Impact of $h$-index on author’s rankings: an improvement to the $h$-index for lower-ranked authors

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Abstract
In academia, the research performance of a faculty is evaluated based on the number of publications, the number of citations, and the impact of publication where one publishes. Most of the time $h$-index is widely used during the hiring process or the faculty performance evaluation. However, there is a significant impact of varying $h$-index among different databases on the author’s research evaluation. Here we analyze the publication records of 385 authors from Monash University (Australia) to investigate (i) the impact of different databases like Scopus and Web of Science on the ranking of authors within a discipline, and (ii) to complement the $h$-index, named $h_c$, by adding the weight of the highest cited paper to the $h$-index of the authors. The results show the positive impact of $h_c$ on the lower-ranked authors ($h \leq 10$) in every discipline.

Keywords $h$-Index · $g$-Index · $h_c$-Index · Authors ranking

Introduction
Scientific evaluation is best carried out with the number of publications, the number of citations, and contribution of an author to scientific knowledge and society (Martin, 1996; Garfield, 2006). However, citation analysis plays a crucial role while evaluating the research performance of an individual in the academic community, that is why it acts as a key tool in scientometrics (Cronin et al., 1997; Bornmann & Daniel, 2005; Molinari & Molinari, 2008; Bornmann, 2017). Along with the citations, the number of publications and $h$-index also have a strong validation in research evaluation (Hirsch, 2005). Popularity and the interest gained by the $h$-index is due to its simple calculation among the scientific community (Ball, 2005; Duné, 2005; Glänzel, 2006). Instead of presenting individual...
values like the number of publications, and the number of citations, etc. which are giving a single dimension of the author’s performance, $h$-index introduced multidimensional presentation (quantity and impact) and that is too with a single integer number (Maabreh & Alsmadi, 2012). Hence, it is considered as a balanced way to combine and evaluate the broad scientific impact of an author (Braun et al., 2005). Gracza et al. have suggested $h$-index of an author as equivalent to the impact factor of a journal (Gracza & Somoskővi, 2007). Braun et al. have identified $h$-index as a measure of journal credibility and assessments as well (Braun et al., 2006). Due to its popularity, different indexing databases like Scopus, WoS, etc. provide the calculated $h$-index of an author on their website (Egghe, 2008; Abramo et al., 2010). Thus, to perform the fair evaluation of an individual within a university/institution, funding bodies, scientific society, etc., it is the essential requirement that the considered scientometric parameters should be field, discipline, and time normalized (Waltman, 2016).

**Difference between Scopus and Web of Science**

With the rapid increase in the number of scholarly databases or libraries like Google Scholar, Scopus, WoS, Dimension, PubMed, etc., the choice of database consideration has become tedious due to the choice of considered journals (Bakkalbasi et al., 2006; Falagas et al., 2008; Meho & Yang, 2007; Mongeon & Paul-Hus, 2016; Martín-Martín et al., 2018). Among all, WoS and Scopus are well known and most commonly used indexing databases. Both offers advancement of knowledge, great impact and influence as a citation enhanced databases (Zhu & Liu, 2020). WoS core collection includes Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI), Arts and Humanities Citation Index (AHCI), Emerging Sources Citation Index (ESCI), Book Citation Index (BKCI) and Conference Proceedings Citation Index (CPCI). With unrivaled breadth in the research literature, WoS was considered as a gold standard until 2004, when Scopus was announced (Pérez-Gutiérrez & Cobo-Corrales, 2022). Since then, Scopus has emerged as a close competitor of WoS with biggest and wide range of citation and bibliographic records (Adriaanse & Rensleigh, 2013). Multidisciplinary nature and empirical characteristics of indexing databases like Scopus and WoS have provided an opportunity to the authors to conduct studies with different perspectives and with their crucial relevance (Aghaei Chadegani et al., 2013).

**Defects and improvement of $h$-index**

Usefulness of indexing databases may be carefully considered for valid assessments of $h$-index with their coverage, consistency of data, saving options, data fields, browsing options, searching options, analytical tools, exporting options and accuracy of data (Neuhäus & Daniel, 2008). As proposed by Hirsch (2005), “A scientist has index $h$ if $h$ of his/her $N_p$ papers have at least $h$ citations each and the other $(N_p - h)$ papers have $\leq h$ citations each.” In bibliometrics, $h$-index is considered as one of the important, robust, primitive, quantified, and a single measure used to evaluate the individual’s work quality, impact, influence, and importance (Bar-Ilan et al., 2007; Bar-Ilan, 2008).

