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GFsa (GF "Scientific Age") Index Application for Assessment of 1020 Highly Cited Researchers in Dentistry: A Pilot Study Comparing GFsa Index and H-Index

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Abstract: Objective: The goal of this pilot study was to present a new index system (GFsa©) based on two variables, the total citations and "scientific age", to evaluate the best-ranked researchers in dentistry. Methods: All researchers included were cited in the AD Scientific Index (2024, dentistry field) and had their Google Scholar page accessible for a manual consultation. Two authors retrieved this information. A dataset was prepared (name, H-index, i10 index, and publications). The formula applied was GFsa = (total number of citations)/("scientific age")^2. The Pearson correlation statistically evaluated the data obtained; the confidence interval was 95%. Results: A total of 1020 were included. The mean "scientific age" was 34.18 ± 13.34. The GFsa© index was calculated, presenting a minimum value of 0.2186 and a maximum of 154.8. The data were organized and sorted following the ranking obtained. The Pearson correlation showed that the H-index had a weakly positive association with the researcher's "scientific age"; thus, the H-index increased according to the increase in "scientific age". By contrast, a moderately negative correlation between GFsa and "scientific age" was demonstrated. Moreover, a positive correlation was observed between both indexes. Conclusions: The variable reported ("Scientific age") provided a better evaluation among the researchers in dentistry.

Keywords: dentistry; citation; ranking; bibliometrics

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1. Introduction

Research articles are essential for describing new ideas, techniques, and procedures and consolidating concepts. They create an opportunity to expose studies and publicly assimilate published knowledge [1]. The depth and extension of the recognition, acceptance, and utilization of methods transmitted by these articles will result in author metrics. Currently, author metrics are available at Scopus (Elsevier), Web of Science, Google Scholar Citations, ImpactStory, ResearchGate, Academia.edu, and Plum Analytics [2]. Five main metrics are used to evaluate quality, H-index, i10-index, g-index, Eigenfactor, and Article Influence Score, but others also exist [3,4]. Therefore, one of them is the most used and accepted to verify the author's scientific impact: the H-index or Hirsch index. It provides a robust single metric that combines quality and quantity.

1.1. H-Index: The Most Important Currently Index

Hirsch (2005) [5] proposed a number (H-index) as a simple and useful way to characterize the cumulative scholarly impact of a researcher's scientific output. It measures the productivity and impact of an author's published study [2]. It is defined as the highest number of publications from a scientist that receives h or more citations each, while the other publications have no more than h citations each [6]; e.g., a researcher with an H-index of 10 has published 10 papers, each of which has been cited by others at least 10 times. Therefore, comparing individuals within different disciplines may not be optimal, even though they can be closely related [7–9]. Thus, it is considered discipline-size-dependent.

Therefore, the pattern of citations and publications differs across various medical and health sciences disciplines.

Due to the importance of this index, it has been suggested as a tool permitting the evaluation of a professional as part of the data required by some promotion committees [10]. In many disciplines, a general rule is followed for an acceptable H-index matching the number of years the author has worked in that discipline [11]. Also, a good H-index can be considered as 20, 40 is outstanding, and 60 is exceptional; therefore, high numbers are reached after many years of research life [5]. H-index has several advantages: (1) it is a reliable and robust indicator of scholarly achievement [12]; (2) it applies to researchers individually or in a group; (3) it is a mathematically simple index; (4) it combines two types of activity (in the original setting, this is citation impact and publications); (5) any document can be included; (6) publications that are hardly ever cited do not influence the H-index—the H-index discourages publishing unimportant work; (7) single peaks (top publications) have hardly any influence on the H-index; (8) the H-index is closely correlated to total publication output [5]; and (9) it can be easily obtained from databases such as Google Scholar, Web of Science, and Scopus. It is important to highlight some critical factors when using Google Scholar as a source: (1) in many cases, it indexes the names of only the first and last authors; (2) it uses initials rather than first names, so searches may yield articles from a variety of authors who share first initials and last names; and (3) it does not totally capture articles in languages other than English (LOTE articles) and citations in chapters and books, leading to mistakes or an underestimation of the H-index. Therefore, in spite of these issues, the comparison of h-indices obtained by using Google Scholar and Scopus is highly correlated [10].

