British Journal of Anaesthesia **107** (3): 306–7 (2011)
doi:10.1093/bja/aer236

EDITORIAL III

Bibliometrics and assessing performance and worth

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There are two papers in this issue of the *British Journal of Anaesthesia* which look at *h*-index[1 2]—one in UK academic departments of anaesthesia and the other in anaesthesia journals' editorial board members. The concept of *h*-index has rapidly been elevated to great importance in the UK because of changes in the way money will be distributed to Universities through the Research Excellence Framework (REF). Elsewhere in the world, it is used already for both this and other purposes.

Although it is easy to count the number of academic papers written by an individual researcher, it is difficult, if not impossible, to accurately gauge the *effectiveness* of the publications. The *h*-index is an attempt to quantify the productivity and scientific impact of the work of a scholar. The index is calculated on the basis of the scientist's most-cited papers and the number of citations that they have received in other publications. The index has also been applied to the impact of groups of scientists—such as departments. The index was suggested by Hirsch,[3] a physicist working at University of California, San Diego, as a tool for determining theoretical physicists' relative quality.

In the past, the more usual way to prove one's worth was to list one's publications along with the various impact factors (IFs) of the journal where they were published. IF is calculated for an individual year by taking the total number of citations of articles published by an individual journal for the preceding 2 yr and dividing by the number of 'eligible' articles published during that year. There are several criticisms of the use of IF as a means of ranking journals—not least of which is the relative ease of adjusting the denominator in the calculation of individual IFs. Because only the most highly cited articles contribute to the *h*-index, its determination is a relatively simple process, less subject to bias by individuals. Hirsch found that in physics, a moderately productive scientist would have an *h*-index equal to the number of years of active publishing while in the biomedical sciences, researchers tended to have higher values—perhaps reflecting a trend to generally 'over-cite'. In addition, it is apparent that the *h*-index increases as citations accumulate and thus it depends on the 'academic age' of a researcher. Coupled to this, not all papers will contribute to the *h*-index—for example, those written later in a scientist's career when they may already have a high *h*-index. There is another 'problem' with the *h*-index in that a researcher may concentrate on quality *vs* quantity and thus publish few very highly cited articles. To get over this problem, the *g*-index was proposed, which is the largest (unit) number of articles cited at least g^2 times.[4]

Hirsch suggested from his experience that an *h*-index of 10–12 might be typical for advancement to tenure in a US institute (associate professor level), and an index of around 18 for full professor. He also showed that *h* has a high predictive value for whether a scientist has won honours such as National Academy membership (around 45) or a Nobel prize, where the peak is between 35 and 39 (Fig. 1).

Problems have been raised with the *h*-index and there are certainly situations where it may provide misleading information about a researcher's output.[5] One of the problems of *h* is that it does not take into account the contribution of others. Areas of research involving many co-authors or large collaborations will usually be associated with high *h* values. It has been suggested that it may be useful to normalize the *h*-index by a factor that takes into account the average number of co-authors. Age of the researcher can be taken into account by dividing by years of active research to give an *m* value (e.g. $m=1$ where $h=20$ after 20 yr; $m=2$ where $h=60$ after 30 yr, etc.).[6] A further problem arises from the coverage of the various databases used to calculate *h*. Web of Science® has strong coverage of journal publications, but poor coverage of conferences. Scopus™ has better coverage of conferences, but poor coverage of publications before 1996. Bould and colleagues,[7] in this journal, found problems with the level of agreement when calculating the *h*-index for individuals in an academic anaesthesia department using either Scopus™ or Web of Science®. Google Scholar has the best coverage of conferences and most journals but also has limited coverage of pre-1990 publications.[8] Scopus™ and Web of Science® calculations fail to count the citations that a publication gathers while 'in press' even with electronic pre-publication. Google Scholar has been criticized for producing 'phantom citations'.[9]

The *h*-index can be manipulated through self-citation,[10] and if based on Google Scholar output, then even

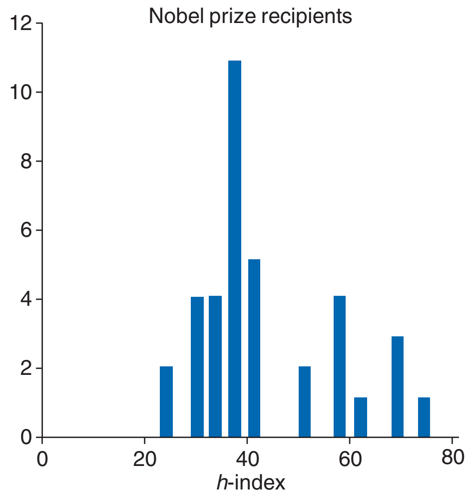

Fig 1 Histogram of Nobel prize recipients in Physics over a 20 yr period along with their *h*-index. Redrawn with permission from Hirsch.[3]

computer-generated documents can be used for that purpose.

These indexes can also be used for groups of researchers or perhaps journal board members. For example, a scientific institution has an index of *i* when at least *i* researchers from that institution have an *h*-index of at least *i*. It is this approach that could be used to assess the standing of a journal—by measuring the *i* value of its editorial board. Again this approach would favour larger boards or institutions.

Pagel and Hudetz[2] showed that editorial board members of anaesthesia journals with higher IFs had higher *h*-indices as did those holding more than one journal appointment. This would suggest that journals with higher IFs attract those with the higher *h* to sit on their editorial boards. It does not necessarily mean that those with a higher *h* are able to improve a journal's IF. When it comes to academic departments,[1] it appears that, with the notable exception of department R, the departments with the most academic staff tended to have the most publications, the most citations, and perhaps most citations per article—and also the higher *h* and *g*. In this case, perhaps correcting for numbers of collaborators or authors may have evened out this distribution. It could also be that these departments are those that publish in journals with known higher citation rates—such as is known to occur in the biosciences.[11]

One last word of caution: it is well known that some scientists, who are perhaps familiar with the lobbying process, deliberately omit to cite their competitors so that they can lower their impact.[12] Incidentally, this last reference (a web address) suggests 10 useful rules on how to get ahead in academia—but then again, perhaps I should not have mentioned that.

Conflict of interest

Member of the Editorial Board of the *BJA*. Chairman and Director of *BJA*. Received research funding from *BJA*.

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