Journal of Biomedical Informatics 75 (2017) 107–109

Contents lists available at ScienceDirect

Journal of Biomedical Informatics

journal homepage: www.elsevier.com/locate/yjbin

Commentary

The ranking of scientists based on scientific publications assessment

Enver Zerem*

Department of Medical Sciences, The Academy of Sciences and Arts of Bosnia and Herzegovina, Bistrik 7, 71000 Sarajevo, Bosnia and Herzegovina
Department of Gastroenterology, University Clinical Center Tuzla, Prof. Dr. Ibre Pašića 18, 75000 Tuzla, Bosnia and Herzegovina

ARTICLE INFO

Keywords:
Scientific impact factor
Number of citations
Author contribution in scientific article
Science metrics

ABSTRACT

It is generally accepted that the scientific impact factor (Web of Science) and the total number of citations of the articles published in a journal, are the most relevant parameters of the journal's significance. However, the significance of scientists is much more complicated to establish and the value of their scientific production cannot be directly reflected by the importance of the journals in which their articles are published. Evaluating the significance of scientists' accomplishments involves more complicated metrics than just their publication records. Based on a long term of academic experience, the author proposes objective criteria to estimate the scientific merit of an individual's publication record. This metric can serve as a pragmatic tool and the nidus for discussion within the readership of this journal.

1. Introduction

The publication of scientific research is the cornerstone of knowledge dissemination, as well as an essential criterion for academic and scientific evaluation, recruiting funds and career progression [1,2]. This is especially important in developing countries where a complex interrelation between politics and the academic community prevents implementation of internationally recognized criteria in the process of acquisition of scientific and academic titles [3,4].

In many academic communities worldwide, the use of reliable science metrics in assessment of the quality of individual contributions of scientists is recognized as important [5,6]. As a matter of fact, making these kinds of assessments is a science in itself. Along evaluation of scientific publications, a wide range of other scientific activities also reflect scientific credibility of a scientist such as: number and quality of extramural grants, leadership in national or international academic societies, service on editorial boards of respected journals, service on government sponsored national peer review committees, the number of PhD students delivered, the amount of coverage of one's scientific output in the lay press, etc. Although, above mentioned activities are important and give certain significance to the scientific credibility of a scientist, the relevant science metrics systems only cover publications, and omit other criteria of scientific relevance, which are typically used in judging promotions and tenure of scientists. The reason for this is the fact that these activities, regardless of their importance, are very heterogeneous since each of them has specific characteristics and requires different parameters for evaluation. Hence, for these parameters of scientific relevance there are no universal evaluation criteria and their value is mainly assessed individually depending on the purpose of the assessment.

Amongst many science metrics [4–12] the most widespread approach includes the use of the so-called H-index, the impact factor (IF) (Web of Science-WoS), along with the overall number of citations [5,9]. Some authors introduce a new index for evaluation and comparison of the publication records of scientists named the PageRank-index which uses a version of PageRank algorithm and the citation networks of papers in its computation. Using combination of the H-index and the PageRank algorithm it is possible to do away with some of the individual limitations of these two indices [11,12]. Nonetheless, the scientific metrics mentioned above asses the value of scientific production based on the number of citations of an article, not reflecting the full value of the scientific production of a scientist, particularly the author contribution.

In this paper I am proposing the criteria which can objectively estimate the scientific effect and offer fair comparison of scientists and institutions. Similar to the other science metrics systems these criteria only cover publications and are focused on the assessment of quality of the scientific articles.

2. Calculation of authors and citations scores

It is generally accepted that the IF (WoS) and the total number of citations of articles published in the journal, are the most relevant parameters of the journal's significance. The scientific significance of a scientist is much more complicated to evaluate and the value of their scientific production cannot be directly reflected by the importance of

* Address: Department of Gastroenterology, UKC Tuzla, Prof. Dr. Ibre Pašića 18, 75000 Tuzla, Bosnia and Herzegovina.
E-mail address: zerem@live.com.

http://dx.doi.org/10.1016/j.jbi.2017.10.007
Received 1 July 2017; Received in revised form 9 October 2017; Accepted 10 October 2017
Available online 12 October 2017
1532-0464/

the journals in which their articles are published, since the IF of the journal is defined as the average value, calculated on the basis of the number of citations of all the articles published in that journal, and does not necessarily represent the value of each individual article. Also, the number of citations of a particular article, as the relevant measure of the value of that article, has its limitations since it requires excessive time lag and gives advantage to older articles of similar quality. Furthermore, the contribution of all the authors in a scientific article is usually not the same.