As disadvantages, (1) the H-index puts, in its original setting [5], newcomers at a disadvantage since both publication output and observed citation rates will be relatively low (it is based on long-term observations)—researchers with shorter scientific careers may have fewer articles and citations than those with longer scientific careers; (2) it allows scientists to rest on their results (H-index obtained), since the number of citations received may increase even if no new papers are published—the influence of researcher "scientific age or academic age"; (3) it is only useful for comparing the better scientists in a field (it does not discriminate among average scientists); (4) this indicator can never decrease; (5) it is only weakly sensitive to the number of citations received; and (6) the major and minor (or no) contributor in the research gains an equal H-index; there is the influence of self-citation of an author by quoting earlier research publications [13]. Thus, some relevant criticisms have been raised for the H-index because it may provide incorrect information about a scientist's output [14]; for example, (1) overall citations, neglecting personal relevant contributions/performances (e.g., first or last author); (2) it does not consider the context of the citations—in respected journals (with high impact factor [IF]) or otherwise; and (3) it does not take the number of publishing authors in the same article into account, which could suggest adjustments to the index to prevent and avoid over-assigning credit for papers that had large authorship teams [15]. Thus, it is difficult to propose a competitive or acceptable H-index for the recruitment/promotion of faculties or for funding and grant purposes.

Furthermore, the H-index is also affected by the accuracy of the citation database used for its calculation, where different databases may present different H-indexes because each database covers different journals and years of indexation [6]. In addition, some authors [10] suggested that the H-index increases according to academic rank increases; the authors in [10] reported that the persons with the highest H-indices were the chairs of the department. This may occur because the H-index is also related to the time spent in a discipline (the longer the time, the more citations one's papers will receive). On the other hand, it is extremely incorrect to verify, mainly because this index never uses the time variable to determine the researchers' impact.

1.2. Time: One of the Most Important Variables

In an attempt to reduce the possible contrast observed, the H5-index was developed, in 2005, as an individual-level metric. It was defined as the "largest number H such that H articles published by a journal have at least H citations each for articles over a specified period", retaining the same strategy as the original H-index but being limited within 5 years [16].

Within the concept of time as a measure, many existing indexes, including the H-index (except the H5-index), neglect this important variable. By contrast, some indices consider the time variable to formulate the researcher's impact: the age-weighted citation rate (AWCR and AWCRpA (AWCR per Author)), AW-index (age-weighted) [17]. The AWCR measures the number of citations to an entire body of work, adjusted for the age of each individual paper, where the number of citations to a given paper is divided by the age of that paper. The AWCRpA is similar to the plain AWCR but is normalized to the number of authors for each paper. The AW-index is adjusted for the age of each individual paper (the older the researcher is, the higher their H-index will be) and is defined as the square root of the AWCR to allow comparison with the H-index. The AR-index [17] is the square root of the sum of all age-weighted citation counts over all papers that contribute to the H-index.

Currently, there is no single perfect bibliometric index that accurately describes a researcher's impact. Essentially, the number of publications and the impact factor are widely regarded as measures of the researchers' qualifications and, hence, their reputation. It has also been implemented to promote the standing of scientific journals worldwide. Guraya et al.'s study [18] reported that some universities can offer generous grants to researchers who have a high H-index and more publications, mainly if the studies are published in leading well-reputed journals, in order to ensure more reliability and chances of more citations and, consequently, higher positions in the scientific ranking. Although the H-index is the most used, observed, and accepted index, combining two or more metrics has been suggested [19].

1.3. Objective

However, due to the lack of total citations and "scientific age" consideration, the aim of this pilot study was to present a new index system (GFsa© index), which is based on two variables, considering both as good parameters to rank the scientists in dentistry. This pilot study was developed to prove the concept developed, and the best-ranked researchers in dentistry were included.

2. Materials and Methods

2.1. H-Index Explanation

The H-index measures the number of publications (productivity) as well as how often they have been cited. It is determined based on the following calculation: H-index = *n* of publications with a citation number greater than or equal to h. For example, if 10 publications are cited 10 times or more, the researcher will receive an H-index of 10. Therefore, this index, which is currently the most relevant, has two problems based on the lack of consideration of the time variable and forgetting the total of citations that a researcher can receive.

2.2. "Scientific Age", Researcher's Lifetime, or Academic Age: The Concept

"Scientific age", the researcher's lifetime, or the academic age can be considered one of the hardest parameters to be defined and acquired. This may be the reason no other index has tried to use it. The definition is the time spent by a researcher since the beginning of the research activities. Therefore, finding the first researcher's moment life is not simple; moreover, there is no registry to prove when the researcher "was born". Thus, the most practical and feasible set of data to define this concept was chosen as the first time the author appeared in the literature (the time elapsed from the first publication) [20], which was considered the "researcher's birthday".

Many landmarks in the author's life could be considered, such as (1) when the researcher started their first investigation (first contact with science); or (2) when they started

their master's or Ph.D. Therefore, in order to standardize and permit feasible and simple access to the "researcher's birthday", the "YEAR" of the first publication publicly found was considered, which means the year of the first article that the authors publicly appeared in, easily sought and found in Google Scholar, Scopus, Web of Science, or PubMed.

It was calculated by subtracting the year of the first publication found in Google Scholar (in case of questions, PubMed/MedLine, PubMed Central, and Scopus databases were consulted) from the current year. Thus, **"scientific age" (sa) = yt − y1**, where yt is the current year (today) and y1 is the year of the first publication.

