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The H-Index, A Bibliometric Indicator With Several Limitations: Critical Reflections

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ABSTRACT

The h-index, proposed by Hirsch in 2005, is a useful bibliometric indicator for characterizing a researcher's scientific output. Since its introduction, although its widespread adoption has been rapid, thanks in part to its relatively simple calculation, several authoritative scholars have highlighted the numerous limitations of this widespread and renowned index, which measures a researcher's scientific impact by taking into account the number of publications and the number of citations those publications have received from other researchers. Therefore, in addition to taking productivity into account, the indicator also takes into account the researcher's impact within the scientific community. Based on our study, we believe there are several limitations that could seriously compromise the usefulness of this well-known bibliometric indicator. The h-index is important, yes, but not exhaustive, and in the absence of other indicators, it could prove both mathematically precise and misleading.

Keywords: h-index, Hirsch, bibliometric indicator, references, citations.

INTRODUCTION

The origin of the h-index. Hirsch, in 2005, published an article in which he stated: “I propose the index *h* , defined as the number of papers with a citation number ≥h, as a useful index to characterize the scientific output of a researcher” [1]. His proposal is innovative because, according to Hirsch, the evaluation of an author's research is essentially based on 4 numerical criteria: the first two consider the total number of publications and the total number of citations [1]. These numerical criteria, however, have clear limitations: the first measures productivity but not impact, while the second measures impact but is « hard to find and may be inflated by a small number of “big hits” » [1]. The h-index was created to overcome these limitations, by relating quantity and impact and considering both the number of publications and the citations received. The indicator thus provides an overall evaluation of the researcher. It is clear that, in some particular cases, the bibliometric indicator is not useful: “For the few scientists who earn a Nobel prize, the impact and relevance of their research is unquestionable. Among the rest of us, how does one quantify the cumulative impact and relevance of an individual's scientific

research output?" [1]. According to what Hirsch himself states, the impact and relevance of Nobel Prize winners are indisputable, regardless of their h-index, while for all the others a quantification proves useful. Although the h-index is useful, several authoritative scholars have subsequently highlighted its numerous limitations, and it is precisely on these limitations that we believe it is necessary to reflect critically.

METHODS

The usefulness of the h-index has already been highlighted by Hirsch in 2005 [1] and the advantages of its use are well known. Its limits are also beginning to be known. To further investigate and understand the limits of the h-index, we conducted a bibliographical research using the electronic biomedical database PubMed/MEDLINE, the Google Scholar search engine and the Google search engine. In selecting the articles, we constantly considered the authoritativeness of the authors and their respective affiliations.

RESULTS

The results of our bibliographic research will be reported below, that is, some carefully selected authoritative articles will be reported. The articles mentioned clearly highlight some of the limitations of the h-index. Furthermore, to facilitate transparency, we faithfully report, in quotation marks, some short and significant passages taken from the articles of the authoritative authors. The title of an article by Gupta is unequivocal: "h index and its limitations" [2]. To deepen our critical reflections, we believe it is important to underline the following passage from an authoritative article by Mondal *et al.:* "The h-index can be manipulated by self-citing excessively to increase the number of citations. The h-index does not take into account other important factors, such as the quality of publications, the impact of a researcher's work beyond citations, or their contributions to teaching and service" [3]. After the passage just quoted, we think it is useful to organically quote the title of an authoritative article by Koltun and Hafner: "The h-index is no longer an effective correlate of scientific reputation" [4]. In an authoritative article by Ding, Liu and Kandonga reads: "Analysing the principles of the h-index, g-index, AR-index, p-index, integrated impact indicator (I3), and academic trace, this paper explores their limitations in measuring the research performance of authors from the perspectives of consistency, the degree of discrimination, and the statistical relationship between the values of indicators and the number of publications and citations. There are some interesting findings. These six indicators are highly consistent, and they are all more susceptible to the number of publications than to the frequency of citations" [5], in short, the indicators reward quantity more than quality and impact. In an authoritative article by Costas and Bordons we read: "Since the h-index is easy to obtain, we run the risk of indiscriminate use, such as relying only on it for the assessment of scientists. Research performance is a complex multifaceted endeavor that cannot be adequately assessed by means of a single indicator (Martin, 1996)"[6]. In an authoritative article by Martin , a contradiction is highlighted: "Yet although most of those who now use science indicators would agree that a combination of indicators is desirable, analysis of a sample of Scientometrics articles suggests that in practice many continue to use just one or two indicators" [7]. In an authoritative article by Glänzel it is highlighted that the h-index allows scientists to rest on their laurels: "The index allows scientists to rest on their laurels ('your papers do the job for you') since the number of citation received might increase even if no new papers are published" [8]. In an authoritative article by De Cassai *et al.* a clear and unequivocal message is sent: "The key message of this editorial is that the most important element of a researcher is his/her ideas and the potential