Over time, researchers have shown the use and importance of the $h$-index while calculating the ranking of authors, universities, the impact of a journal, etc. (Bornmann & Daniel, 2009; Torres-Salinas et al., 2009; Vieira & Gomes, 2009). Dunaïski et al. have evaluated the bias and performance of the authors over a range of citations; however, no significant differences
between the globalized and averaged variants based on citations were found (Dunaiski et al., 2019). Different approaches have been used in literature to analyze the author’s ranking. Authors have also shown the use of the PageRank algorithm on the author co-citations network to get the respective ranking (Ding et al., 2009; Nykl et al., 2015; Dunaiski et al., 2016, 2018). Usman et al. have shown in their research the analysis of various assessment parameters like \( h \)-index, citations, publications, authors per paper, \( g \)-index, \( hg \)-index (Alonso et al., 2010), \( R \)-index (Jin et al., 2007), \( e \)-index (Zhang, 2009a), \( h’ \)- (Zhang, 2013), \( w \)-index (Zhang, 2009b) etc. to evaluate the authors ranking (Usman et al., 2020).

Over the numerous advantages, it has some drawbacks too as mentioned by Hirsch in his core publication (Hirsch, 2005; Costas & Bordons, 2007). The most discussed disadvantage is not to incorporate the impact of highly cited paper which means it under-estimates the academic performance of the scientists. To overcome this limitation, many new indices were proposed in this line and one such index is \( g \)-index (Egghe, 2006b; Batista et al., 2006; Costas & Bordons, 2007, 2008; Vinkler, 2007; Bornmann et al., 2008; Schreiber, 2008a). The limitations of not considering highly cited papers, have encouraged Leo Egghe to propose \( g \)-index in 2006 as follows: “A set of papers has a \( g \)-index \( g \) if \( g \) is the highest rank such that the top \( g \) papers have, together, at least \( g^2 \) citations. This also means that the top \( g + 1 \) papers have less than \((g + 1)^2 \) papers” (Egghe, 2006a). In comparison, the \( g \)-index shows improvement to \( h \)-index by giving more credit to highly cited papers and more discriminatory power to represent the scientific impact of author (Schreiber, 2008b; Tol, 2008). Further, Leo Egghe introduced the concept of adding fictitious articles with 0 citations to overcome the limitations and complete the calculation of \( g \)-index (Egghe, 2006b). The \( g \)-index takes care of highly cited papers; however, it reduces the impact of the highest cited paper significantly (Ding et al., 2020).

The present study resolves this problem by introducing a complementary index, named \( h \_c \), that is complimenting \( h \)-index by including the weight of the highest cited paper while keeping the most important advantage of the \( h \)-index (a single-number to measure the academic performance).

**Research objectives**

This study aims to investigate the following questions:

1. Impact of \( h \)-index on author’s rankings based on different databases like Scopus and WoS.
2. Improving \( h \)-index by considering the weight of the highest cited paper that in turn improves the performance of the lower-ranked authors.

The study is organized as follows: Sect. 2 is on methodology and data description. Results are explained in Sect. 3. Finally, conclusion is presented in Sect. 4.
Methodology

Definition of $h_c$ index

Here, we proposed a complementary analysis to the existing $h$-index, named $h_c$ (see Algorithm 1). We computed the impact of the most cited paper and add it to the $h$-index of an author. Equation 1 is used to get the impact of the highest cited paper as

$$h^k < H_{cite},$$  \hspace{1cm} (1)

where $h \geq 0$ is the $h$-index. $H_{cite} \geq 0$ is the citation count of an author’s highest cited paper, $k$ is the weight of the highest cited paper and $k \leq h$. Now $h_c$ is computed as

$$h_c = h + k.$$  \hspace{1cm} (2)

$h_c \geq h$ is the compliment of $h$.

**Algorithm 1: Calculation of $h_c$**

```plaintext
set k=0, i=0
while k \leq h do
    if $h^k < H_{cite}$ then
        i = k
        k = k + 1
    end
    else
        break
    end
end
$h_c = h + i$
```

Examples

**Example I:** Let’s say an author is having $n$ publications with $h = 0$ and $H_{cite} = 0$. In this case, none of the paper got citations, hence $h = 0$. Using 1 and 2, the value of $h_c$ will be 0.

**Example II:** Let’s say an author is having $n$ publications with $h = 1$ and $H_{cite} = 1$. In this case, atleast one paper got cited once. Using 1 and 2, the value of $h_c$ will be 1.