2.3. Databases Used and Researchers' Inclusion

The recently published AD Scientific Index was used for consultation (https://www.adscientificindex.com/?subject=Medical+and+Health+Sciences+/+Dentistry) (accessed on 18 March 2024). All researchers included in this study were cited in the AD Scientific Index (2024) in the dentistry field and had their respective Google Scholar pages accessible and consulted (scholar.google.com, accessed on 28 March 2024) to obtain the desired information, which was performed by two authors (G.V.O.F. and J.C.H.F.). The data were assessed twice to avoid errors or mistakes.

There was a limitation/cutline for the inclusion of a minimum H-index value of 30 (29 March 2024). The author was excluded if they (i) did not have a Google Scholar page; (ii) had duplicated authors; or (iii) presented any suspicious activities about the manipulation of articles. We collected all researchers' Google Scholar publications, including citation data. We filtered out the first publication in order to obtain the year.

2.4. Total Citations

It was observed that the H-index or i10 index counts only some citations according to their parameters. This fact brings disadvantages as observed, e.g., a researcher with around 10,000 citations received an H-index of 33, and another study with 3700 citations also received an H-index of 33. Analyzing and observing this issue in-depth, we judged that it was not fair. Thus, we also introduced the use of total citations in order to correctly qualify the professional.

2.5. Data Collection for the Highly Cited Researchers in Dentistry

We constructed a dataset of all researchers who were reported in dentistry. The name, H-index, i10 index, and publications were retrieved. Then, as previously established, we selected the highly cited researchers via Google Scholar. The retrieved researchers were sorted by the H-index. Each author included had Google Scholar consulted.

2.6. GFsa© Formula

Whereas the H-index can be considered deficient in correctly evaluating the researcher, the GF index considers the researcher's real impact, evaluating the researcher's "scientific age" and taking into consideration the total citations received. It brings better weighting and comparison between all professionals, independent of age. It permits the elimination of the disadvantages of old researchers and new ones.

Within this context, considering the "scientific age" as the most important parameter, the formula used to obtain GFsa© was $\mathbf{GFsa = (a)/(b)^2}$, where (a) is the total citations and (b) is the "scientific age".

2.7. Statistical Analysis

The data obtained were statistically evaluated. The Pearson correlation coefficient was measured, quantifying the strength and direction of the linear relationship between two quantitative variables (Index and "Scientific age"). The confidence interval was 95%. The range of the coefficient r takes values between −1 and 1. A positive r indicates a positive correlation, which means when one variable increases, the other tends to increase as well, whereas a negative r indicates a negative correlation: when one variable increases, the

other tends to decrease. An r value of 0 implies no linear relationship between the variables. The strength of the correlation was as follows: (1) strongly positive: $r > 0.5$; (2) moderately positive: $0.3 < r \leq 0.5$; (3) weakly positive: $0 < r \leq 0.3$; (4) weakly negative: $-0.3 \leq r < 0$; (5) moderately negative: $-0.5 \leq r < -0.3$; and (6) strongly negative: $r < -0.5$.

3. Results

After manually evaluating the AD Scientific Index, we recorded a total of 9093 researchers in dentistry, of whom 1020 were included, respecting an H-index of at least 30. All of them had Google Scholar also manually analyzed. Then, we collected all 1020 researchers' Google Scholar data (publications, citations, and indexes). Specifically, each researcher's total citations and "scientific age" were registered and calculated (all data will be available at http://gfindex.us.to (accessed on 28 May 2024)).

The minimum H-index registered was 30 (as previously established), and the maximum was 134 (mean = 46.22 ± 16.94; standard error of mean = 0.5311). The mean "scientific age" registered was 34.18 ± 13.34 (standard error of mean = 0.4181), with a minimum of 7 and a maximum of 103. With this information and data collected, the GFsa© index was calculated, presenting a minimum value of 0.2186 and a maximum of 154.8 (mean = 10.33 ± 11.82; standard error of mean = 0.3706) (Supplementary Table S2). Then, the data were organized and sorted following the ranking obtained in the GFsa© index (Supplementary Table S1 (complete ranking; Table 1 (ranking of the 30 first authors))).

Table 1. Comparison of the result and the ranking of the 30 first researchers between H-index and GFsa© index (sorted by GFsa© ranking). Authors are sorted following the GFsa© index ranking. (In "What's happened (ranking)?": green (background and font colors) = position increased; red (background and font colors) = position decreased; yellow (background and font colors) = kept the same position).

