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Editorial

The positive and negative impacts, and dangers of the Impact Factor

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The journal impact factor (IF) is widely used but surrounded by considerable controversy. It is important to restrict it to only its appropriate use. The IF can reasonably be useful for evaluating a journal, but even then can be influenced by many factors such as the number of review papers, letters or other types of material published, variations between disciplines, and various biases. The extent to which the IF is appropriate for the evaluation of the quality of an individual, department or institution however, is undoubtedly highly debatable.

Introduction

"Publish or perish" is a well-worn phrase in research in dentistry as in other life sciences, and is fully discussed elsewhere (http://www.harzing.com/pop.htm). The growing importance of research publications is the source of intense and increasing debate, and is strongly influencing the lives of academics in most fields. There is a tremendous drive to assess quality, and this is easiest to attempt to achieve when there is some tangible product such as a research or scientific paper. However, the importance of papers (or journals), and the real impact of these on users and the specialty in the long term is extremely difficult, if not impossible, to judge. One attempt to evaluate the impact of a journal is by use of the Impact Factor (IF), developed in USA by Eugene Garfield of the Institute for Scientific Information (the ISI) (Garfield 1972, 1986,http://www.isinet.com/essays/journalcitationreports/7.html/).

The IF has become widely used and, although there may be some advantages in its use, there has equally been concern already expressed about the use of IF in dentistry (Scully & Lodge 2005). There is a huge debate elsewhere, much of which is summarized below.

Definitions

The idea underlying the IF is *citations* - the papers and book chapters listed in the references at the end of a scientific paper, and the number of them. The IF is a measure of the frequency with which the "average article" of a journal has been cited in a particular year or period (though clearly, as discussed below, there can be no such thing as an "average article").

The IF is calculated by *dividing the number of current citations to articles published* in a specific journal in the previous two-year period, *by the total number of articles published in the same journal* in the corresponding two-year period defined by the ISI (Table 1).

The IF is published every year so, say in June 2007, the IF for a journal for 2006 would have been calculated from the number of citations in the year 2006 to articles published in the journal in 2004 and 2005, divided by the number of articles published in the journal in 2004 and 2005. The IF is published by a private, profit-oriented commercial US-based organization, Thomson Scientific http://scientific.thomson.com/free/essays/journalcitationreports/impactfactor/ (formerly the ISI; http://www.isinet.com, http://portal.isiknowledge.com/portal.cgi?DestApp=JCR&Func); access to the databank is not free of charge.

When the IF is calculated, *the numerator is the total number of citations to virtually any item in the journal*, and so all types of articles, such as editorials, letters and abstracts from meetings are included as cited items. In contrast, *the denominator is the number of peer-reviewed items only* and includes only normal articles, and reviews – not letters or abstracts.

Uses of impact factor

The IF can be helpful to evaluate a journal's relative "importance", especially when compared to others in the same field. The IF, along with other criteria, are sometimes used to compare, evaluate and rank journals; indicate the largest journals, the "hottest" journals, what publications a journal cites and which publications cite the journal itself.

Publishers often use IF for marketing (many fliers give the journal IF) or in identifying opportunities for new journals or in taking decisions as whether to expand, merge or discontinue existing journals.

Authors sometimes use the IF to decide where to publish and to discover other journals in their specialty.

Other uses (and misuses) of the IF are discussed below.

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Table 1. Calculation of journal impact factor

A	*B*	*C*	*B/C*
Total citations in 2006	Citations in 2006 to articles published in 2004-05	Number of articles published in 2004-05	The 2006 IF

Care in the use of impact factors

Several points which should be considered in relation to IF and their use, include the following fundamental problems:

