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EDITORIAL

The *h*-index: A new way of assessing the scientific impact of individual CAM authors

When it comes to the word 'impact factor', most people will associate this with the impact factor of a particular scientific journal. In the world of bibliometrics there is however a new index available, the *h*-index, that quantifies the scientific impact of individual authors. The *h*-index was developed in 2005 by Jorge Hirsch, a condensed-matter physicist at the University of California in San Diego. Hirsch's aim was to qualify the impact and quantity of individual scientist's research output. The measure he devised is simple: a scientist with an *h*-index of, say, 5 has published 5 articles that have each attracted at least 5 citations. This means that the rest of the author's papers have less than 5 citations. Hirsch's original paper appears at: http://arxiv.org/abs/physics/0508025.

The *h*-index is simple to calculate and takes into account both the productivity and quality of a scientist's articles. The original idea behind it was to calculate the impact of a scientist within its respective field, but it can also be used to calculate the impact of a group of scientists. It is currently not a widely accepted measure and only one of a possible number of indices, but it is likely to be increasingly used. I would therefore like to address both the possibilities and pitfalls of this index.

Without going into the mathematical detail, the *h*-index quantifies the average number of citations that all of the publications of a particular scientist has received during its lifetime. So the *h*-index enables a quick check on how many papers a scientist has published and whether they were interesting enough to be cited.

Citation data are collected by indexing databases, the main ones being Elsevier's Scopus and Thomson Scientific's Web of Science. A few (Scopus) examples of leading CAM academics who have been actively publishing at least during the last 15 years are given in the Table 1 (status September 2007).

Fig. 1 is an example of a *h*-graph, in this case of Brian Berman. Each dot on the graph represents a paper and where the curve crosses the 45 degree diagonal line is in effect the average number of citations that each of the papers of the author has received. It is easy to visualise that if an author has published many papers that are hardly cited, the right hand side of the curve will remain close to zero on the citation axis and therefore the point where it crosses the diagonal line will be low.

The *h*-index also takes into account the total volume of publications of a particular author. For instance, an author who has only published 10 papers, is limited by a maximum *h*-index of 10 (which would be the case if all 10 papers would be cited at least 10 times). A benefit of the *h*-index is therefore that it takes into account both the productivity and the quality of articles authored or co-authored. The incorporation of productivity works in favour of Edzard Ernst, who has the highest *h*-index of 38, which is aided by a phenomenal amount of 496 published papers. This is about four times the volume of papers published by Brian Berman, but his *h*-index is a bit less than double compared to that of Brian Berman. This indicates that per published paper, 'the average scientific yield' (as quantified by the number of citations) is higher for Brian Berman than for Edzard Ernst.

There are a number of limitations to the *h*-index. One is that the *h*-index is not affected by several very highly cited papers that are of great and/or seminal importance for determining the influence of a scientist, or group of scientists, in a particular field. For instance, the group led by Dieter

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Table 1 Illustration *h*-index of a few influential CAM researchers

Authors	Institution/affiliation	Total number of publications[a]	*h*-Index
Brian Berman	University of Maryland, USA	117	21
Edzard Ernst	Peninsula Medical School, UK	496	38
Dieter Melchart	Technical University Munich, Germany	68	16
Andrew Vickers	Memorial Sloan-Kettering Cancer Center, USA	166	22

[a] Citations counted in papers published from 1996 onwards.

Melchart, published two papers that had a disproportionate influence in the CAM field: the first was the Review on St John's worth for depression published in the British Medical Journal in 1996 (636 citations since 1996). The second was the Meta-analysis by Linde et al. on placebo controlled trials of homeopathy published in The Lancet in 1997 (408 citations since 1996). These two papers have contributed only two points to the *h*-index of 16, whereas the real impact in the CAM research community has been much greater.