**Example III:** Let’s say an author is having $n$ publications with $h = 1$ and $H_{cite} = 2$. In this case, only paper got 2 citations. Using 1 and 2, the value of $h_c$ will be 2.

**Example IV:** Let’s say an author is having $n$ publications with $h = 2$ and $H_{cite} = 2$. In this case, two or more papers got cited twice each and highest citation is 2. Using 1 and 2, the value of $h_c$ will be 3.

**Example V:** Let’s say an author is having $n$ publications with $h = 1$ and $H_{cite} = 3$. In this case, one paper got cited with 3 citations. Using 1 and 2, the value of $h_c$ will be 2.

Table 1 explains the above-mentioned examples representing different scenarios of the research productivity.
Data extraction and filtration

In order to study the ranking of authors based on the $h$-index, we have extracted author’s number of publications and citations from Scopus and WoS. The choice of the databases is arbitrary and is on the availability of the data. The criteria for author’s selection is based on the availability of author’s Researcher ID, Author ID or ORCID ID. Hence, we used author’s information provided by Monash University, a public research university in Australia https://research.monash.edu/en/persons/. The university provided the profiles of 6316 persons associated at different designations and in different disciplines. There are three associated benefits with this dataset:

- First, all the profiles are sorted on the basis of the last name of persons.
- Second, authors ORCID, Researcher, and Scopus IDs are mentioned.
- Third, a search tab is given on the website to filter the profiles with at least 5 years or 10 years work with the university.

Further, we searched manually for those author’s profiles that have all of three IDs: ORCID ID, Researcher ID, and Author ID [see flowchart in Fig. 1 (left panel)]. After filtration, a sample of 385 persons from various disciplines is finalized and used to analyze the identified research questions.

Further, we extracted the following information from both Scopus and WoS using respective API’s [see Fig. 1 (right panel)]:

- Author name, affiliation, $h$-index,
- Detailed records of the number of publications and citations received on those publications for all 385 authors,
- DOI of all publications.

The data downloaded from both Scopus and WoS is filtered based on the DOI number of the publication. 92.2% of Scopus and 82.9% of WoS data qualified the selection criteria. Further for the analysis, the data is filtered based on the common publications [both in Scopus (80.4%) and WoS (92.8%)] and unique publications [either Scopus (19.6%) or WoS (7.2%)] across both indexing databases (see Fig. 1 (right panel)).

We have categorized 385 records into five disciplines: Biochemistry and Molecular Biology, Engineering, Health and Medical Sciences, Natural Sciences, and Social Sciences. In broader sense, Biochemistry and Molecular Biology includes microbiology, blood diseases, molecular sciences, etc. Engineering includes civil, computer, electrical,
mechanical, etc. *Health and Medical Sciences* includes epidemiology, medicine, physiology, etc. *Natural Sciences* includes physics, chemistry, mathematics, etc. *Social Sciences* includes sociology, economics, psychology, etc.

**Discipline-wise data distribution**

Figure 2a shows the proportion of number of common and unique publications in Scopus and WoS. *Biochemistry and Molecular Biology* and *Natural Sciences* contains more than...
80% of common publications whereas Engineering, Health and Medical Sciences, and Social Sciences contains more than 70% of common publications. Similarly, Engineering and Social Sciences contains more than 20% of the unique Scopus publications, whereas WoS contains less than 10% of unique publications. On average, the number of common publications is 76%, unique-Scopus is 19%, and unique-WoS is 5%. Hence, the number of unique-Scopus publications is higher in five disciplines as compared to unique-WoS (Falahas et al., 2008; Mongeon & Paul-Hus, 2016).

Figure 2b shows the proportion of publications that received citations from both Scopus and WoS. In Natural Sciences both Scopus and WoS contains more than 90% of publications that received citations. However, in Biochemistry and Molecular Biology Scopus contains more than 90% publications. In Scopus, Engineering, Health and Medical Sciences, and Social Sciences contains more documents that received citations as compared to WoS. An index is being calculated on the number of publications and citations received on those publications. The variation in the number of publications in any database like Scopus, WoS, Google Scholar, MAG, PubMed, etc. affects the index computed on those publications (Meho & Yang, 2007; Martín-Martín et al., 2018). We will see this variation further in the study. For the detail count of the number of authors, publications, unique publications, the number of publications that received citations, total citations, and common publications for both Scopus and WoS for five disciplines see Table 2.

