Characterizing scientific production of Italian Oral Surgery professionals through evaluation of bibliometric indices

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Summary

The aim of this study was to characterize the scientific production of Italian Oral Surgery professionals by evaluating different bibliometric indices. The bibliometric evaluation was conducted on the Scopus Database upon all the Active Members joining three important Italian scientific societies in Oral Surgery (SIdCO, SIO, and SICOI). The scientific production was analysed by considering the number of total publications, number of total citations, h-index, and hc-index. Moreover, the overall sample was divided into two groups (*Academics* and *Not Academics*), according to the fact the professionals had or not a university position, and then into sub-groups according to the different career lengths. Statistical analyses were performed to compare the scientific productivity amongst groups. For all the considered parameters a lack of homogeneity between groups was reported, and significantly greater mean values were recorded for the *Academics* compared to the *Not Academics* Group. Moreover, the h-index values increased more regularly as the career length progressed than the hc-index values, even if the last seemed to be less variable. h- and hc-indices are both stable bibliometric parameters, but as the hc-index values are related not only to the number of citation but also to their age, it seems to be less influenced by the authors' career length. Bibliometric analysis of the scientific production in dentistry may facilitate the recognition of factors that may further enhance research activity and clinical performance and be useful for a comparative assessment of authors or research groups in terms of quality and quantity of the scientific production.

Key words: career length, contemporary h-index, h-index, oral surgery, scientific production.

Introduction

Recently, scientific research in dentistry gained great importance due to the technological innovation in materials and techniques, which were also introduced in this field, and not less important, in order to improve the quality of dental care. Nowadays, even more dental professionals are involved in dental research, not only researchers with a University position. The diffusion also of national and international scientific societies improved the interest of the clinicians in dental research, both in an indirect way by showing their interest in meetings participation and in staying up to date on innovations, and both directly, by conducting primary or clinical research. In order to evaluate the quality and the impact on society of this scientific activity, many different bibliometric indices were introduced (1). The bibliometric analysis conducted on a group of authors is important because it allows to monitor the scientific development in that specific research field, to permit an efficient allocation of research funds, to improve the research activity in a determined field, to reward structures that host "high quality" researchers, and to verify the presence of inefficiencies (2).
Characterizing the scientific production of a single author or of a group of professionals involved in scientific and clinical research is currently a complex process, which is not based on a standardized methodology, and that often uses criteria not entirely satisfactory for both the researchers and institutions (3).
Nowadays, the bibliometric evaluation in the medical field is possible by consulting numerous databases on the World Wide Web, each offering search facili-

ties on a particular subject. The scientific research posed many questions about what tools and which database is best to use and what are their features, even if a common idea has yet to be achieved (4).
Evaluation of different bibliometric indices is one of the best known methods for analyzing the entire scientific production of an author or group of authors in order to detect the historical development, the quantitative amount and the qualitative impact of scientific studies. This method turns out to be at the same time also the most criticized, because of the many variables that may be included in this evaluation (5).
For example, the evaluation of the absolute number of publications or citations often does not allow to evaluate in a proper way the entire research activity of an author, and often it is not useful to compare two authors. Therefore, many other indicators were introduced and are currently used in order to perform these evaluations (6).
One of the most popular and useful index for the evaluation of an author's scientific production is the h-index, suggested by Hirsch J., and its variables. The h-index is defined as the highest number of papers of a scientist that have been cited *h* or more times (7).
The h-index is simple to calculate and allows in a synthetic way to determine both the quantity and the quality of an author's scientific production, based on both the number of publications and the number of citations each publication received. The total number of publications give back, by scientific insight, the production of a specific author, while the number of citations made from the scientific community, give the opportunity to verify the best researchers, works and institutions, as well as the most common areas of research or interest, based on the assumption that the most interesting scientific contributions are also those that are most frequently cited (6). From its introduction, the h-index was already applied to several disciplines, such as Physics, Biology, Biomedicine, Healthcare, etc. (6).
Many researchers pointed out some drawbacks of the h-index, related to several different variables which influence the assessment of scientific output of a researcher. Moreover once a paper has reached the number of citations which qualifies it for the core set, then further citations are irrelevant (7, 8).
An other criticism could be that no other kind of production such as books, chapter in books or proceedings are being considered, neither publications in journals that are not part of the database used for the author's search, no matter how many times they are cited (9, 10).
Many authors consider the h-index roughly influenced by the career length, as its value is likely to increase linearly with time. A time related index was proposed by Sidiropoulos et al., the contemporary h-index (11).
These authors investigated how this index could be adapted to take into account the age of the papers, thus differentiating between senior scientists that have received many of their cites due to papers published a long time ago and brilliant young scientists who produced a large number of significant publications but that nowadays have a small number of important papers due to the time constraint, and the age of the cites that would allow to identify scientists whose contributions are still influential even if they were published a long time ago.
In fact, the h-index does not decline with the passing of time, and likely an author may maintain unchanged its h-index value even though he may not have any published scientific articles in recent (12, 13). Differently, the contemporary h-index, by assigning a different weight to the most recent publications compared to older ones, favors the authors with a substantial recent scientific production respect to not more "scientifically active" researchers (1, 14, 15).
The aim of this study was to characterize the scientific production of Italian Oral Surgery professionals by evaluating different bibliometric indices, and to compare the performance of h-index and hc-index in mirroring the scientific production distribution among researchers with different career lengths.