- Only a very small proportion (about 9,000 science and technology titles) of the world total of over 100,000 English -language journals - and chiefly those from the USA - are covered by the database. Other languages are ignored.
- Books are never scanned for their bibliographies, or included in any IF calculation.
- IFs are most relevant for fields that have a similar publication pattern to the life sciences, where research publications are almost always journal articles, that cite other journal articles, but they are not relevant for specialties where the most important publications are books citing other books or where the principal scientific output is conference proceedings, technical reports, and patents.
- The scientific field to which the journal belongs influences the IF greatly though, to be fair, ISI recognises this and warns against making comparisons between fields. For example, the highest IF in the ISI subject category "Dentistry" in 2005 was 3.933, whereas the highest IF in "Oncology" was a massive 49.794, but that does not mean that Oncology is so much better or more important than Dentistry. Different disciplines have widely differing citation practices. The absolute value of an IF is therefore meaningless and citing the above examples, a journal with an IF of 3 would not be very impressive in Oncology, while it would be in Dentistry.
- The ISI databases are oriented to life sciences journals; clinical titles for example such as *Dental Update* and *Dental Clinics of North America* do not currently have IFs.
- Scientific journals generally have higher IFs than clinical journals, partly due to the fact that scientific papers tend to cite only scientific and not clinical articles or books, whereas clinical papers tend to cite both scientific and clinical articles and books.
- General journals are at a particular advantage over more specialist journals.
- IFs are biased toward journals that are review journals or mainly publish review articles, since those tend to be cited more frequently - often in authors' introductions (Krauze et al 1971). Amongst the dental journals with the highest IFs (Table 2) are the review journals *Critical Reviews in Oral Biology and Medicine*, and *Periodontology 2000.*
- Multi-author and consortia articles can pose a problem, regarding who - or what - should be cited, and how. For example, the International Human Genome Sequencing Consortium described the sequencing of the human genome in a paper in Nature in 2001 - probably the most important scientific advance ever published, but the IF was low (Editorial 2001).
- Free electronic access, or the inclusion of a journal as part of the membership to a Society and therefore greater availability, tends to raise the IF of a journal. This could apply to *Journal of Dental Research*. Apart from the high quality, the fact that this is taken by most dental researchers, has surely helped it become the most highly cited journal. Accessibility may mean that the source is cited but it does not necessarily follow that the most appropriate or "best" reference has been chosen to be cited.
- It is worth remembering that a paper may be cited as an example of poor research or may be highly cited if it covers a controversial topic e.g. suggesting that HIV is not the cause of AIDS (Moed and Van Leeuwen 1995).
- By merely counting the frequency of citations per article and disregarding the prestige of the citing journals, the impact factor becomes merely a metric of popularity, not of prestige.
- A change in journal title may adversely affect the IF. In the first year after a change, the IF is not available for the new title unless the data for old and new can be unified, and in the second year, the IF is split. The new title may rank lower than expected and the old title may rank higher than expected because only one year of source data are included in the calculation.

Other points which should be considered in relation to IF and their use, include the following problems which can produce bias:

- Fundamental to the IF is the citation of papers, but researchers have estimated that, when scientists write up their work and cite other researcher's papers, only around 20% have read the original article (Simkin and Roychowdhury 2003).
- Citation errors, misprints and inconsistencies can distort the IF; there may be errors in up to one-quarter of references (Seglen 1997).
- If a journal publishes more additional items, they become included in the numerator which thus may well increase the IF. However, an increase in *citable items* can have the opposite effect: the IF can be affected, for example, by a large correspondence section.
- The IF can artificially be enhanced by publishing controversial editorials or papers.
- Self-citation is also able to increase the IF. Some authors cite previous papers in the same journal; some editors may cite editorials and some journals have been known to try to manipulate the IF by re-

questing authors add references to articles published in that journal. There has been a tendency towards self-citation among some US scientists (Moller 1990).

Locating impact factors

A university library or a library of one of the larger institutions can access the IF either on the Internet (http://www.isinet.com/isi or http://wos.mimas.ac.uk), or on CD. Many publishers advertise the IF of their journals on their websites and publicity fliers and in the journals (e.g. http://www.elsevier.com/locate/oraloncology).

Impact factors of dentally-related journals

The IFs for 2005 (the most recent available at time of writing) for the 49 dental journals evaluated by ISI are shown in Table 2. The IFs ranged from 0.522 to 3.933, and 30 had an IF >1. Interestingly, two of the three dental journals with the highest IFs are review journals i.e. they contain no original research, illustrating well that IF is not related to the quality of research.

Advantages of impact factors

The advantages of the IFs are that they are widely (though not freely) available to use and understand, and are at least an objective measure, which has a wider acceptance than any of the alternatives thus far.