As a director for scientific research in the institution where I work, every year I am involved in setting the ranking criteria for evaluation of the scientific contribution of our institution's employees. Based on the long term experience, in this article I am proposing the criteria which can objectively estimate the scientific effect of scientists and institutions.

The scientific contribution of the scientist is evaluated on the basis of the scientific values of the journals in which their articles are published and the authors' specific contribution in these articles.

The value of an article is obtained as the sum of the journal's IF (in the article publication year) multiplied by 10, and the total number of citations during that year, divided by 1000. The reason for such calculation is that the journal's IF is the most commonly used and relevant measure of its quality, and yet, the journals which publish bigger volume of articles over the year have a harder task of getting enough citations in order to have the same IF compared to the journals with smaller article volume. Also, it is the total number of citations, and not only those referring to the articles published in the previous two years (included in calculation of IF) - that give contribution to the relevance of the journal (Fig.1, Panel A).

Calculation example:

The journal has IF 1 and has received altogether 1000 citations throughout the year for all articles published at any time in this journal. The points are calculated according to the formula: $1 \times 10 + 1000/1000 + 1 = 12$ points. Adding one point at the end of the calculation prevents the situations whereby fewer points could be obtained for an article published in a journal with an IF (WoS), than in a journal without an IF. The article published in a journal without an IF (not included in WoS) simply gets 1 point.

Author contribution score (ACoS) in an article is calculated so that the first author gets the total number of points, the corresponding author (if not the first author) gets half of the total number of points, and the remaining authors share the other half of the total number of points equally. If the first author is also the corresponding author, the other authors share the total number of points equally, calculated as explained (Fig.1, Panel B).

Calculation example:

Points, in an article which received 12 points, and has four authors, are divided as follows: the first author gets 12 points, the corresponding author (if not the first author) gets 6 points, and the other 2 authors get 3 points each. If the first author is also the corresponding author, the three remaining authors get 4 points each. This method of point division may help prevent the common problem of having a large number of co-authors in an article, since it would automatically decrease the number of points given to co-authors.

Author Score (AS) is calculated as the sum of ACoS for all articles published by the author.

Citation contribution score (CCS) for particular article is calculated so that the first author gets the total number of points (the same as total number of citations which the article got), the corresponding author (if not the first author) gets half of the total number of points, and the remaining authors share the other half of the total number of points equally. If the first author is also the corresponding author, the other authors share the total number of points (citations) equally (Fig.1, Panel B).

Calculation example:

In an article which received 60 citations, and has four authors, points are divided as follows: the first author gets 60 points, the corresponding author (if not the first author) gets 30 points, and the other 2 authors get 15 points each. If the first author is also the corresponding author, the three remaining authors get 20 points each.