Materials and methods

Experimental parameters

All data were found and recorded from January 7 to January 19, 2013. For each author were considered publications and related citations indexed in SciVerse® Scopus database until 31 December 2012; on the other hand, were excluded from the calculation at the time of data acquisition, articles published from January 1, 2013 and 2013 citations of articles published until December 2012.

Selection of the study population

The list of Italian professionals involved in Oral Surgery was obtained by selecting the Active Members of the 3 most important Italian scientific societies in Oral Surgery, SIdCO (Italian Society of Oral Surgery, SIO (Italian Society of Osseointegration), and SICOI (Italian Society of Oral Surgery and Implantology), downloadable online (http://www.sidcoinforma.it/, http://www.sicoi.it/, http://www.osteointegrazione.it/, respectively). All researchers names were included in a Microsoft Excel file created ad hoc. The overall population was firstly divided into two different groups, depending on the member belonging to a university setting or not, named *Academics* and *Not Academics*, respectively. The overall sample was then further divided into sub-groups according to the different career length, where the definition of career length of a researcher was used to identify the period since his first publication to 31 December 2012. The sub-groups were obtained by dividing the *Academics* Group into tertiles according to their career length, and the *Not Academics* Group into quartiles (Tab. 1).

Data collection

The database chosen for the collection of data bibliometric was SciVerse® Scopus (www.scopus.com). The bibliometric data collection was performed by three operators with experience in the field of literature search. In accordance with the site instructions to search for author, for each name in the "Author Search", (http://www.scopus.com/search/form.url?display=authorLookup&clear=t&origin=searchbasic&txGid=4GSgDGaqqvp9pwfgYXjS7W8%3a3) the following data have entered: surname, first names, and in subsection "Subject Areas" have been checked items "Life Science" and "Health Science". It was decided to include only the initials of the name to prevent possible loss of data due to the fact that some publications, not showing the name of the author, cannot be traced by the system. After viewing the search results, it was proceeded to click on the "Show Profile Matches with One Document", where present, to include in the calculation of the total profiles with a single publication that were not shown in the first instance.
In cases of same name and surname or mismatch of affiliations among the results, profiles that were not attributable to the contact examined were excluded at the discretion of operators according to the researcher's topics of interest, the scientific production of the author and the time period in which it was produced, in order to enclose in the most faithful way as possible the scientific production of the same author. Total number of publications were calculated regardless of the type of all indexed publications on Scopus (at example: proceddings, review, article, letters).

Data recording and characterization of the scientific production

For each researcher, the following parameters were derived from the authors Scopus data: total number of publications, total number of citations, and h-index. The corresponding hc-index was calculated using the ABILITANVUR v0.9, 2012-11-15© software (Vincenzo Della Mea, University of Udine http://mitel.dimi.uniud.it/varia/abilitanvur/), through the achievement of a file ad hoc (.csv) where every single publication from each author were reported including the data of publication and the number of citation in the format (year,citation). All this parameters were inserted into spreadsheet Office Excel 2007 (Microsoft Corporation. Redmont, Washington State) containing the authors and each numeric value was formatted to three decimal fraction (Tab. 2).

Table 1. Groups definition and numerosity. (x = career length is defined as the number of years since each professional's first publication to December 31st 2012.)