Results

Author’s ranking in Scopus and WoS based on $h, h_c$, and $g$-indices

Figure 3 shows the ranking of authors for five disciplines in terms of $h, h_c$, and $g$-indices for both Scopus and WoS. The ranks are sorted according to Scopus $h$-index in descending order and the $g$ and $h_c$-indices of the author are plotted respectively. A large number of fluctuation is observed for the authors with varying $h$-index in all disciplines. The fluctuations in $h_c$ with respect to $h$ are more prominent at the tail. The inset shows probability density function of $h$ and $h_c$. The minor shift of the $h_c$ towards the right shows the impact of $h_c$ on lower-ranked authors.

The major impact is on Social Sciences where the $h$-index value of 34.1% authors in Scopus and 40% in WoS is increased by $k = 2$. Similarly, for $k = 3$, negligible increase is recorded. The second highest is Health and Medical Sciences with 32.1% in Scopus and 27.4% in WoS for $k = 2$. There is negligible impact of $k = 3$ in this discipline too. In Biochemistry and Molecular Biology, the gain is 22.7% in Scopus and 23.9% in WoS for $k = 2$ and for $k = 3$ the impact is negligible. In Engineering, 16.7% in Scopus and 15% in WoS is increased for $k = 2$ and for $k = 3$ it is 3.3% for Scopus and 1.7% for WoS. In Natural Sciences, 19.6% in Scopus and 21.7% in WoS for $k = 2$ and for $k = 3$ it is negligible. The overall impact is 25.0% in Scopus and 25.6% in WoS for $k = 2$ and 1.1% in Scopus and 0.6% in WoS for $k = 3$.

Comparative analysis of $h, h_c$, and $g$-indices

Figure 4 shows the comparison among (a) $h$ and $h_c$, and (b) $h$ and $g$ for both Scopus and WoS. A correlation coefficient is computed on varying $h$-index. The fluctuations are
| Disciplines                              | Total authors | ID | Total publications | Unique publications | Publications received citations | Total citations | Common publications |
|-----------------------------------------|---------------|----|--------------------|---------------------|-------------------------------|----------------|---------------------|
| Biochemistry and Molecular Biology      | 88            | S  | 7095               | 972                 | 6553                          | 294,374        | 5732                |
|                                         |               | W  | 6979               | 366                 | 6241                          | 283,221        |                     |
| Engineering                             | 60            | S  | 5746               | 1221                | 4899                          | 137,875        | 3806                |
|                                         |               | W  | 5212               | 270                 | 4418                          | 124,490        |                     |
| Health and Medical Sciences             | 106           | S  | 9687               | 1786                | 8503                          | 352,286        | 7125                |
|                                         |               | W  | 9807               | 724                 | 7813                          | 330,846        |                     |
| Natural Sciences                        | 46            | S  | 3266               | 500                 | 2964                          | 101,380        | 2577                |
|                                         |               | W  | 3055               | 123                 | 2773                          | 96,889         |                     |
| Social Sciences                         | 85            | S  | 5473               | 1185                | 4762                          | 164,524        | 3929                |
|                                         |               | W  | 5085               | 323                 | 4122                          | 141,739        |                     |
captured for the lower ranked authors, i.e. for $h \leq 10$ with mean correlation 0.9 for both Scopus and WoS in Fig. 4a. However, in Fig. 4b the fluctuations are higher for varying $h$-index.
In all disciplines, the $h_c$ value is either increased or remained the same, i.e. $h_c \geq h$ as shown in Table 3. A slight deviation in median and average values for both Scopus and WoS is observed.

Figure 5 shows the growth curve of $h_c$ based on $H_{cite}$. For different values of highest cited paper ($H_{cite}$), the respective $h_c$ is calculated. For Fig. 5, we kept the value of $h$ as 2. The similar growth curve can be generated for any value of $h$. The growth curve clearly shows the impact at earlier stage and after that the impact is negligible. We clearly see that for an author with $h = 2$ and $8 < H_{cite} < 100$, the $h_c$ makes a difference, i.e. the author gets weightage to his/her most cited paper.