Researchers	H-Index	H-Index Ranking	GFsa© Index	GFsa© Index Ranking	What's Happened (Ranking)?
Georgios Kotsakis	38	583	154.828402	1	582
Qian Wang	123	4	109.997622	2	2
Marta Revilla León	38	583	102.387755	3	580
Alberto Monje	57	178	78.5763889	4	174
Ratilal Lalloo	57	178	72.8310658	5	173
Yu-Kang Tu	65	118	65.2928	6	112
Maha El Tantawi	43	432	63.3767313	7	425
Van Meerbeek Bart	134	1	60.5198962	8	−7
Andy Wai Kan Yeung	37	618	60.0082645	9	609
Richard J Miron	59	161	57.0488889	10	151
Songtao Shi	112	10	56.0138776	11	−1
Takeshi Noda	65	118	55.3671875	12	106
Giuseppe Troiano	41	488	54.7933884	13	475
José F. Siqueira Jr.	117	7	54.0249703	14	−7
Bogna Stawarczyk	67	101	52.7301038	15	86
Jürgen Groll	69	89	51.5575	16	73
Mutlu Özcan	96	23	49.0919067	17	6
Yu Leo Lei	37	618	47.5804989	18	600
Mohammad Atai	39	555	47.4545455	19	536
Solmaz Maleki Dizaj	45	389	46.8106509	20	369
Nawshad Muhammad	53	236	46.2653061	21	215
Biao Ren	43	432	43.8977778	22	410
Frank Witte	43	432	43.705104	23	409
Yin Xiao	86	40	42.5701531	24	16
Andrew I Su	68	97	42.3264	25	72
Isabela N Rôças	91	33	42.112	26	7

Table 1. *Cont.*

Researchers	H-Index	H-Index Ranking	GFsa© Index	GFsa© Index Ranking	What's Happened (Ranking)?
İrena Sailer	61	142	41.7777778	27	115
Muhammad Sohail Zafar	56	196	41.7093426	28	168
Gabriel Kalil Rocha Pereira	36	669	40.93	29	640
Gaetano Isola	54	227	40.5039063	30	197

The full ranking can be found in Supplementary Table S1. Green = position increased; red = position decreased; yellow = kept the same position; orange = H-index and H-index ranking; blue = GFsa© index and GFsa© index ranking.

The interpretation was clear when observing the Pearson correlation coefficient obtained for the variables analyzed (Figure 1). The H-index had a weakly positive association with the researcher's "scientific age"; this fact means that the H-index will increase according to the increase in "scientific age". By contrast, a moderately negative correlation between GFsa© and "scientific age" was demonstrated, in which a higher GFsa© had a lower "Scientific age". This assessment shows that the variable introduced was fairly used for the proposal made. Moreover, a weak positive correlation was observed between both indexes (H-index and GFsa©).

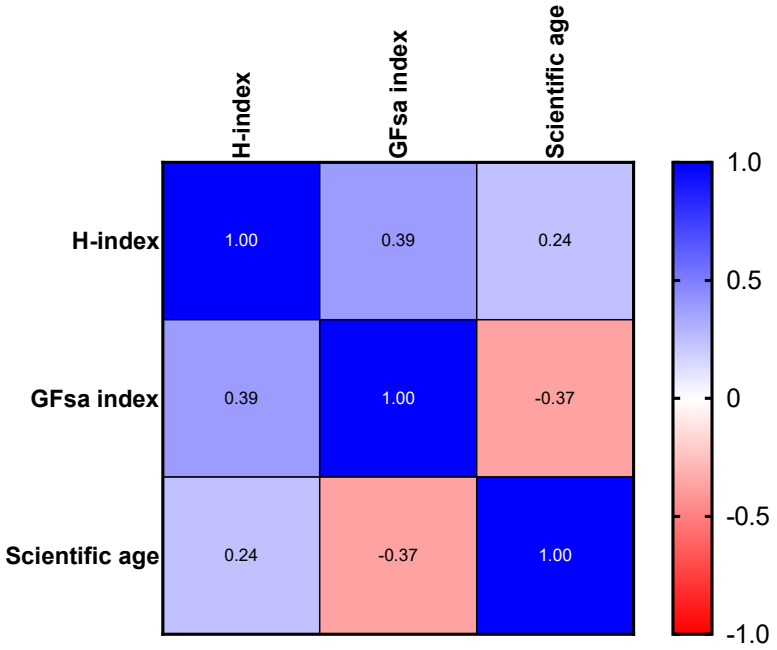

Figure 1. Pearson correlation (r) demonstrating a negative association between GFsa© and "scientific age" and a positive correlation between H-index and "scientific age". Moreover, a positive correlation was observed between both indices (H-index and GFsa©).

4. Discussion

While the H-index evaluation of a researcher's productivity evaluates the number of publications alone according to the article published, it does not indicate any quality or impact. A researcher's standing (ranking) and reputation depend on how the author impacts the research community or field. This fact is easily observed through the citations that a study receives. Thus, along with the growing number of articles published, a question arises: how can a researcher's influence, standing, reputation, and research impact be fairly measured?