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impact of those ideas on the community. A valid idea should be supported by the researcher's institution, the academic world, and their colleagues, irrespective of their H-indexes" [9]. Finally, we cite a passage from a recent and authoritative article by Goyanes *et al.* : "The findings reveal that women are significantly underrepresented among highly cited scholars globally (0.255 women per man) and receive fewer citations and have lower h-indexes than men in most regions and disciplines. However, after controlling for productivity and career length, female scholars are cited more than men in the pooled sample, Asia, Europe, and in two fields (natural sciences and exact sciences/physics). Despite this, women's h-index remains significantly lower than men's in all regions except Africa and South America, and in all fields except social sciences. This study highlights the persistence of gender inequalities in academic representation and long-term impact, as measured by the h-index. The results suggest that while citation rates for female researchers can match or exceed those of male scholars when productivity is controlled for, structural barriers continue to limit women's long-term recognition in academia" [10].

DISCUSSION

Our study is not based on statistical and mathematical analyses, but on the reading and rereading of authoritative scientific articles that have highlighted the limits of the h-index. We intend to reflect on these limits. To proceed rigorously in the reflection and discussion, we believe it is appropriate to comment and clearly underline some passages of the authoritative articles that we have cited and that clearly highlight some limits of the h-index. The indicator is not "infallible". Although the usefulness of the h-index is known and evident, we believe that this usefulness should be reconsidered on the basis of other indicators and other aspects analysed by some authoritative scholars. We also ask ourselves whether the h-index, in the absence of other indicators, could be arithmetically precise and simultaneously misleading since, for example, "the h-index does not take into account other important factors, such as the quality of publications, the impact of a researcher's work beyond citations, or their contributions to teaching and service" [3]. Therefore, given that the h-index does not take into account some important factors, we ask ourselves whether its importance is less than that which is frequently attributed to it. This is just one question, one among many, which allows us to reflect and allows us to hypothesize that it is very reductive to condense the scientific profile of a researcher or a professional into a number, in fact: "Since the h-index is easy to obtain, we run the risk of indiscriminate use, such as relying only on it for the assessment of scientists. Research performance is a complex multifaceted endeavour that cannot be assessed adequately by means of a single indicator (Martin, 1996)" [6]. Let us also reflect on what is stated in an authoritative article: "We find that the correlation of the h-index with awards that indicate recognition by the scientific community has substantially declined" [4]. The title of the authoritative article just cited is very clear: "The h-index is no longer an effective correlate of scientific reputation" [4]. The passage just cited needs no comment. Another very serious aspect that should be taken into consideration is the sensitivity of the different indicators. In fact, an authoritative article reports the following: "These six indicators are highly consistent, and they are all more susceptible to the number of publications than to the frequency of citations" [5] **.** In essence, the six indicators in question are more sensitive to productivity than to impact. Another aspect that we would like to underline is the possibility that citations may increase even if no new articles are published: "The index allows scientists to rest on their laurels ('your papers do the job for you') since the number of citations received might increase even if no new papers are published" [8]. On the basis of what has been cited, we believe that the h-index

should be taken into consideration, because it is a useful indicator, but at the same time we believe that it is important to take into account the researcher's ideas. An authoritative article states: “The key message of this editorial is that the most important element of a researcher is his/her ideas and the potential impact of those ideas on the community. A valid idea should be supported by the researcher's institution, the academic world, and their colleagues, irrespective of their H-indexes” [9]. A final reflection should be made on the possible inequality between women and men in academic recognition: “The results suggest that while citation rates for female researchers can match or exceed those of male scholars when productivity is controlled for, structural barriers continue to limit women's long-term recognition in academia” [10]. Based on what has been exposed, based on the authoritative passages cited rigorously in quotation marks for transparency's sake, based on the limits of the h-index that have been highlighted by the high-level scholars that we have mentioned and appreciated, we believe that it is necessary to re-examine several issues in order to better evaluate the overall value of a researcher and a professional.

CONCLUSIONS

The h-index is a very useful bibliometric indicator, but it has several limitations. Therefore, we believe it should not be underestimated, but neither should it be overestimated, because in some cases it could even be misleading.

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