**Impact of indexing databases on author’s rankings**

Figure 6 shows the distribution of 385 authors among five disciplines with varying $h$-index for (a) Scopus and (b) WoS. We have placed the authors into six categories with varying $h$-index. In total, 23.4% of authors are having $h \leq 10$ in Scopus and 28.6% in WoS. However, after complementing $h$ index as $h_c$, this proportion lower down to 19% for Scopus and 21% for WoS for $h \leq 10$. On the other hand, Scopus shows 34.5% and WoS shows 32.2% of authors in the range $11 \leq h \leq 20$, whereas this count is increased for $h_c$, as 35.6% for Scopus and 36.1% for WoS. Hence, there is a 1% gain in the author’s count for Scopus and a 4% gain in the author’s count for WoS. For higher-ranked authors ($h > 50$), Scopus shows 4.4% and WoS shows 4.2% of authors, and $h_c$ shows no impact on authors ranking for WoS at a higher level whereas for Scopus $h_c$ has a minor impact.

Table 4 shows the discipline wise distribution of authors (in %) based on $h$ and $h_c$ for both Scopus and WoS. The proportion of authors having $h \leq 10$ is higher in WoS for all disciplines. In disciplines, Social Sciences shows highest count (35.3%) and Biochemistry and Molecular Biology shows lowest count (11.4%) for authors with $h \leq 10$ for both Scopus and WoS. Further, a significant change is noticed in Health and Medical Sciences, and Natural Sciences where the authors ranked $h \leq 10$ shows 6% (approx) change in ranking from $h$ to $h_c$. For rest of the disciplines the change is between 2 and 5% (approx).
Table 3  Statistics of $h$, $h_c$, and $g$ in terms of min, max, median, average, and standard deviation (SD) of both indexing databases (ID) Scopus and WoS for all five disciplines.

| Disciplines             | ID | Min | Max | Median | Average | SD |
|-------------------------|----|-----|-----|--------|---------|----|
|                         |    | $h$ | $h_c$ | $g$     | $h$ | $h_c$ | $g$ | $h$ | $h_c$ | $g$ | $h$ | $h_c$ | $g$ |
| Biochemistry and Molecular Biology | S  | 4   | 7    | 11   | 79     | 80  | 137 | 22  | 23  | 43   | 25.2 | 26.4 | 47.5 | 15.3 | 15.2 | 27.1 |
|                         | W  | 5   | 7    | 10   | 77     | 78  | 133 | 22  | 23  | 41   | 24.5 | 25.7 | 46.2 | 15.0 | 14.9 | 27.3 |
| Engineering             | S  | 2   | 4    | 3    | 64     | 65  | 102 | 18  | 19  | 31   | 20.7 | 21.9 | 36.2 | 14.0 | 13.7 | 23.0 |
|                         | W  | 1   | 2    | 2    | 62     | 63  | 99  | 16  | 17.5| 30   | 19.6 | 20.8 | 34.4 | 13.5 | 13.4 | 22.8 |
| Health and Medical Sciences | S  | 2   | 4    | 4    | 91     | 92  | 173 | 17  | 18  | 33   | 21.6 | 23.0 | 41.9 | 16.1 | 16.0 | 33.9 |
|                         | W  | 2   | 4    | 3    | 95     | 96  | 168 | 16  | 17  | 30   | 20.6 | 21.9 | 39.6 | 16.1 | 16.0 | 33.9 |
| Natural Sciences        | S  | 4   | 5    | 6    | 50     | 51  | 98  | 18  | 19.5| 36   | 21.2 | 22.4 | 38.1 | 12.2 | 12.1 | 22.1 |
|                         | W  | 2   | 4    | 4    | 49     | 50  | 101 | 17  | 18  | 33   | 20.6 | 21.8 | 36.8 | 12.3 | 12.2 | 22.0 |
| Social Sciences         | S  | 1   | 2    | 2    | 72     | 73  | 146 | 13  | 15  | 25   | 17.0 | 18.4 | 31.6 | 13.9 | 13.7 | 26.7 |
|                         | W  | 1   | 1    | 1    | 68     | 69  | 141 | 11  | 13  | 23   | 15.4 | 16.8 | 28.8 | 13.2 | 13.1 | 24.9 |
Conclusion

In this study, we extended the pioneering work of Hirsch (2005) by simply focusing on one of the limitations of the $h$-index (Costas & Bordons, 2007; Egghe, 2010). The $h$-index focuses on both quantity and impact of publications but ignored the impact of highly cited papers which under-estimates the importance of the work.

