides more weight toward articles with high citation counts, the hi-norm takes into account the number of

Key words
- Bibliometrics
- h-index
- Neurosurgery
- United Kingdom

Abbreviations and Acronyms
BNTRC: British Neurosurgical Trainee Research Collaborative
GMC: General Medical Council
NNAP: Neurosurgical National Audit Programme
SBNS: Society of British Neurological Surgeons
SPSS: Statistical Package for the Social Sciences

From the [1]Department of Clinical Neuroscience, Western General Hospital, Edinburgh, United Kingdom; and [2]Department of Neurosurgery, Aberdeen Royal Infirmary, Aberdeen, United Kingdom

To whom correspondence should be addressed: Aimun A. B. Jamjoom [E-mail: aabjamjoom@gmail.com]

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authors per publication. These variants provide context for the h-index and allow for a more robust interpretation of an individual's academic output.

A number of studies have assessed the h-index in a neurosurgical population.[6–10] Khan et al. examined the h-index of 188 neurosurgeons working in the United States and found a mean h-index of 20.3 based on Google Scholar.[10] Khan went on to further assess the productivity of 1225 academic neurosurgeons in the United States.[6] The study found that the median h-index, g-index, hc-index, and m-quotient were 11, 20, 8, and 0.62, respectively. Wilkes assessed the h-index and m-quotient of neurosurgeons working in the United Kingdom and found results of 6 and 0.41.[9] The observed differences between the 2 national cohorts are partly driven by the populations assessed, with Khan's studies focusing on academic neurosurgeons. Though these studies provided useful insights into the academic output of neurosurgeons, they either concentrated on part of a national cohort of neurosurgeons or only used a limited number of metrics to measure academic output in a full national cohort. In this study, we aimed to quantitatively analyze the scientific output of all neurosurgeons working in the United Kingdom. By using a broad portfolio of metrics, we aimed to address the major shortcomings of the h-index including bias toward more experienced researchers, lack of weighting toward highly cited articles, and limited differentiation between authorship patterns. We therefore aim to provide a robust assessment of the academic productivity of neurosurgeons working in a single country and create a bibliometric profile to guide academic policy and for future comparative assessments.

MATERIALS AND METHODS

Neurosurgical consultants working in the United Kingdom were identified using The Society of British Neurological Surgeons Neurosurgical National Audit Programme (NNAP) website. From this we sourced the consultant's units, General Medical Council (GMC) number, and higher degrees (Ph.D., M.D., or none). In the United Kingdom, an M.D. is a postgraduate qualification normally awarded after 2 years of original research and submission of a thesis. The GMC's medical register was then interrogated for consultant's date of entry to the Specialist Neurosurgery Register. Online and departmental website searches were then used to identify consultant academic positions (professor, senior clinical lecturer, or none). University rankings were identified from the University League table, which ranks institutions on the basis of an aggregate score of their research quality (as indicated by the university Research Excellence Framework),[11] student satisfaction (measured by the National Student Survey of final year undergraduates),[12] graduate prospects (employability of first-degree graduates based on data from the Higher Education Statistics Agency),[13] and entry criteria (average university entrance tariff for undergraduate students). Following the collection of baseline demographic data, 2 search engines (Scopus and Google Scholar) were used to gather a range of academic metrics for each consultant. These included the metrics defined later, as well as the number of papers published by each consultant and the total number of citations received.

Academic Metric Engines

A number of engines are available for tracking and analyzing citation patterns. Bakkalbasi compared 3 engines (Google Scholar, Scopus, and Web of Science) across a range of disciplines and in 2 different years.[14] The study showed that no one resource provided a superior performance across disciplines or timeframes. We opted to use the following 2 search engines:

Scopus. Scopus (www.scopus.com) uses an author-identifying algorithm to match author names on the basis of their affiliation, address, subject area, source title, dates of publication citations, and coauthors. A list of publications for each consultant was generated, as well as the number of coauthors and the total number of citations. Scopus automatically generates an h-index, but it is inaccurate for authors with papers published before 1996 as Scopus has incomplete citation data before this date.

Google Scholar. Publish or perish (PoP) is a free program available to download from Anne-Wil Harzing's website (www.harzing.com) that searches Google Scholar to calculate a wider range of citation metrics than Scopus.[15] Google Scholar had a number of documented drawbacks at its inception in 2004 including poor indexing of publications and variability in citation counts. However, a number of recent longitudinal studies have identified a significant improvement in Google Scholar's stability and coverage in the past few years.[16,17] PoP has been tested by assessing the publication record of 20 Nobel Laureates across a range of disciplines.[18] It showed comprehensive coverage of 800 of their most cited publications except in 4 cases. PoP has also been used for citation analysis across a range of disciplines including economics and the social sciences.[19] There is no author-matching algorithm, so lists of publications were manually checked to ensure that only papers pertaining to the author in question were included. This was achieved by assessing the author's initials and article title. Names that generated >1000 hits were excluded from analysis. Once the author publication list was finalized, POP automatically generated a range of citation metrics including the h-index, hi-norm, hi-annual, hc-index, e-index, g-index, and m-quotient.

Citation Metrics

We opted for a portfolio of 7 metrics that were calculable using the search engines used and addressed the major shortcomings of the h-index. These include:

h-index: h is defined as the highest number such that the academic has h publications with at least h or more citations.[8]

hi-norm: instead of dividing the total h-index, it first normalizes the number of citations for each paper by dividing the number of citations by the number of authors for that paper. The hi-norm is then calculated as the h-index of the normalized citation counts. This metric is meant to mitigate the effect of differing authorship numbers that is seen across disciplines and provides a per-author measure.[15]

hi-annual: the individual, average annual increase of the h-index. This metric is designed to allow comparisons between researchers with differing years of experience.[15]