4.1. H-Index

Many criticisms and disadvantages have been reported for the most used index (H-index) [21–23]. It is considered an easily obtained index, disregarding the complexity of

the research performance, which is a multifaceted endeavor that cannot be adequately measured by means of a single indicator. Furthermore, other questions can be raised: (a) The H-index should not be used to compare scientists from different disciplines; there are inter-field differences in typical h values due to differences among fields in productivity and citation practices. Due to this fact, we only included one field in this study (dentistry). (b) The H-index depends on the duration of each scientist's career because the pool of publications and citations increases over time. Therefore, the H-index does not consider the total citations one author receives per article, with the comparison between older and newer researchers becoming unfair. (c) Highly cited papers are important for the determination of the H-index; however, once they are selected as belonging to the top h papers, the number of citations they receive is irrelevant. (d) The H-index could provoke changes in the scientists' publishing behavior. (e) It presents technical limitations (difficulty in obtaining the complete output of authors with similar/common names or determining whether self-citations should be removed). (f) h does not take into account multiple co-authorship, self-citations, the age of publications, and the publication type. (g) The information obtained from the database used can be affected by citation errors—for instance, caused by homonymous author names, typographical errors in the source papers, or errors due to some nonstandard reference formats, which also affect other indexes.

Then, in an attempt to overcome the shortcomings of the H-index, some authors postulated complementary indexes by describing mathematical models, and they proposed new "Hirsch-type" indexes. These are grouped into two broad categories: (1) Productive Output Core (describe the number of published papers)—H-index, Egghe's G-index [24,25], Kosmulski's H(2)-index [26], and m-quotient; and (2) the impact of research papers—m-index, HW-index, R-index, Jin's A-index [27], and AR-index. Both groups, even though they are different, can complement each other [28]. Similarly, the goal of this pilot study was to introduce a new methodology of evaluation (a new index system—GFsa© index©), considering two variables: the total number of citations and the "scientific age" of the authors. The GFsa© index can be easily calculated as the H-index, using public databases (Google Scholar or Web of Science); in this study, we standardized the use of Google Scholar. It can also be framed in some of the criticisms raised against the H-index (abovementioned items d, e, f, and g, showing that the ideal index was not obtained yet). Otherwise, GFsa© improves some of the disadvantages previously mentioned, as observed in items a, b, and c. These facts justify the weak positive correlation found between the H-index and the GFsa© index.

Similarly to the H-index, the GFsa© index can be used to evaluate not only the authors but also the journals and to compare different fields (disciplinary areas), countries (geographic areas), and universities. Moreover, in order to try to normalize the H-index across disciplines, some authors proposed mixed results. It can be observed that the G-index aimed to improve it by considering with more weight the highly cited articles [29]; the E-index differentiated scientists with similar H-indexes considering different citation patterns [30]; the AW-index considered adjusting the relevance according to the age of each individual paper ("the older you are the higher your H-index will be") [17]; and the multi-authored H-index modified the original metric considering the shared authorship of articles.

Even though all of them provide improvements in the initial H-index, this original metric is still the most widely used. Thus, due to a possible lack of simplicity presented by the abovementioned indexes, they were not implemented routinely. This fact motivated us to propose GFsa©, which utilizes the total number of citations and the new concept proposed, the "Scientific age". It was possible to confirm, by observing the results of this study, that these criteria, when applied, brought a fair assessment of the researchers, avoiding the trend of "the older, the higher index".

Trying to provide a better and current level of significance for a researcher, the H5-index was introduced, limiting the evaluation to the last 5 years (or the 5 years of choice). Accordingly, it retains the same methodology of the H-index and ignores the scientific history of older professionals, which continues presenting flaws in the evaluation.

4.2. "Scientific Age" Variable

Based on some publications, two authors suggested that this variable could be obtained in the following two ways: (1) the date of receiving a PhD (or a master's degree); or (2) the date of the first publication [20]. The Ph.D. date to determine the "scientific age" can be typically obtained from curriculums (CVs). Therefore, this information is not commonly available for public assessment; otherwise, using the Academic Analytics commercial database, it can be sought. Many studies used this methodology [31–35], generally on a small scale; therefore, Savage and Olejniczak [36] conducted a large-scale study of faculty members (n = 167,299) with a Ph.D. in American universities. Thus, the choice of this parameter to find the variable of interest can be considered failed and introduces a bias.

Considering the date of the first publication from numerous bibliometric indicators, it was suggested to be the best single linear estimator of the ages of individual researchers/"scientific age" [37]. It works well in small- [38–41] or large-scale sets of professionals [37,42–47], when used for different purposes; on the other hand, the predictive power in the individual observational case can be considered "relatively limited" [37]. In our analysis of the GFsa© index (for now, using a small sample size [n = 1020], which will be extended to around 10,000 professionals in dentistry [large scale]), this variable, similarly applied for all professionals, demonstrated a fair way to determine them.