Groups	Definitions	Sample size
Total sample	Active Members having at least one scientific publication indexed on Scopus	n=214
Academics	Active Members of the Italian scientific societies analyzed belonging to a university setting	n=58
10≤x≤23	Authors career length comprised between 10 and 23 yrs	n=19
24≤x≤29	Authors career length comprised between 24 and 29 yrs	n=22
30≤x≤43	Authors career length comprised between 30 and 43 yrs	n=17
Not Academic	Active Members of the Italian scientific societies analyzed not belonging to a university setting	n=156
1≤x≤7	Authors career length comprised between 1 and 7 yrs	n=40
8≤x≤16	Authors career length comprised between 8 and 16 yrs	n=44
17≤x≤28	Authors career length comprised between 17 and 28 yrs	n=38
29≤x≤50	Authors career length comprised between 29 and 50 yrs	n=34

Table 2. Indicators formulae used in the study

Indicator	Description	Formula
Total Publication	Total number of pubblication for each author found on Scopus until December 31st 2012	$Doc_1 + doc_2 + \ldots . doc_n$
Total Citations	Total number of citation for each author found on Sopus database until December 31st 2012	$Cit_1 + cit_2 + \ldots . cit_n$
h-index	Hirsh-index resulted from the author's account of Scopus database	*Index h: h of his Np have h citations each and the other (Np - h) papers have ≤ hc*
hc-index	Contemporary H index variable of Hirsh-index calculated from the Abilitanvur online software	$S(I,t)=4/(t-t_1+1) * C(I,T), t >= t_1$

Statistical analysis

Researchers showing 0 publication were excluded from the statistical analysis. All the analysis were conducted on the total population sample and for each group considered. Data were processed to calculate median, interquartile range (IR), coefficient of variation, and range (R) of the following: the number of total publications, number of total citations, h-index, and hc-index. Kurtosis test was performed in order to assess data distribution. Data were then analysed by the Wilcoxon test, in order to check whether there was statistically significant difference between the groups, using the add-in for Microsoft Excel, PHStat2 (Prentice Hall, Inc., Pearson Education). Each statistic test was considered true when the probability value (p-value), compared with the desired significance level of our test ($p < 0.05$), was smaller.

Results

Characterization and impact of scientific production

In this study, a total of 260 Active Members belonging to the three main Italian scientific societies involved in Oral Surgery, SIdCO, SIO, and SICOI, were selected. Between all the Active Members considered, 83,4% of them (n=214) had at least one scientific publication indexed on Scopus database, and were considered for the bibliometric analysis.

The overall data, related to the total population, proved the scientific production distribution of those professionals to be rather uneven, by considering the median value of 11 (IR: 3 - 34). Also according the number of citations per researcher, a median of 4 (IR: 9 - 191.75) was recorded, revealing a high variability between the overall sample. Similarly, the median h-index was 4 (IR: 1-7), while the median hc-index was 3 (IR: 1 - 6).

By considering the overall population, the scientific production in the last ten years represented about 68.95% compared to the total scientific publications of the samples (data not shown). All the Active Members were divided between the *Academics* and *Not Academics* Groups, as previously described. Among the Active Members of the scientific society considered, the *Not Academics* (n=156) were more numerous than the *Academics* (n=58).

In particular, the *Academics* showed a median value for total number of publications significantly higher (36.5; IR: 22.25 - 66.5) than *Not Academics* (6; IR: 2 - 20.25).

As regards the other parameters considered, i.e. the number of citations, the h-index and hc-index, it was possible to notice a lack of homogeneity between the *Academics* and the *Not Academics* Groups, as described in Table 3.

Furthermore, the distribution of the overall scientific production among researchers with different career length was evaluated both for the *Academics* and *Not Academics*. Data regarding the different sub-groups were reported in Tables 4 and 5. In particular, it could be noted that the h- and hc-index did not have a continuous increase along with the progression of an author career, as with the increasing number of total publications and citations. As for the median h-index in the *Academics* group, it was found to remain stable when considering the researchers with a career length of more than 24 years, while a peak of hc-index could be recorded for the subgroup with a career length between 24 and 29 years. As for the *Not Academics* group, a slight gradual increase of the h-index median values was observed, while the highest hc-index median value was recorded for the researchers with a long career.

