Bibliographic characteristics of the research output of pediatric anesthesiologists in Canada

Caractéristiques bibliographiques de la production d'études de recherche des anesthésiologistes pédiatriques au Canada

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Abstract

Purpose Various bibliometric citation indices have been used to evaluate research productivity and scientific impact, but recently, Hirsch's *h*-index has gained widespread recognition. Although described initially for physical sciences, *h*-indices are being used to assess research productivity and impact in other disciplines.

Methods In this descriptive study, ScopusTM and Web of Science[®] citation databases were used to identify the bibliographic characteristics of pediatric anesthesiologists from all university affiliated departments of pediatric anesthesia in Canada up to May 2009. For each anesthesiologist, the *h*-index, mean citations per publication, total number of publications, total number of citations, and year of first publication were determined.

Results A study population of 151 pediatric anesthesiologists was identified. The range of *h*-index values for this cohort was 0–32 with a median (interquartile range) of 2 (1–5). The 90th percentile was 8.0. The median (interquartile range) number of citations per publication was 6 (1–15), with a range of 0–87. The median (interquartile range) number of publications was 4 (1–9) with a range of 0–165.

Conclusions We describe the bibliographic characteristics of the research output of pediatric anesthesiologists in Canada. This study highlights the growing influence of scientometrics on the evaluation of scientific performance in medical specialties.

Résumé

Objectif Différents indices de citation bibliométriques ont été utilisés pour évaluer la productivité en recherche et l'impact scientifique, mais l'indice *h* de Hirsch a acquis une vaste reconnaissance. Bien qu'ils aient à l'origine été conçus pour s'appliquer aux sciences physiques, les indices *h* sont aussi utilisés dans d'autres disciplines pour évaluer la productivité et l'impact de la recherche.

Méthode Dans cette étude descriptive, les bases de données de citation ScopusTM et Web of Science[®] ont été utilisées afin de déterminer les caractéristiques bibliographiques des anesthésiologistes pédiatriques de tous les départements d'anesthésie pédiatrique affiliés à des universités au Canada jusqu'en mai 2009. Pour chaque anesthésiologiste, on a déterminé l'indice *h*, les citations moyennes par publication, le nombre total de publications, le nombre total de citations et l'année de première publication.

Résultats Au total, 151 anesthésiologistes pédiatriques ont été identifiés comme constituant la population à l'étude. L'étendue des valeurs d'indice *h* de cette cohorte allait de 0 à 32, avec une médiane (écart interquartile) de 2 (1–5). Le nombre médian (écart interquartile) de citations par publication était de 6 (1–15), avec des extrêmes de 0 et 87. Le nombre médian (écart interquartile) de publications était de 4 (1–9), avec des extrêmes de 0 et 165.

Conclusion Nous décrivons les caractéristiques bibliographiques de la production d'études des anesthésiologistes pédiatriques au Canada. Cette étude souligne l'influence grandissante de la scientométrie dans l'évaluation des performances scientifiques dans les spécialités médicales.

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Scientometrics, the quantitative study of scientific communication, proposes that research productivity is amenable to measurement using statistics derived from publications indexed in scientific citation databases.¹ Scientific performance of researchers in medicine seeking academic advancement, tenure, or funding is commonly assessed using bibliographic indices, such as mean citations per publication, total publications, journal impact factors, or number of papers with $> n$ number of citations. All of these measures have limitations. For example, *total publications* measures productivity but does not indicate the importance or impact of an individual's work, whereas *mean citations per paper* might reward low productivity or fail to recognize high productivity.

Hirsch's *h-index* is designed to improve on commonly used metrics and reflects the cumulative impact of an individual's work. It is determined from the distribution of citations received by a researcher's publications. A researcher has Hirsch index *h* if *h* of his/her *N_p* publications have at least *h* citations each and the other (*N_p - h*) publications have, at most, *h* citations each.² For example, to have an *h-index* of 10 a researcher must have published ten publications that each have at least ten citations. Thus, a high *h-index* reflects sustained productivity of highly cited publications.

The *h-index* has gained rapid and widespread recognition by scientists in physical sciences as a measure of research productivity.³ In the original description of the index, Hirsch calculated *h-indices* (range) for prominent physicists (62–110) and inductees to the National Academy of Sciences in biological and biomedical sciences in 2005 (18–135). For other disciplines to use the *h-index* to measure scientific performance the bibliographic characteristics of the scientific output of researchers across that field must be known. A Medline (U.S. National Library of Medicine) search of core clinical journals using the key words “scientometrics”, “Hirsch index”, or “*h-index*” revealed that no publication has addressed the subject of the *h-index* or its role in assessing researchers in medicine.