4.3. Limitations of this Study

A potential limitation was found in the collection of the authors' "scientific age", with many incorrect and old articles included on the Google Scholar page, due to similar names; many authors are receiving credits from other researchers on Google Scholar (articles wrongly included), leading to an incorrect or misinterpretation of the "researcher's birthday". A limitation of the GFsa© index is the reliance on a concept that is difficult to reliably apply (first publication year), which was manually acquired. As observed by other authors, accessing the data on the date of the first publication on a large scale will require complex preparation, particularly including a list of individual identifiers of all authors, but it is technically possible [20]. Moreover, it considers the context of citations (e.g., the impact factor of the journal and the scientific level of the reviewers); in addition, other factors were not observed, such as the susceptibility to the influence of self-citations/citation cartels and the susceptibility to the influence of a single or few highly cited articles, which do not account for minor contributions in multiple-author publications.

Furthermore, it is necessary to avoid any manipulation of the first article published (to obtain a better GFsa© index); this fact can be considered unfair and unethical, and hence can bring a misinterpretation of the "scientific age". We also verified that Google Scholar generally under-reports the number of authors for publications with large author sets. Through manual access and inspection, it was assessed that Google Scholar does not record all authors in all articles; this is an important limitation of the Scholar's data but does not interfere with the GFsa© index.

4.4. Future Research

Future research of the GFsa© application includes (1) improving the methodology to find the year of the first publication instead of manually accessing the database, (2) evaluating the 9093 researchers in dentistry (total initially registered), including more authors/researchers in the dentistry field, (3) extending and comparing the Google Scholar database with other reliable databases (such as Web of Science), (4) expanding the exposition of this new index for other areas of the knowledge (disciplines), and (5) providing free access of all data through the website (http://gfindex.us.to (accessed on 28 May 2024)).

Moreover, according to DORA (Declaration On Research Assessment, https://sfdora.org/ (accessed on 28 May 2024)), some general recommendations must be observed by the scientific community and in future studies on metrics/indexes: do not use journal-based metrics (e.g., Impact Factors or H-index) as a measure of the quality of individual research articles, to assess individual contributions, or in committees for hiring, promotion, or

funding decisions; make assessments based on scientific content rather than publication metrics; cite primary literature in which observations are first reported rather than reviews; use a range of article metrics and indicators on personal/supporting statements, as evidence of the impact; reduce emphasis on the journal impact factor; inappropriate manipulation of metrics will not be tolerated; and the research needs to be assessed on its own merits rather than on the basis of the journal in which it is published [48].

5. Conclusions

Within the limitations of this study, it is possible to conclude that the new variable reported ("Scientific age") and the use of the total citations brought a fairer and more feasible evaluation among the researchers. Thus, we are launching, for the first time in the literature, the new GFsa© index, using the "Scientific age" and total citations found.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/publications12020018/s1, Table S1: Comparison of the result and researchers' ranking between H-index and GFsa index (sorted by GFsa ranking). Green = position arrived; Red = position decreased; Yellow = kept the same position; Table S2: GFsa ranking for the highest cited researchers in Dentistry, following the H-index ranking.

Author Contributions: Conceptualization, G.V.O.F.; methodology, J.C.H.F. and G.V.O.F.; software, J.C.H.F. and G.V.O.F.; validation, J.C.H.F. and G.V.O.F.; formal analysis, J.C.H.F. and G.V.O.F.; investigation, J.C.H.F. and G.V.O.F.; resources, G.V.O.F.; data curation, J.C.H.F. and G.V.O.F.; writing—original draft preparation, J.C.H.F. and G.V.O.F.; writing—review and editing, J.C.H.F. and G.V.O.F.; visualization, G.V.O.F.; supervision, G.V.O.F.; project administration, G.V.O.F. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: GFsa© index 2024 by Gustavo Vicentis Oliveira Fernandes is licensed under CC BY-NC 4.0.

