A New Index for Evaluating Academic Performance: *Hos* - index

Handan Ankarali[1], Ozge Pasin[2] and Seyit Ankarali[3]

[1] **Biostatistics Department, Faculty of Medicine, Istanbul Medeniyet University, Istanbul, 34100, Turkey**

[2] **Biostatistics Department, Faculty of Medicine, Istanbul University, Istanbul, 34110, Turkey**

[3] **Physiology Department, Faculty of Medicine, Istanbul Medeniyet University, Istanbul, 34100, Turkey**

Abstract

In this study, development of a new index named as *Hos* index recommended to eliminate h-index's disadvantages, has been aimed. *Hos* index, considers all publications of scientist. It has been calculated, according to number of citations to publications, by weighting increasingly and removing the effect of publishing start date. In Hos index development, by examining number of citations, number of publications and h-index values, with the help of stratified sampling, a sample selected from 5 counties from 5 continents has been created. Number of citations and effect of publishing start date has been calculated by multiplying and adding number of publications within designated citation intervals with the highest level of percentile value. By dividing this value by the difference between the first and last publication year of scientist, performance value adjusted according to publishing start date (*Hos* index) has been obtained. In calculation of this index, different weightings are given to researcher's all publications that are cited and uncited.

Keywords: *Academic performance, h-index, Google Schooler, Web of Science, g-index, e-index*

1. Introduction

Scientist always update himself, investigates the truth and has a critical questioning structure. In line with these abilities he/she produces new publications continuously. At all stages of their lives scientists are engaged in academic activities and has been conducting publications of interest in order to be beneficial to its environment. Besides the number of publications, other criteria to consider are the originality and quality of the publication.

By the search engines for scientific researches created in the last years by various Corporation or publishing firms, articles written by scientists can easily be accessed. Accessibility provides mutual benefit both with respect to reader and the writer. While readers benefit from the scientific writings at maximum level, researches making publications cite from the writings read. As a result of this citations that the scientist takes from the publications effects the academic performance assessment significantly.

Major criterion used in academic performance assessment is the number of publication. It is a quantitate criterion. Of course the number of publication of a scientist being large is a precious situation but a scientist's having numerous publications does not mean that person is a successful academician. Nowadays academicians with the rush to make publications, may violate the codes of conduct and scientist becomes far away from the word sense. Thus in addition to the number of publication, quality of the publications made by the scientist has importance. A way to measure this quality is number of citations. The number of citation is indication of the scientific article as reference by others and is an important criterion in academic performance assessment. The criterion that needs to be considered while assessing the number of citation is publishing start date of scientist. A scientific article is not cited in the first year. But after 3-4 years, increase in the number of citation can be observed. Additionally if the publication belongs to very old years, as ageing of the publication is a matter, the number of citation of this publication might decrease. Another criterion that has to be assessed for the number of citation is science discipline variety. For example generally, researches who work in social sciences have less citation than researches who work in health sciences. Also the number of citation of health researchers may even differ to their study area. Therefore, while academic performance is evaluating, an adjustment should be made according to the publishing start date, science discipline as well as the number of citation.

A method or coefficient that assess academic performance in perfect of a scientist completely has not been developed yet. Developed performance criteria are open to critic and new index criteria or coefficients continuously until present are recommended. These coefficients are named as index and can be calculated in data bases like Google Scholar, Web of Science, and Research Gate. Among subject indexes, the oldest and most commonly used index is named as h-index [1-10]. H-index, is an index that is easy to calculate. However it has some disadvantages in assessing the performance accurately. First of these is that the index doesn't take un-cited publications into consideration in academic performance assessment. But, not being cited does not mean that the publication is worthless or has low scientific value. Because the reason of being un-cited may be being a new published article or being published in an unrecognized journal and in a specific language or being made in a specific discipline. But, these publications have contribution to the index is necessary. Second disadvantage of h-index is that it does not take the first publication year of scientists into consideration. Accordingly high results in h-index of researches whose first publication year is old become unavoidable. In addition to aforesaid disadvantages, h-index and some other indexes are not calculated separately according to science discipline. Thus it is ignored that some researches made in some discipline are read more as they include more trending issues.