ISI's international coverage of journals is fairly wide (but by no means complete; see above).

Wrongful use of impact factors

Some of the criticisms of IFs have been discussed above and are otherwise well-documented (Seglen 1997).

The IF is of particularly questionable value in the evaluation of individual and collective research achievements (Saper 1999, Bloch and Walter 2001; Chew and Relyea-Chew 1988; Garfield 1970; Kaltenborn and Kuhn 2003; Talamanca 2002).

The IF of a journal should not be used as a substitute measure of the citation impact of individual articles in the journal, since most papers published in the journal will be cited many fewer times than the IF might seem to suggest, and some may never be cited. For example, a 2005 editorial in the top journal, *Nature*, (Editorial 2005), stated "For example, we have analysed the citations of individual papers in *Nature* and found that 89% of last year's figure was generated by just 25% of our papers. The most cited *Nature* paper from 2002−03 was the mouse genome, published in December 2002. That paper represents the culmination of a great enterprise, but is inevitably an important point of reference rather than an expression of unusually deep mechanistic insight. So far it has received more than 1,000 citations. Within the measurement year of 2004 alone, it received 522 citations. Our next most cited paper from 2002−03 (concerning the functional organization of the yeast proteome) received 351 citations that year. Only 50 out of the roughly 1,800 citable items published in those two years received more than 100 citations in 2004. The great majority of our papers received fewer than 20 citations." This emphasizes the fact that the journal IF refers to the average number of citations per paper, which is not in a Gaussian distribution.

Citation analysis, in the hands of non-experts, can be an extremely blunt instrument (Adam 2002). There has been a widespread belief that the IF is representative of an individual author (or article) but this is incorrect. Some authors have consequently felt significant pressure to submit papers to a journal with a high IF, whether or not that journal was the most appropriate platform for their work. Many have also believed that the higher the IF of the journal that published their paper, the more their paper would be cited, but this is also a myth (Seglen 1997). The number of citations to papers in a particular journal does not really directly measure the true journal quality, much less the scientific merit of the papers within: it also reflects, at least in part, the intensity of publication or citation in that area, the current popularity of that particular topic, and the availability of particular journals. *Certainly, the actual impact on the community of an article is not necessarily related to the IF.*

Probably the most serious criticism of IFs relates to their erroneous and potentially dangerous use to determine "author impact". In some countries and institutions, academic administrators significantly (and controversially) use IF as a convenient tool in the process of deciding on promotion and tenure, for hiring, or the assessment of research groups and grant proposals for funding and resource allocation i.e. the IFs of journals in which candidates have published are used to help determine the impact or importance of their research. IFs can thus represent an all too convenient shortcut to bypass proper appraisal, and the work involved in obtaining the more meaningful information of citation counts for individual articles and authors. IFs may thus be taken as an indication of a person's scientific worth and, by extension, there is a possibility of IFs being used to compare departments or even institutions. The IF can be used to provide a gross approximation of the prestige of journals in which individuals or groups have published, but this is best done in conjunction with other considerations such as peer review, productivity, and subject specialty citation rates.

It cannot be over- emphasised that the IF was created with the intent of comparing journals, *not* authors or individual articles, groups of workers, departments or instiututions. It is not possible to say, for example, that a person or department whose publications have an average IF below 2 is low-level. Indeed, Garfield himself warns against the "misuse in evaluating individuals" because there is "a wide variation from article to article within a single journal" (Garfield 1998).

New metrics

In view of the limitations of the IF, there have been a number of attempts to develop and introduce new metrics. For example, one alternative to IF is a PageRank algorithm (Bollen et al 2006). Other new metrics include the following:

- *Hirsch's H index or number* of an individual scientist's impact and citation record may be used to describe the impact of individual researchers, rather than journals and aims to provide a robust single-number metric of an academic's impact, combining quality with quantity. If a scientist has published n articles