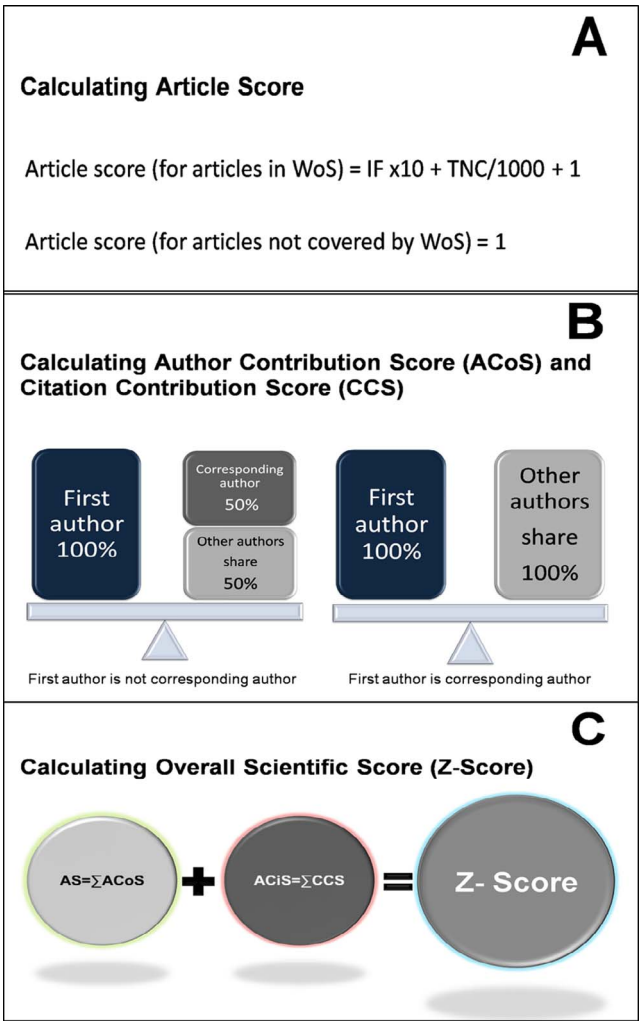

Fig. 1. Calculation of author and citation scores; Panel A - Calculating Article Score; Panel B - Calculating Author Contribution Score (ACoS) and Citation Contribution Score (CCS); Panel C - Calculating Overall Scientific Score of an Author (Z-Score). *TNC- total number of citations of journal in which the article is published; WoS-Web of Science; AS - Author Score; ACiS - Author Citation Score.

Author Citation Score (ACiS) is calculated as the sum of all CCS of all articles by that author. Using this method it is also possible to calculate H-index with suggested modifications.

According to these criteria the overall scientific score of an author, named as Zerem-score (Z-score) is calculated as the sum of AS and ACiS (Fig.1, Panel C). Also, the overall scientific score of an institution is calculated as the sum of the total points (Z-scores) of all the scientists at that institution.

3. Discussion

In recent years, even decades, academic advancement and access to scientific research grants have been greatly conditioned by the scientific production of scientists as well as scientific institutions. This has led to a dramatic increase of interest in the evaluation and ranking of the scientific production. Almost all relevant science metrics indexes which evaluate the achievement of scientists are focused on the number of citations of their articles [1,2,6,9,11,12]. The best-known science metrics system which assesses the individual scientific contribution of

scientists is the so-called H-index which is calculated as the lowest ranked article which number of citations matches its ranking number [9].

The H-index is a well-conceived evaluation measure of one's scientific contribution, impacting significantly on the scientific profile score. However, in my opinion, H-index has considerable shortcomings that need to be addressed:

1. The system is based solely on the evaluation of the number of individual article citations. However, it obviously favors older articles (available for quotation for a longer time), and negatively impacts on assessment of scientific production of perspective scientists, affecting their academic advancement, and their access to scientific research grants. Therefore, I consider that the system of scientific production evaluation needs to take into account the importance of evaluation of more recent articles, which, due to the lesser time availability to the scientific community, have not reached the number of citations reflecting their realistic scientific value. Calculating article score according to the suggestion given in the previous section would greatly remedy this discrepancy (Fig. 1, Panel A).
2. H-index does not take into account the individual contribution of each author in an evaluated article [9], and does not tackle the ever-present problem of expanding author lists with authors whose contribution may be minute or none (according to H-index all authors of an article are treated as equal) (Fig. 1, Panel B).
3. Particular drawback of this system can be noticed in publications which give guidelines in diagnostic and treatment of certain diseases, and are recommended on behalf of some professional or scientific associations. These articles generally have a multitude of authors (over 50 or even 100), where in fact the article is usually written by a small number of authors and everyone else gets the authorship only because they may have given a comment on the paper or just because they are members of the association. A similar situation is observed with articles published after multicentric clinical trials conducted by some scientific and professional associations or pharmaceutical companies, whereby authorship is mainly obtained solely on the basis of transferring the research data to the corresponding article author. In this way, theoretically speaking, a "scientist" may have H-index score over 20 without having actually written a single significant article.
4. In some scientific fields like physics and computer science, in some journals, author order may be random or alphabetical and not ranked by importance. Since contribution of authors in an article is not equal, listing authors in an alphabetical or random order is not adequate since all authors of an article are treated as equal, not taking into account the individual contribution of each author in an evaluated article.