The purpose of this study is to define a new index that will remedy the deficiencies in performance assessment of indexes taking place in literature. Recommended new index has been named as Hos index. This index, assesses academic performance by considering scientist's all publications in literature, and by giving weightings changing according to the number of citation of these publications and besides removing the effect of publishing start date. Furthermore this index can be used for field specific. Hos index can be defined by applying steps used in index calculation in each science discipline.

2. Materials and Methods

2.1 Commonly used indexes to assess academic performance

Some key index criteria used in academic performance assessment have been explained as summary below.

h-index: It is widely used in science world due to its easiness in calculating and understanding. h-index is defined as "A scientist has index h if h of his/her Np number of publications have at least h citations each, and the other (Np-h) publications have no more than h citations each" [1]. Calculation of the index starts with the question whether there is a publication cited at least once or not, this process continues with number of publications cited at least two, three… and h index is calculated. The number of publication and the number of citations, after points are placed on x and y axis, a curve through these points is drawn. Drawing a bisector to the graph follows this. Projection value of junction point of bisector and the curve on x or y axis gives the h-index value (Fig. 1). For example a scientist with 60 h-index, means that 60 or more citations have been made to 60 publications of this scientist.

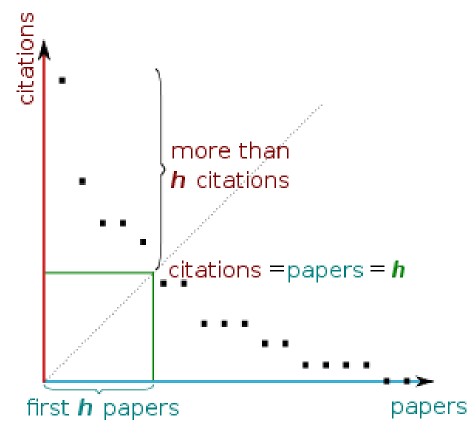

Fig. 1. H-Index (Hirsch 2009)

H-index considers the number of citations more that publication place of the study. It does not become a dramatically skewed distribution when numerous citations are made to only one publication. Numerous publications having few citations does not increase H index value. H-index does not only compare individuals, it also provides opportunity to compare departments, divisions, programmes or scientists in different groups. Furthermore it is pretty successful in comparing scientists in the same phase and same division. H-index does not consider the number of scientist and their order, duration of publication namely difference between the publishing start date and recent publishing date. Furthermore in calculations h-index value of a scientist who's the number of publication is low but the number of citation is high may be high. In order for h-index to be calculated, the investigator must have a certain number of publications. It is calculated based on the previous data, cannot be used for predictions in future performance. It is difficult to get high points from h-index. For example, h-index being 100 is equal to have minimum 10.000 number of citations. H-index can only have the value at most equal to the number of publication no matter how the number of citation is large (Hirsch 2009). Scientist, even if they have very different publications and number of citation, can have the same h-index.

IJCSI
www.IJCSI.org

g-index: When compared to h-index, it concentrates more on number of citations in performance assessment. Index, realizes a calculation based on distribution of number of citations by sorting the publications according to number of citations in a decreasing structure. g-index, defines g number of publications which had been cited g^2 or more in total and is calculated as shown below. Therefore g-index may be higher than h-index (Egghe 2006).

$$g^2 \leq \sum_{i \leq g} c_i$$

$$g=\left(\frac{\alpha-1}{\alpha-2}\right)^{\frac{\alpha-1}{\alpha}} T^{1/\alpha}$$

When there is α>2 between h-index and g-index, a relation as shown in Fig. 2 (Egghe 2006).