We describe the bibliographic characteristics of the research output of pediatric anesthesiologists from university affiliated departments of pediatric anesthesia in Canada. In addition, we compare the *h-index* to other commonly used measures of research productivity.

Methods

We conducted a descriptive study examining the bibliographic characteristics of the research output of pediatric anesthesiologists in Canada up to May 2009. Pediatric anesthesiologists from all university affiliated departments of pediatric anesthesia in Canada (Table 1) were identified

Table 1 University affiliated departments of pediatric anesthesia in Canada

Alberta Children's Hospital
BC Children's Hospital
Children's Hospital of Eastern Ontario
Children's Hospital, Winnipeg
CHU Sainte-Justine
Izaak Walton Killam Children's Hospital
Janeway Children's Health and Rehabilitation Centre
Montreal Children's Hospital
Stollery Children's Hospital
The Hospital for Sick Children

using university faculty website lists and by contacting departments of pediatric anesthesia directly at the respective hospitals.

Data were collected using two internet-based citation resources, ScopusTM (Elsevier) and Web of Science® (Institute for Scientific Information). The *author search* function of Scopus was used to identify each anesthesiologist's full name, including middle initials and variations of the author's name used in published articles and previous institutional associations. These data were then used in the *author finder* function of Web of Science to define the search. The search was limited to life sciences and biomedicine, excluding arts and humanities, multidisciplinary science and technology, and physical and social sciences. Institutional association was not used as a search limitation. The search returned all article types for each author, including publications of non-original investigations. Then, we refined the search by excluding meeting abstracts, book reviews, biographies, corrections, news, reprints, and documents published prior to 1969. Search results were further refined by reviewing each result individually to identify author, institution, and subject area. Those articles that did not meet known name variations, institutional associations, and subject area were excluded. Using the refined results, a citation report was created with Web of Science, providing the *h-index*, mean citations per publication, total number of publications, total citation count, and year of first publication for each anesthesiologist.

Data were analyzed using Prism 5 (GraphPad Software, San Diego, CA, USA). Descriptive statistics (median, interquartile range, range) were determined for *h-index*, mean citations per publication, total number of publications, total citation count, and year of first publication. The Mann-Whitney rank sum test was used to compare data. Linear regression analysis was used to show the relationship between *h-index* and time since first publication and between mean citations per publication and time since first publication. Linear regression analysis was used to show the relationship between *h-index* and mean citations per

publication for all anesthesiologists in the cohort and for high performing (mean citations per publications > 90th percentile or *h*-index > 90th percentile) anesthesiologists in the cohort.

Results

Our search strategy identified 151 pediatric anesthesiologists (Table 2). The range of *h*-index values for the cohort was 0–32 with a median (interquartile range) of 2 (1–5) (Figure 1). The 90th percentile was 8.0. Table 2 shows citations per publication, total number of publications, total citations, and time since first publication for the cohort. There was a positive correlation between *h*-index and time since first publication ($r^2 = 0.31$; $P < 0.0001$) (Figure 2) and between mean citations per publication and time since first publication ($r^2 = 0.32$; $P < 0.0001$) (Figure 3). There was a positive correlation between mean citations per publication and *h*-index for all anesthesiologists in the cohort ($r^2 = 0.13$; $P < 0.0001$) and for those anesthesiologists with *h*-index > 90th percentile ($r^2 = 0.29$; $P = 0.03$). There was no significant correlation between *h*-index and mean citations per publication ($r^2 = 0.071$; $P = 0.36$).

Table 2 Bibliographic characteristics of Canadian pediatric anesthesiologists

	Pediatric anesthesiologists (n = 151)
<i>H</i> -index	2 (1–5)
Citations per publication	6 (1–15)
Total publications	4 (1–9)
Total citations	31 (2–106)
Time since first publication (yr)	13 (4–19)

Data are median (interquartile range)

Fig. 1 Distribution of *h*-indices among pediatric anesthesiologists in Canada

Fig. 2 Scatter plot showing a positive correlation between *h*-index and time since first publication (yr) ($r^2 = 0.31$; $P < 0.0001$)

Fig. 3 Scatter plot showing a positive correlation between mean citations per publication and time since first publication (yr) ($r^2 = 0.32$; $P < 0.0001$)

for those anesthesiologists with mean citations per publication > 90th percentile.

Discussion

We describe the bibliographic characteristics of the research output of 151 pediatric anesthesiologists in Canada. This study provides descriptive data that allows objective evaluation of scientific performance of pediatric anesthesiologists. Analysis of the data also demonstrates some of the known attributes and limitations of the *h*-index as a measure of research output.