After the introduction of the $h$ index, many variants of $h$ have been proposed by scientists in order to improve the research evaluation of an individual (Schreiber, 2010). Some became meaningful like the $g$-index; however, each and every index is lacking in one or the other sense. Based on the $h$-index, we introduced $h_c$, which is a complementary approach to the $h$-index. $h_c$ takes care of one of the limitations of the $h$-index, especially $h$ ignores the highly cited papers. $h_c$ works on $h$-index by adding weight to the highest cited paper of an individual. The new index $h_c$ is computed on the same ranking and we found that in total the major fluctuations appeared for the authors ranked $h \leq 10$ for both Scopus and WoS; however, this variation/fluctuation is higher in WoS.
Table 4 Proportion of authors in five disciplines for varying $h$ and $h_c$ for Scopus (S) and WoS (W)

| Disciplines                      | ID | No. of authors (%) | $h \leq 10$ | $11 \leq h \leq 20$ | $21 \leq h \leq 30$ | $31 \leq h \leq 40$ | $41 \leq h \leq 50$ | $h > 50$ |
|----------------------------------|----|--------------------|-------------|---------------------|---------------------|---------------------|---------------------|----------|
|                                 |    |                    | $h$         | $h_c$               | $h$         | $h_c$               | $h$         | $h_c$               | $h$         | $h_c$               | $h$         | $h_c$               | $h$         | $h_c$               |
| Biochemistry and Molecular Biology | S  | 11.4                | 9.1         | 33.0                | 29.5         | 29.5                | 33.0         | 12.5                | 12.5         | 8.0                 | 10.2        | 5.7                 | 5.7         | 5.7                 |
|                                 | W  | 15.9                | 9.1         | 30.7                | 31.8         | 28.4                | 33.0         | 15.9                | 13.6         | 3.4                 | 6.8         | 5.7                 | 5.7         | 5.7                 |
| Engineering                      | S  | 23.3                | 20.0        | 35.0                | 35.0         | 21.7                | 23.3         | 8.3                 | 10.0         | 8.3                 | 6.7         | 3.3                 | 5.0         | 5.0                 |
|                                 | W  | 30.0                | 21.7        | 33.3                | 36.7         | 18.3                | 21.7         | 10.0                | 11.7         | 5.0                 | 5.0         | 3.3                 | 3.3         | 3.3                 |
| Health and Medical Sciences      | S  | 25.5                | 18.9        | 34.0                | 38.7         | 18.9                | 19.8         | 10.4                | 9.4          | 4.7                 | 5.7         | 6.6                 | 7.5         | 7.5                 |
|                                 | W  | 28.3                | 21.7        | 34.0                | 38.7         | 17.0                | 17.9         | 9.4                 | 7.5          | 5.7                 | 8.5         | 5.7                 | 5.7         | 5.7                 |
| Natural Sciences                 | S  | 19.6                | 13.0        | 37.0                | 39.1         | 23.9                | 21.7         | 10.9                | 17.4         | 8.7                 | 6.5         | 0.0                 | 2.2         | 0.0                 |
|                                 | W  | 23.9                | 15.2        | 32.6                | 39.1         | 23.9                | 26.1         | 10.9                | 10.9         | 8.7                 | 8.7         | 0.0                 | 0.0         | 0.0                 |
| Social Sciences                  | S  | 35.3                | 31.8        | 35.3                | 36.5         | 16.5                | 18.8         | 7.1                 | 7.1          | 2.4                 | 2.4         | 3.5                 | 3.5         | 3.5                 |
|                                 | W  | 43.5                | 35.3        | 30.6                | 35.3         | 16.5                | 18.8         | 5.9                 | 7.1          | 0.0                 | 0.0         | 3.5                 | 3.5         | 3.5                 |
as compared to Scopus. In discipline-wise analysis, the results vary among Scopus and WoS.

Due to its simplicity and in complement to h-index, h_{c} could provide a useful insight towards the young or lower-ranked authors which in turn significantly improves the ranking of an individual within a discipline. It could be helpful in an institution/university for the internal ranking of the faculties within a discipline. It also highlights the importance of the work carried out by an individual as it takes into account the h-index along with the contribution of the highest-cited paper. For future study, the same concept can be extended towards the ranking of the organizations and journals.

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**Data availability** The datasets generated during and/or analysed during the current study along with python codes are available from the corresponding author on reasonable request.

**Declarations**

**Conflict of interest** The author declares no conflict of interest.

**References**

Abramo, G., D’Angelo, C. A., & Viel, F. (2010). A robust benchmark for the h-and g-indexes. *Journal of the American Society for Information Science and Technology*, 61, 1275–1280.