Another drawback is that the *h*-index can sometimes mislead due to the way authors and publications are identified and counted. Potential bias can only be properly assessed by a detailed look at the articles used in the calculation of the index. For instance, closer scrutiny of the 166 articles by Andrew Vickers indicates that during the last few years he has mainly published 'conventional', rather than CAM related articles due to his current affiliation with a leading oncological academic centre. One could argue that such articles are not necessarily of relevance for his influence in the CAM field: manual review of his papers identified a subset of 99 articles related to CAM, with a *h*-index of 21. So in this example, there is only a marginal

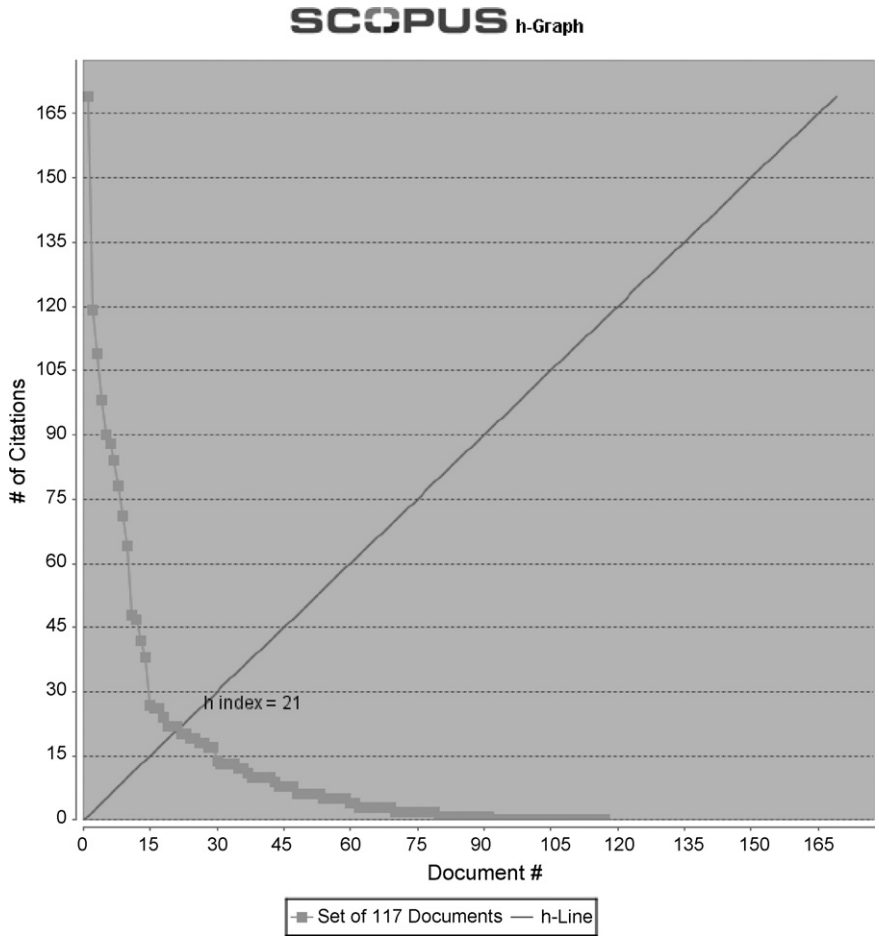

Figure 1 *h*-Graph Brian Berman (created 25 September 2007): 21 out of 117 documents have each been cited at least 21 times.

difference with his 'overall' *h*-index. This example touches on a further limitation of the *h*-index: it will not decrease with time, so therefore it cannot be used to detect declining research output.

Given all this, one could ask the question: ''how reliable is the *h*-index''? It is fair to say that 'the jury is still out', but the emerging evidence suggests that it is reliable.[1] Like any statistic, it has its limitations and there is always the potential for abuse, in line with ''There are lies, damn lies, and then there are statistics''. Having said this, the latter is not due to the statistics themselves, but to the person that applies it.

In the end, judicious use of the *h*-index is likely to come from combining it with other metrics, such as for instance the average impact factor of all journals in which an author has published.

Despite some limitations, the *h*-index is a new and useful way of assessing the scientific impact of individual scientists as well as research teams. My gut feeling is that is here to stay.

Reference

1. Bohrmann L, Daniel HD. Does the h-index for ranking of scientists really work? *Scientometrics* 2005;**65**:391—2.

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