References

1. Pendlebury, D.A. The use and misuse of journal metrics and other citation indicators. *Arch. Immunol. Ther. Exp.* **2009**, *57*, 1–11. [CrossRef] [PubMed]
2. Utrecht Universiteit. Research Impact and Visibility: Traditional and Altmetrics. Available online: https://libguides.library.uu.nl/researchimpact (accessed on 4 April 2024).
3. Azer, S.A.; Holen, A.; Wilson, I.; Skokauskas, N. Impact factor of medical education journals and recently developed indices: Can any of them support academic promotion criteria? *J. Postgrad. Med.* **2016**, *62*, 32–39. [CrossRef] [PubMed]
4. ResearchGate. Available online: https://www.researchgate.net/ (accessed on 16 March 2024).
5. Hirsch, J.E. An index to quantify an individual's scientific research output. *Proc. Natl. Acad. Sci. USA* **2005**, *102*, 16569–16572. [CrossRef] [PubMed]
6. Schreiber, M. An empirical investigation of the g-index for 26 physicists in comparison with the h-index, the A-index, and the R-index. *J. Am. Soc. Inf. Sci. Technol.* **2008**, *59*, 1513. [CrossRef]
7. Castillo, M. Measuring Academic Output: The H-Index. *Am. J. Neuroradiol.* **2010**, *31*, 783–786. [CrossRef] [PubMed]
8. Bastian, S.; Ippolito, J.A.; Lopez, S.A.; Eloy, J.A.; Beebe, K.S. The use of the h-Index in academic orthopaedic surgery. *J. Bone Jt. Surg. Am.* **2017**, *99*, e14. [CrossRef] [PubMed]
9. Ence, A.K.; Cope, S.R.; Holliday, E.B.; Somerson, J.S. Publication productivity and experience: Factors associated with academic rank among orthopaedic surgery faculty in the United States. *J. Bone Jt. Surg. Am.* **2016**, *98*, e41. [CrossRef]
10. Lee, J.; Kraus, K.L.; Couldwell, W.T. Use of the H-index in neurosurgery. *J. Neurosurg.* **2009**, *111*, 387–392. [CrossRef] [PubMed]
11. Shah, F.A.; Jawaid, S.A. The h-Index: An Indicator of Research and Publication Output. *Pak. J. Med. Sci.* **2023**, *39*, 315–316. [CrossRef]
12. Rousseau, R. The influence of missing publications on the Hirsch index. *J. Informetr.* **2007**, *1*, 27. [CrossRef]
13. Bornmann, L.; Daniel, H.D. What Do We Know About the h Index? *J. Am. Soc. Inform. Sci. Technol.* **2007**, *58*, 1381–1385. [CrossRef]
14. Wendl, M.C. H-index: However ranked, citations need context. *Nature* **2007**, *449*, 403. [CrossRef] [PubMed]