Adriaanse, L. S., & Rensleigh, C. (2013). Web of Science, Scopus and Google Scholar: A content comprehensiveness comparison. *The Electronic Library*, 31(6), 721–744.

Aghaie Chadegani, A., Salehi, H., Yunus, M., Farhadi, H., Fooladi, M., Farhadi, M., & Ale Ebrahim, N. (2013). A comparison between two main academic literature collections: Web of Science and Scopus databases. *Asian Social Science*, 9, 18–26.

Alonso, S., Cabrerizo, F. J., Herrera-Viedma, E., & Herrera, F. (2010). hg-Index: A new index to characterize the scientific output of researchers based on the h-and g-indices. *Scientometrics*, 82, 391–400.

Bakkalbasi, N., Bauer, K., Glover, J., & Wang, L. (2006). Three options for citation tracking: Google Scholar, Scopus and Web of Science. *Biomedical Digital Libraries*, 3, 1–8.

Ball, P. (2005). Index aims for fair ranking of scientists. *Nature*, 436, 900.

Bar-Ilan, J. (2008). Which h-index? A comparison of WoS, Scopus and Google Scholar. *Scientometrics*, 74, 257–271.

Bar-Ilan, J., Levene, M., & Lin, A. (2007). Some measures for comparing citation databases. *Journal of Informetrics*, 1, 26–34.

Batista, P. D., Campiteli, M. G., & Kinouchi, O. (2006). Is it possible to compare researchers with different scientific interests? *Scientometrics*, 68, 179–189.

Bornmann, L. (2017). Measuring impact in research evaluations: A thorough discussion of methods for, effects of and problems with impact measurements. *Higher Education*, 73, 775–787.

Bornmann, L., & Daniel, H. D. (2005). Does the h-index for ranking of scientists really work? *Scientometrics*, 65, 391–392.

Bornmann, L., & Daniel, H. D. (2009). The state of h index research: Is the h index the ideal way to measure research performance? *EMBO Reports*, 10, 2–6.

Bornmann, L., Mutz, R., & Daniel, H. D. (2008). Are there better indices for evaluation purposes than the h index? A comparison of nine different variants of the h index using data from biomedicine. *Journal of the American Society for Information Science and Technology*, 59, 830–837.

Braun, T., Glänzel, W., & Schubert, A. (2005). A Hirsch-type index for journals. *The Scientist*, 19, 8.

Braun, T., Glänzel, W., & Schubert, A. (2006). A Hirsch-type index for journals. *Scientometrics*, 69, 169–173.

Costas, R., & Bordons, M. (2007). The h-index: Advantages, limitations and its relation with other bibliometric indicators at the micro level. *Journal of Informetrics*, 1, 193–203.
Costas, R., & Bordons, M. (2008). Is g-index better than h-index? An exploratory study at the individual level. *Scientometrics*, 77, 267–288.

Cronin, B., Snyder, H., & Atkins, H. (1997). Comparative citation rankings of authors in monographic and journal literature: A study of sociology. *Journal of Documentation*, 53(3), 263–273.

Ding, J., Liu, C., & Kandonga, G. A. (2020). Exploring the limitations of the h-index and h-type indexes in measuring the research performance of authors. *Scientometrics*, 122, 1303–1322.

Ding, Y., Yan, E., Frazho, A., & Caverlee, J. (2009). PageRank for ranking authors in co-citation networks. *Journal of the American Society for Information Science and Technology*, 60, 2229–2243.

Dumé, B. (2005). How high is your h-index? *Physics World*, 18, 7.

Dunaiski, M., Geldenhuys, J., & Visser, W. (2018). Author ranking evaluation at scale. *Journal of Informetrics*, 12, 679–702.

Dunaiski, M., Geldenhuys, J., & Visser, W. (2019). Globalised vs averaged: Bias and ranking performance on the author level. *Journal of Informetrics*, 13, 299–313.

Egghe, L. (2006a). An improvement of the h-index: The g-index. *ISSI Newsletter*, 2, 8–9.

Egghe, L. (2006b). Theory and practice of the g-index. *Scientometrics*, 69, 131–152.

Egghe, L. (2008). The influence of transformations on the h-index and the g-index. *Journal of the American Society for Information Science and Technology*, 59, 1304–1312.

Egghe, L. (2010). The Hirsch index and related impact measures. *Annual Review of Information Science and Technology*, 44, 65–114.

Falagas, M. E., Pitsouni, E. I., Malietzis, G. A., & Pappas, G. (2008). Comparison of PubMed, Scopus, Web of Science, and Google Scholar: Strengths and weaknesses. *The FASEB Journal*, 22, 338–342.