Discussion

Approaching a bibliometric analysis, the crucial initial point is the choice of the best database where finding data with minor risks to have bias or mistakes for authors' scientific production. Among the more known databases for bibliometric evaluation, we considered SciVerse® Scopus was used for this study. In the opinion of the authors, Scopus appeared to be the most complete database with the largest bibliography of abstracts and citations in the scientific literature. Scopus indexes nearly 18,000 journal titles (mostly peer-reviewed journals) in the scientific, medical, technical, humanities and social sciences, published from more than 5,000 publishers, and is regularly updated (16). Among the most important features, Scopus citation can easily derive the h-Index of the authors allowing to make the citation analysis of authors and publications (through the Citation Tracker) and to carry out the analysis of the profile of the authors and affiliations. However, it has the considerable limit that it calculates the h-index without taking into consideration papers published prior to 1996; in this way authors with a scientific production more limited in time have an advantage (2).

Other databases were also evaluated before using SciVerse® Scopus for this study. With regard to ISI Web of Science, although easy to use because it incorporates the calculation function h-index, it possesses several "weak points". First, the database includes only the journals that are listed in the Thomson Reuters (17). Consequently, the scientific production of an author may be severely underestimated because of the absence of some publications. In addition for the reasons set out above, in calculating the h-index of an author, all citations made in journals not indexed in ISI Thomson Reuters database are excluded, whereby the result does not respond to a precise mathematical calculation. Finally, from the citations report are excluded all references showing even small errors in the formatting or writing.

Also the databases which can be accessed for free, as Medline and Google Scholar, have some limitations. Even if, Medline was found to be the database

Table 3. Characterization of the overall scientific production of the Active Members and comparison between the Academics and Not Academics Groups.

	Total publications			Total citations			h-index			hc-index		
Group	*Total Sample*	*Academics*	*Not Academics*	*Total Sample*	*Academics*	*Not Academics*	*Total Sample*	*Academics*	*Not Academics*	*Total Sample*	*Academics*	*Not Academics*
Median	11	36.5	6	59	196	31	4	7	2	3	6	2
Interquartile range	3-34	22.25-66.5	2 – 20.25	9-191,75	70-541.75	4-112.75	1-7	4 – 11.75	1 – 5	1-6	4 - 10	1 – 4
Coefficient of variation	1,78	1,351	0,694	2,66	2,029	1,921	1,11	0,812	1,1	0,96	0,654	1,004
Range	1-584	9 - 584	1 - 106	0-7187	2 - 7187	0 - 1487	0-41	1 - 41	0 - 22	0-23	1 - 23	0 - 15

Table 4. Characterization of the Active Members with a University setting divided into tertiles according to their career length.

	Academics											
	Total publications			Citations			h-index			hc-Index		
Group	10 ≤ x ≤ 23	24 ≤ x ≤ 29	30 ≤ x ≤ 43	10 ≤ x ≤ 23	24 ≤ x ≤ 29	30 ≤ x ≤ 43	10 ≤ x ≤ 23	24 ≤ x ≤ 29	30 ≤ x ≤ 43	10 ≤ x ≤ 23	24 ≤ x ≤ 29	30 ≤ x ≤ 43
Median	21	39	59	122	199	225	6	8	8	6	7	6
Interquartile range	14-41,5	25,5-62,5	36-105	42-303,5	80-703,5	80-590	4-8,5	6-14,5	5-12	4-8,5	4-12	4-10
Coefficient of variation	1,139	0,752	1,31	1,992	1,273	2,184	0,873	0,696	0,867	0,667	0,596	0,68
Range	10-191	10-156	23-584	7-3179	56-2121	31-7187	2-31	3-27	2-41	2-18	2-19	2-23

Table 5. Characterization of the Active Members without a University setting divided into quartiles according to their career length.

	Not Academics															
	Total publications				Citations				h-index				hc-Index			
Group	1 ≤ x ≤ 7	8 ≤ x ≤ 16	17 ≤ x ≤ 28	29 ≤ x ≤ 50	1 ≤ x ≤ 7	8 ≤ x ≤ 16	17 ≤ x ≤ 28	29 ≤ x ≤ 50	1 ≤ x ≤ 7	8 ≤ x ≤ 16	17 ≤ x ≤ 28	29 ≤ x ≤ 50	1 ≤ x ≤ 7	8 ≤ x ≤ 16	17 ≤ x ≤ 28	29 ≤ x ≤ 50
Median	2	6	7	32	5	54	42	108,5	1	2,5	3	4	1	2,5	2	3
Interquartile range	1-3	2,25-17,5	3-19	9,25-55	1-11,5	22-145	7-109	11,75-263,75	1-1,5	1-5,75	2-6	2-7,75	1-1	1-5	1-5	1-6
Coefficient of variation	1,72	1,491	1,427	0,791	1,847	1,136	1,947	1,355	0,901	0,792	1,135	0,855	0,852	0,761	1,052	0,835
Range	1,35	1-106	2-105	1-90	0-101	1-415	0-1487	0-1113	0-5	1-11	0-22	0-17	0-4	1-10	0-15	0-11