15. Koltun, V.; Hafner, D. The H-index is no longer an effective correlate of scientific reputation. *PLoS ONE* **2021**, *16*, e0253397. [CrossRef] [PubMed]
16. Chapman, C.A.; Bicca-Marques, J.C.; Calvignac-Spencer, S.; Fan, P.; Fashing, P.J.; Gogarten, J.; Guo, S.; Hemingway, C.A.; Leendertz, F.; Li, B.; et al. Games academics play and their consequences: How authorship, h-index and journal impact factors are shaping the future of academia. *Proc. Biol. Sci.* **2019**, *286*, 20192047. [CrossRef] [PubMed]
17. BiHui, J.; LiMing, L.; Rousseau, R.; Egghe, L. The R- and AR-indices: Complementing the H-index. *Chin. Sci. Bul.* **2007**, *52*, 855–863.
18. Guraya, S.Y.; Norman, R.I.; Khoshhal, K.I.; Guraya, S.S.; Forgione, A. Publish or Perish mantra in the medical field: A systematic review of the reasons, consequences and remedies. *Pak. J. Med. Sci.* **2016**, *32*, 1562–1567. [CrossRef] [PubMed]
19. Ahangar, H.G.; Siamian, H.; Yaminfirooz, M. Evaluation of the scientific outputs of researchers with similar h index: A critical approach. *Acta Inform. Med.* **2014**, *22*, 255–258. [CrossRef]
20. Kwiek, M.; Roszka, W. Academic vs. biological age in research on academic careers: A large-scale study with implications for scientifically developing systems. *Scientometrics* **2022**, *127*, 3543–3575. [CrossRef]
21. Alonso, S.; Cabrerizo, F.J.; Herrera-Viedma, E.; Herrera, F. H-Index: A review focused in its variants, computation and standardization for different scientific fields. *J. Informetr.* **2009**, *3*, 273–289. [CrossRef]
22. Franceschini, F.; Maisano, D.A. Analysis of the Hirsch index's operational properties. *Eur. J. Oper. Res.* **2010**, *203*, 494–504. [CrossRef]
23. Schubert, A.; Schubert, G. All along the H-index-related literature: A guided tour. In *Springer Handbook of Science and Technology Indicators*; Springer International Publishing: Cham, Switzerland, 2019; pp. 301–334.
24. Egghe, L. How to improve the H-index. *Scientist* **2006**, *20*, 14.
25. Egghe, L. An improvement of the H-index: The G-index. *ISSI Newsl.* **2006**, *2*, 89.
26. Kosmulski, M. A new Hirsch-type index saves time and works equally well as the original h-index. *ISSI Newsl.* **2006**, *2*, 46.
27. Jin, B.H. H-index: An evaluation indicator proposed by scientist. *Sci. Focus* **2006**, *1*, 89. (In Chinese)
28. Bornmann, L.; Mutz, R.; Daniel, H.D. 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. *J. Am. Soc. Inform. Sci. Technol.* **2008**, *59*, 830–837. [CrossRef]
29. Egghe, L. Theory and practice of the g-index. *Scientometrics* **2006**, *69*, 131–152. [CrossRef]
30. Zhang, C.T. Thee-index, complementing the h-index for excess citations. *PLoS ONE* **2009**, *4*, e5429.
31. Badar, K.; Hite, J.M.; Badir, F.Y. The moderating roles of academic age and institutional sector on the relationship between co-authorship network centrality and academic research performance. *Aslib J. Inf. Manag.* **2014**, *66*, 38–53. [CrossRef]
32. Coomes, O.T.; Moore, T.; Paterson, J.; Breau, S.; Ross, N.A.; Roulet, N. Academic performance indicators for departments of geography in the United States and Canada. *Prof. Geogr.* **2013**, *65*, 433–450. [CrossRef]
33. Perianes-Rodriguez, A.; Ruiz-Castillo, J. Within- and between-department variability in individual productivity: The case of economics. *Scientometrics* **2014**, *102*, 1497–1520. [CrossRef]
34. Sugimoto, C.R.; Sugimoto, T.J.; Tsou, A.; Milojević, S.; Larivière, V. Age stratification and cohort effects in scholarly communication: A study of social sciences. *Scientometrics* **2016**, *109*, 997–1016. [CrossRef]
35. Van den Besselaar, P.; Sandström, U. Gender differences in research performance and its impact on careers: A longitudinal case study. *Scientometrics* **2016**, *106*, 143–162. [CrossRef] [PubMed]
36. Savage, W.E.; Olejniczak, A.J. Do senior faculty members produce fewer research publications than their younger colleagues? Evidence from Ph.D. granting institutions in the United States. *Scientometrics* **2021**, *126*, 4659–4686. [CrossRef]
37. Nane, G.F.; Larivière, V.; Costas, R. Predicting the age of researchers using bibliometric data. *J. Informetr.* **2017**, *11*, 713–729. [CrossRef]
38. Liao, C.H. Reopening the black box of career age and research performance. In *Human Aspects of IT for the Aged Population. Applications, Services and Contexts, Proceedings of the ITAP 2017, Vancouver, BC, Canada, 9–14 July 2017*; Zhou, J., Salvendy, G., Eds.; Lecture Notes in Computer Science; Springer: Berlin/Heidelberg, Germany, 2017; p. 10298. [CrossRef]
39. Simoes, N.; Crespo, N. A flexible approach for measuring author-level publishing performance. *Scientometrics* **2020**, *122*, 331–355. [CrossRef]
40. Petersen, A.M. On the impact of super ties in scientific careers. *Proc. Nat. Acad. Sci. USA* **2015**, *112*, E4671–E4680. [CrossRef] [PubMed]
41. Wildgaard, L. A comparison of 17 author-level bibliometric indicators for researchers in Astronomy, Environmental Science, Philosophy and Public Health in Web of Science and Google Scholar. *Scientometrics* **2015**, *104*, 873–906. [CrossRef]
42. Costas, R.; Nane, G.F.; Lariviere, V. Is the year of first publication a good proxy of scholars academic age? In *Istanbul: Bogaziçi University Printhouse, Proceedings of the 15th International Conference on Scientometrics and Informetrics, Istanbul, Turkey, 29 June–3 July 2015*; 2015; pp. 988–998. Available online: https://www.issi-society.org/proceedings/issi_2015/0988.pdf (accessed on 14 May 2024).
43. Milojević, S. How are academic age, productivity, and collaboration related to citing behavior of researchers? *PLoS ONE* **2012**, *7*, e49176. [CrossRef] [PubMed]
44. Radicchi, F.; Castellano, C. Analysis of bibliometric indicators for individual scholars in a large data set. *Scientometrics* **2013**, *97*, 627–637. [CrossRef]
45. Chan, H.F.; Torgler, B. Gender differences in performance of top cited scientists by field and country. *Scientometrics* **2020**, *125*, 2421–2447. [CrossRef]

46. Robinson-Garcia, N.; Costas, R.; Sugimoto, C.R.; Larivière, V.; Nane, G.F. Task specialization across research careers. *eLife* **2020**, *9*, e60586. [CrossRef] [PubMed]
47. Aref, S.; Zagheni, E.; West, J. The demography of the peripatetic researcher: Evidence on highly mobile scholars from the web of science. In *Social Informatics. SocInfo 2019*; Weber, I., Ed.; Lecture Notes in Computer Science; Springer: Berlin/Heidelberg, Germany, 2019; p. 11864.
48. Available online: https://sfdora.org/read/ (accessed on 14 May 2024).

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