Garfield, E. (2006). Citation indexes for science. A new dimension in documentation through association of ideas. *International Journal of Epidemiology*, 35, 1123–1127.

Glänzel, W. (2006). On the h-index—A mathematical approach to a new measure of publication activity and citation impact. *Scientometrics*, 67, 315–321.

Gracza, T., & Somoskövi, I. (2007). Impact factor and/or Hirsch index? *Orvosi Hetilap*, 148, 849–852.

Hirsch, J. E. (2005). An index to quantify an individual’s scientific research output. *Proceedings of the National Academy of Sciences of USA*, 102, 16569–16572.

Jin, B., Liang, L., Rousseau, R., & Egghe, L. (2007). The r-and ar-indices: Complementing the h-index. *Chinese Science Bulletin*, 52, 855–863.

Maabreh, M., & Alsmadi, I. M. (2012). A survey of impact and citation indices: Limitations and issues. *International Journal of Advanced Science and Technology*, 40, 35–54.

Martin, B. (1996). The use of multiple indicators in the assessment of basic research. *Scientometrics*, 36, 343–362.

Martín-Martín, A., Orduna-Malea, E., Thelwall, M., & López-Cózar, E. D. (2018). Google Scholar, Web of Science, and Scopus: A systematic comparison of citations in 252 subject categories. *Journal of Informetrics*, 12, 1160–1177.

Meho, L. I., & Yang, K. (2007). Impact of data sources on citation counts and rankings of LIS Faculty: Web of Science versus Scopus and Google Scholar. *Journal of the American Society for Information Science and Technology*, 58, 2105–2125.

Molinari, J. F., & Molinari, A. (2008). A new methodology for ranking scientific institutions. *Scientometrics*, 75, 163–174.

Mongeon, P., & Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: A comparative analysis. *Scientometrics*, 106, 213–228.

Neuhaus, C., & Daniel, H. D. (2008). Data sources for performing citation analysis: An overview. *Journal of Documentation*, 64(2), 193–210.

Nykl, M., Campri, M., & Ježek, K. (2015). Author ranking based on personalized PageRank. *Journal of Informetrics*, 9, 777–799.

Pérez-Gutiérrez, M., & Cobo-Corrales, C. (2022). Surfing scientific output indexed in the Web of Science and Scopus (1967–2017). *Movimento*, 26, e26015.

Schreiber, M. (2008a). An empirical investigation of the g-index for 26 physicists in comparison with the h-index, the a-index, and the r-index. *Journal of the American Society for Information Science and Technology*, 59, 1513–1522.

Schreiber, M. (2008b). The influence of self-citation corrections on Egghe’s g index. *Scientometrics*, 76, 187–200.

Schreiber, M. (2010). Twenty Hirsch index variants and other indicators giving more or less preference to highly cited papers. *Annalen der Physik*, 522, 536–554.
Tol, R. S. (2008). A rational, successive g-index applied to economics departments in Ireland. *Journal of Informetrics, 2*, 149–155.

Torres-Salinas, D., Lopez-Cózar, E., & Jiménez-Contreras, E. (2009). Ranking of departments and researchers within a university using two different databases: Web of Science versus Scopus. *Scientometrics, 80*, 761–774.

Usman, M., Mustafa, G., & Afzal, M. T. (2020). Ranking of author assessment parameters using logistic regression. *Scientometrics, 126*, 1–19.

Vieira, E., & Gomes, J. (2009). A comparison of Scopus and Web of Science for a typical university. *Scientometrics, 81*, 587–600.

Vinkler, P. (2007). Eminence of scientists in the light of the h-index and other scientometric indicators. *Journal of Information Science, 35*, 481–491.

Waltman, L. (2016). A review of the literature on citation impact indicators. *Journal of Informetrics, 10*, 365–391.

Zhang, C. T. (2009a). The e-index, complementing the h-index for excess citations. *PLoS ONE, 4*, e5429.

Zhang, C. T. (2009b). A proposal for calculating weighted citations based on author rank. *EMBO Reports, 10*, 416–417.

Zhang, C. T. (2013). The h'-index, effectively improving the h-index based on the citation distribution. *PLoS ONE, 8*, e59912.

Zhu, J., & Liu, W. (2020). A tale of two databases: The use of Web of Science and Scopus in academic papers. *Scientometrics, 123*, 321–335.