The criteria, which are suggested in this article, recognize the first and corresponding authors as factors whose contribution to the scientific article is unquestionable and encourage participation of other authors of the article in preventing false authors from being added to the author list, since their own contribution would otherwise be diminished. Therefore, the proposed criteria significantly objectify evaluation of the scientific contribution and facilitation of the ranking of the scientists and could be practically applied as a relevant measure in ranking of scientists for purposes of academic advancement and application for scientific grants. Also, it needs to be emphasized that these criteria (which besides citations, takes into consideration other aspects of an article) is not opposing the existing science metric systems, but offers solution in order to supplement them.

There are several limitations and open questions regarding these criteria. Firstly, are the factor 10 by which the IF is multiplied, and denominator 1000 by which the total number of citations is divided (chosen subjectively, but on the basis of long term experience of its application) - applicable in all systems of evaluation? Secondly, should this calculation be applied in the same way with all types of articles or should an additional corrective factor be introduced, with certain types of articles (i.e. Case report and Letter to Editor). Thirdly, should all articles which are not indexed in WoS and have no IF, be given 1 point or should they be categorized in several groups depending on whether they are indexed in one or more other scientific bases (e.g. Medline, EMBASE, Scopus)? All those questions could be addressed through discussion and consensus between the experts.

However, this criteria is sustainable even without those corrections since, despite certain limitations, it does not discriminate between scientists (regardless of how we quantify certain aspects of scientific articles), and yet removes major discrepancies in evaluating scientific production of scientists as we know it. It is true that the individual components of the criteria may be subject to improvement (i.e. quantification and evaluation of IF and number of citations), however, this concept may be considered as a good basis for further discussion on this important subject.

Acknowledgement

I would like to express my sincere gratitude to my associate Ms Alma Ažderović for creative assistance in writing the article.

References

[1] A. Abbott, D. Cyranoski, N. Jones, B. Maher, Q. Schiermeier, R. Van Noorden, Metrics: do metrics matter? Nature 465 (7300) (2010) 860–862, http://dx.doi.org/10.1038/465860a.
[2] G. Lippi, C. Mattiuzzi, Scientist impact factor (SIF): a new metric for improving scientists' evaluation? Ann Transl Med 5 (15) (2017) 303, http://dx.doi.org/10.21037/atm.2017.06.24.
[3] E. Zerem, Right criteria for academia in Bosnia and Herzegovina, Lancet 382 (2013) 128, http://dx.doi.org/10.1016/S0140-6736(13)61565-2.
[4] E. Zerem, Academic community in a developing country: Bosnian realities, Med Glas (Zenica) 11 (2) (2014) 248–251.
[5] R. Van Noorden, Metrics: a profusion of measures, Nature 465 (7300) (2010) 864–866, http://dx.doi.org/10.1038/465864a.
[6] T. Thwaites, Research metrics: calling science to account, Nature 511 (7510) (2014) S57–S60, http://dx.doi.org/10.1038/511S57a.
[7] E. Garfeld, Citation indexes to science: a new dimension in documentation through association of ideas, Science 122 (1955) 108–111.
[8] H.I. Stonehill, Science Citation Index: information retrieval by propinquity, Hem Ind 10 (1965) 416–417.
[9] J.E. Hirsch, An index to quantify an individual's scientific research output, Proc Natl Acad Sci USA 102 (2005) 16569–16572, http://dx.doi.org/10.1073/pnas.0507655102.
[10] C.R. Sugimoto, V. Larivière, Altmetrics: broadening impact or amplifying voices? ACS Cent Sci 3 (7) (2017) 674–676, http://dx.doi.org/10.1021/acscentsci.7b00249.
[11] U. Senanayake, M. Piraveenan, A. Zomaya, The Pagerank-index: going beyond citation counts in quantifying scientific impact of researchers, PLoS One 10 (8) (2015) e0134794, http://dx.doi.org/10.1371/journal.pone.0134794 (eCollection 2015).
[12] C. Gao, Z. Wang, X. Li, Z. Zhang, W. Zeng, PR-index: using the h-index and PageRank for determining true impact, PLoS One 11 (9) (2016) e0161755, http://dx.doi.org/10.1371/journal.pone.0161755 (eCollection 2016).