which is updated with the greatest regularity and thus able to provide an overview of the most current scientific production of an author, it dids not have a report or a function that can take into account the citations of each publication and therefore cannot allow the calculation of the h-index and other indices for the assessment of the appreciation of a given publication (18).
As well as other databases, Publish or Perish on Google Scholar is not able to trace the entire scientific output of an author, even if studies showed that it is accurate enough to evaluate properly the scientific productivity of an author. Indeed, this database seemed to have a higher coverage than the other with regard to citations to articles on book chapters and conference proceedings, as well as journals in languages other than English, and seemed to have good coverage for very dated publications. Publish or Perish contains functions able to perform an analysis of the scientific production of the author, including even the automatic calculation of various indices, including the h-index, the m-index, the g-index, the e-index, but it seemed to be less accurate than Scopus in discriminating researchers with similar surnames and names (1, 12).
In the present study, by considering the overall population of Active Members joining the three most important Italian scientific societies in Oral Surgery, a very heterogeneous sample could be recorded, as shown by the Kurtosis test and the coefficient of variation.
Considering the total number of scientific publications, the data showed that more than half of the publications have been produced in the last ten years. This result confirms the validity of the Italian scientific research in the field of oral surgery and how this research has been increasing in recent years.
As expected, the bibliometric analysis showed a significant difference in scientific production between the *Not Academics* group and the *Academics* Group of professionals belonging to the main scientific societies of surgical specialties in dentistry, both in qualitative and quantitative terms. In fact, by analyzing the distribution of all the analysed parameters, significantly higher values could be detected in the *Academics* Group. In the *Not Academics* group, more than 20% of the researchers evaluated did not have any scientific publication indexed in Scopus. This finding can be explained by considering that a professional, unlike a university professor, have more difficulties in being engaged in scientific research.
The h-index and hc-index values recorded suggest that the Italian scientific production in Oral Surgery presents points of excellence, although the median values indicate the presence of few researchers with scientific production quantitatively valid and continuous in time.
The h-index can detect the actual influence of an author on the scientific community, irrespective of the fact that he may have published individual articles of great success or many articles with low number of citations (4).

a. The h-index is represented by a natural number, usually belonging to a small set, which then has, as they say in mathematical jargon, a low resolution, which is determined by a flattening of the values of h-index of researchers, which penalizes those that have a high number of citations compared to those who have less, making the gap between them less noticeable.
b. While some databases penalize “old” researchers, the h-index penalizes “young” researchers, as the more recently published papers are less likely to be cited in other articles just because they did not have enough time to accumulate citations.
c. The h-index is a realistic way to assess the scientific value of an author if its production is spread over 10 years. On the contrary, the h-index could be an advantage for those who have published extensively in the past but whose scientific production in recent years has been reduced or even stopped because the older articles have had more time to be cited by others despite the interest of the scientific production is expected to be very low considering the scientific progress occurred at the same time.
d. In the computation-index there could also be a massive loss of information, since by definition the h-index equals the number (N) of articles that have received a number of citations greater than or equal to N. Items that have received a substantial number of citations did not affect the h-index. To give an example, if an author has an h-index of 5, it means that 5 of its articles have been cited each a number of times equal to 5 or more. In this calculation the total number of citations is not considered, therefore if one or more of these articles has a very high number of citations, the final value of the h-index does not change, and it may be equal to the h-index of an author with a smaller number of citations.
e. One of the most criticized aspects of h- index is the possible influence of self-citations. Self-citations do have a great impact on the h-index, especially in the case of young scientists with a low h-index.