Bibliographical measures used often to evaluate the impact of research include the number of publications per year and the mean number of citations per publication. Without assessing journal impact factors, the number of publications per year may measure industry rather than quality, whereas mean citations per publication may be disproportionately influenced by a few highly cited publications. Other measures of scientific performance for determining academic advancement are defined using arbitrary cutoffs, for example, "best" publications of the past five years and journal impact factor of significant publications. Hirsch argued that the *h*-index is superior to these single-number criteria for assessing scientific output, as it is not defined using arbitrary cutoffs. The *h*-index takes into account scientific impact as well as productivity, and it is difficult to influence by self-citation. He proposed that the *h*-index could identify successful and outstanding scientists and could facilitate academic advancement in departments, universities, and other academic bodies.²

The *h*-index was described initially as a tool to evaluate relative quality among theoretical physicists.² It remains to be seen whether the *h*-index can be applied as successfully to physicians in clinical medicine who have varying levels of academic accomplishment, diverse areas of research, smaller numbers of researchers in each field, and different citation practices. This study highlights the range of academic accomplishment by pediatric anesthesiologists. Twenty-one percent (31/151) of the cohort had never published a research paper, whereas the most highly published anesthesiologist had 165 publications. Furthermore, research productivity by physicians may vary over time and is often greatest relatively early in a physician's career. Hirsch suggested that the *h*-index is ideally suited to measure the cumulative impact of research output in a population that does not maintain a consistent level of productivity over time.²

The *h*-index is not beyond criticism – a limitation being that it is time sensitive. Like mean citations per publication, we demonstrated that the *h*-index for this cohort showed a positive correlation with time. To compensate for this shortcoming, further manipulation to yield an *h*-index matrix has been proposed.⁴ Whereas large *h*-index values are indicators of successful researchers, the converse is not necessarily true, for instance, distinguished researchers with a small number of highly cited publications may have a low *h*-index. Researchers working in non-mainstream areas may not attain *h*-indices as high as those working in more topical areas. Likewise, the *h*-index may be increased by gratuitous co-authorship of published work, as all authors of a scientific publication are considered when calculating the *h*-index. Furthermore, similar to other bibliographic citation indices, the *h*-index does not take into account the context of citations, for example, those

citations with a negative context that highlight a failing or limitation of published research will have the effect of increasing the ranking of scientists when citation indices are used. Lehmann et al. evaluated common bibliographic measures in a homogeneous population, i.e., high energy physicists. They reported that the mean number of citations per publication was superior to the *h*-index, with a lower average error when used to predict the assignment of authors to decide groups.⁵ In our cohort, there was a significant correlation between the two metrics for anesthesiologists with *h*-index > 90th percentile, but not for those with mean citations per publication > 90th percentile. This suggests that the *h*-index might predict high performing anesthesiologists more accurately than mean citations per publication.

Our study has a number of limitations. The *h*-index can be influenced by the choice of citation database. Databases differ in terms of subject, publication timespan, and range of journals referenced, and they may provide quantitatively and qualitatively different citation counts for the same publications.⁶ Non-original research, such as review articles, can have a significant citation impact,⁷ and while these publications may not necessarily reflect the scientific performance of an individual, they will influence an individual's citation profile.

Although ScopusTM is the largest citation database of research literature available, we did not use it to determine the *h*-index for our cohort. In the calculation of the *h*-index, ScopusTM considers only those articles published after 1995, and in our cohort, the median time since first publication was 13 years. By excluding publications prior to 1995, the derived *h*-index may accurately reflect current research impact, whereas the *h*-index derived using Web of Science may be a more accurate measure of lifetime achievement.

By selecting pediatric anesthesiologists, we have attempted to identify a field-specific homogeneous population, a necessary prerequisite for any statistical analysis of citations.² Publications in certain disciplines are cited more frequently than others, and field variation in citation practices is a source of bias when comparing the *h*-index across disciplines.⁸ Subanalysis of this cohort suggested that pediatric anesthesiologists who have an intensive care involvement have different research output and citation results compared with those who are not involved in intensive care. The differences observed in the two groups may be explained by field variation in citation practices or differing cumulative research activity of physicians depending on the balance of clinical work and dedicated research time. However, these results were interpreted with caution due to the low number of intensivists in the cohort ($n = 10$). Although Scopus uses unique author identification numbers and lists all known institutional affiliations, some authors have published their personal information

(name and institutional affiliation) inconsistently, making accurate author identification challenging.

A fair and transparent method is required to evaluate research performance objectively, as assessment of academic achievement by peer review can be affected by subjectivity and bias.⁹ The *h*-index is becoming widely used for evaluating research output among scientists as well as for ranking journals, academic departments, and institutions.¹⁰ This cohort study describes the bibliographic characteristics of the research output of university affiliated pediatric anesthesiologists in Canada. Like other bibliographic ranking tools, the *h*-index has limitations and must be interpreted according to the specific field of research.

Conflicts of interest None declared.

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