Table 2. Impact factors for Dentistry, Oral Surgery and Medicine, 2005

Rank	*Abbreviated Journal Title*	*ISSN*	*Impact Factor*
1	CRIT REV ORAL BIOL M	1045-4411	3.933
2	J DENT RES	0022-0345	3.192
3	PERIODONTOL 2000	0906-6713	2.377
4	ORAL ONCOL	1368-8375	2.266
5	J CLIN PERIODONTOL	0303-6979	2.225
6	DENT MATER J	0287-4547	2.219
7	J ADHES DENT	1461-5185	2.216
8	ORAL MICROBIOL IMMUN	0902-0055	2.210
9	DENT MATER	0109-5641	2.056
10	J PERIODONTAL RES	0022-3484	1.947
11	J ENDODONT	0099-2399	1.933
12	J OROFAC PAIN	1064-6655	1.932
13	CLIN ORAL IMPLAN RES	0905-7161	1.897
14	EUR J ORAL SCI	0909-8836	1.784
14	J PERIODONTOL	0022-3492	1.784
16	CARIES RES	0008-6568	1.721
17	OPER DENT	0361-7734	1.679
18	J ORAL PATHOL MED	0904-2512	1.661
19	J DENT	0300-5712	1.636
20	COMMUNITY DENT ORAL	0301-5661	1.631
21	INT ENDOD J	0143-2885	1.606
22	ORAL DIS	1354-523X	1.445
23	INT J ORAL MAX IMPL	0882-2786	1.412
24	INT J PROSTHODONT	0893-2174	1.346
25	ARCH ORAL BIOL	0003-9969	1.288
26	J ORAL MAXIL SURG	0278-2391	1.246
27	ORAL SURG ORAL MED O	1079-2104	1.193
28	AM J DENT	0894-8275	1.186
29	INT J ORAL MAX SURG	0901-5027	1.123
30	J CRANIO MAXILL SURG	1010-5182	1.017
31	INT J PERIODONT REST	0198-7569	0.963
32	J AM DENT ASSOC	0002-8177	0.935
33	AM J ORTHOD DENTOFAC	0889-5406	0.916
34	INT DENT J	0020-6539	0.908
35	J PUBLIC HEALTH DENT	0022-4006	0.854
36	ACTA ODONTOL SCAND	0001-6357	0.783
37	ANGLE ORTHOD	0003-3219	0.778
38	J PROSTHET DENT	0022-3913	0.748
39	AUST DENT J	0045-0421	0.735
40	J ORAL REHABIL	0305-182X	0.717
41	DENT TRAUMATOL*	1600-4469	0.716
42	BRIT DENT J	0007-0610	0.658
43	EUR J ORTHODONT	0141-5387	0.651
44	DENTOMAXILLOFAC RAD	0250-832X	0.640
45	CLEFT PALATE-CRAN J	1055-6656	0.574
46	BRIT J ORAL MAX SURG	0266-4356	0.573
47	SWED DENT J	0347-9994	0.568
48	QUINTESSENCE INT	0033-6572	0.540
49	CRANIO	0886-9634	0.522
41	DENT TRAUMATOL*	1600-4469	0.716
42	BRIT DENT J	0007-0610	0.658
43	EUR J ORTHODONT	0141-5387	0.651
44	DENTOMAXILLOFAC RAD	0250-832X	0.640
45	CLEFT PALATE-CRAN J	1055-6656	0.574
46	BRIT J ORAL MAX SURG	0266-4356	0.573
47	SWED DENT J	0347-9994	0.568
48	QUINTESSENCE INT	0033-6572	0.540
49	CRANIO	0886-9634	0.522

*In 2002, Endod Dent Traumatol became Dent Traumatol

which all have been cited at least n times, then he or she will have a H-index of n. (Hirsch 2005).

- *Egghe's g-index* aims to improve on the h-index by giving more weight to highly-cited articles (Egghe 2006).
- *Contemporary h-index* aims to improve on the h-index by giving more weight to recent articles, thus rewarding academics who maintain a steady level of activity (Sidiropoulos et al 2006).
- *Individual h-index* divides the standard h-index by the average number of authors in the articles that contribute to the h-index, in order to reduce the effects of co-authorship (Pablo et al 2006).
- *Age-weighted citation rate* (AWCR) and AR-index measures the average number of citations to an entire body of work, adjusted for the age of each individual paper (Jin 2007).

Time will tell if these offer significant advantage or will gain greater acceptance than the Impact Factor!

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