The hc-index is based on the normalization of citations based on the elapsed number of years since the paper has been published. It takes into consideration the age of an article (19). A scientist, for example, has a number of significant articles that produced a large h-index, but recently he became rather inactive or was retired. Therefore, senior scientists, who still keep their contributions, or brilliant young scientists, who are expected to contribute a large number of significant papers in the near future but now have only a small number of important articles due to the time elapsed, are not distinguished by the original h-index. Both indices could have a high value, because they showed a low coefficient of variation in an independent way from the groups considered.
The comparison between h-index and hc-index confirmed how this variable reduced discrepancies in evaluating the scientific production of a group of au-

thor. Moreover, the h-index was found to gradually increase along with the number of publications and citation in each group and to remain stable when considering the researchers with longer career length. Otherwise, hc-index, for its nature, tends to vary less significantly as the professionals career gets longer, thus allowing to compare in a more equal way the scientific production of researchers with a different career length (2).

Conclusions

It should be reported that the results of a bibliometric analysis conducted on the basis of these indices, though providing synthetic measurements, can not be immediately translated into absolute qualitative assessments. In fact, the citation analysis, besides specific considerations regarding reliability, availability and solidity of the data, was not able to fully assess the applied research, or career path a researcher in its entirety, but it can be used for an assessment for the comparative evaluation of different authors or research groups.

References

1. Khan NR, Thompson CJ, Taylor DR, Gabrick KS, Choudhri AF, Boop FR, et al. Part II: Should the h-index be modified? An analysis of the m-quotient, contemporary h-index, authorship value, and impact factor. World Neurosurg 2013;doi:pii: S1878-8750(13)00825-5. 10.1016/j.wneu.2013.07.011.
2. Ball P. Index aims for fair ranking of scientists. Nature 2005;436:900.
3. Jazayeri SB, Alavi A, Rahimi-Movaghar V. Situation of medical sciences in 50 top countries from 1996 to 2010—based on quality and quantity of publications. Acta Med Iran 2012;50:273-278.
4. Han WD, Yu Q, Wang YL. Comparative analysis between impact factor and h-index for reproduction biology journals. J Anim Vet Adv 2010;9:1552-1555.
5. Falagas ME, Pitsouni EI, Malietzis GA, Pappas G. Comparison of PubMed, Scopus, Web of Science, and Google Scholar: strengths and weaknesses. FASEB J 2008;22:338-342.
6. Alonso S, Cabrerizo FJ, Herrera-Viedma E, Herrera F. h-index: A Review Focused in its Variants,Computation and Standardization for Different Scientic Fields. J Informetrics 2009;3:273-289.
7. Hirsch J. An index to quantify an individual's scientifc research out-put. Proceedings of the National Academy of Sciences 2005;102:16569-16572.
8. Patel VM, Ashrafian H, Ahmed K, Arora S, Jiwan S, Nicholson JK, et al. How has healthcare research performance been assessed?: a systematic review. J R Soc Med 2011;104:251-261.
9. Schreiber M. Twenty Hirsch index variants and other indicators giving more or less preference to highly cited papers. Phys 2010;522:536-554.
10. Kellner AW, Ponciano LC. H-index in the Brazilian Academy of Sciences: comments and concerns. An Acad Bras Cienc 2008;80:771-781.
11. Sidiropoulos A, Katsaros D, Manolopoulos Y, Generalized hirsch hindex for disclosing latent facts in citation networks. Scientometrics 2007;72:253-280.
12. Bakkalbasi N, Bauer K, Glover J, Wang L. Three options for citation tracking: Google Scholar, Scopus and Web of Science. Biomed Digit Libr 2006;29:3-7.
13. Thompson DF, Callen EC, Nahata MC. Publication metrics and record of pharmacy practice chairs. Ann Pharmacother 2009;43:268-275.
14. Ugolini D, Parodi S, Santi L. Analysis of publication quality in a cancer research institute. Scientometrics 1997;38:263-274.
15. Chacín-Bonilla L. H-index: a new bibliometric indicator of the academic activity. Invest Clin 2012;53:219-222.
16. Bakkalbasi N, Bauer K, Glover J, Wang L. Three options for citation tracking: Google Scholar, Scopus and Web of Science. Biomed Digit Libr 2006;3:7.
17. Kelly CD, Jennions MD. The h-index and career assessment by numbers. Trends Ecol Evol 2006;21:167-170.
18. Cabezas-Clavijo A, Delgado-López-Cózar E. Google Scholar and the h-index in biomedicine: The popularization of bibliometric assessment. Med Intensiva 2013;37:343-354.
19. Cronin B, Meho L. Using the h-index to Rank influential Information Scientists. J Am Soc Inf Sci Tec 2006;57:1275-1278.