$$g=\left(\frac{\alpha-1}{\alpha-2}\right)^{\frac{\alpha-1}{\alpha}} h \quad \alpha > 2$$

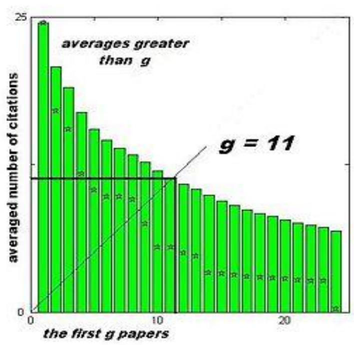

Fig. 2. *g*-index (Egghe 2006)

Lotkaian prime, T is the total number of publications. g-index separates the related impact values between two author more clearly. However in order to calculate g-index, very long and numerous tables are needed. g-index generally takes values larger than h-index, being less than total number of publications. Thus scientists with few citations are also considered. g-index is not limited only with total number of publications. But it is not a suitable measurement in assessing author groups with few numbers. Furthermore g-index which can take only whole number value, gives similar point values to author with very different number of citations. That's why it makes a difficult differentiation in measuring different scientist performances (Egghe 2006).

AR index: It has been recommended to eliminate some disadvantages of h-index. h-index is not an index sensitive to assess performance differences. Decrease is never observed. That's why AR index has been developed. AR index, is defined as root of total of average number of citations of publications in each year (Jin 2007).

$$AR=\sqrt{\sum_{p\ in\ h} \frac{cit_p}{a_p}}$$

In this formula, h, indicates score; p, number of publications; cit_p number of citations and a_p indicates year of p number of publications. The reason why the method is named as AR is that it is based on age and calculated with root. If all cit_p's are equal to h and all a_p's are equal to 1, AR index is equal to h-index. A better assessment can be made by giving h and AR indexes together (Jin 2007).

HG index: It has been developed by eliminating disadvantages and protecting advantages of h and g indexes and by combining h and g indexes. *HG* index of a researcher is calculating by calculating the geometric mean of h and g indexes. It is pretty easy to understand hg index and it can be compared with other indexes (Cabrerizo et al. 2009).

$$hg=\sqrt{hg}$$

Here h ≤ hg ≤g and hg-h ≤ g-hg. *hg* index takes more close value to h-index (Alonso et al. 2010).

H(2) index: H-index provides a suitable assessment possibility mostly for experienced author (for example who has 50 publications or at least 10 h index) and it cannot make a calculation by considering author's surnames before and after marriage or may calculate wrong values when author's names and surnames are similar. Therefore complete verification of the author takes a long time. In order to eliminate this disadvantage H(2) index has been recommended. This index, indicates that in H(2) publications that are most cited, there is at least 〖H(2)〗^ citations. For example H(2) index being 10, indicates that 10 publications have been cited at least 100 times. In this index author working in different fields cannot be compared. Authors with different ages cannot be compared. When a person cites himself again index value increases. When compilations are published index value increases easily. H(2) index is used more in chemistry and physics fields as citations per publication are less when compared to other science discipline (Kosmulski 2006).

m index: When number of citations has skew distribution, median shall be used instead of mean. For this reason m index, uses the median of total number of citations of publications. m index is also known as m quotient. It takes differences during academic career also into consideration. It is a version of h-index adjusted according to experience periods. This index value is calculated by dividing h-index value by active year number (active year number since the first publication) in order to compare authors having different experience periods (h/n) (Bornmann et al. 2008).

h_w index: This index, is a weighted version of h-index with citation impact. Similar to AR index it is calculated as given below (Egghe and Rousseau 2008).

$$h_w = \sqrt{\sum_{j=1}^{r_0} cit_j}$$

Here r_0 j, is the biggest line of the index and $r_{w(j)} = cit_j$. Furthermore h_w index takes value between h $\leq h_w \leq$ g (Egghe and Rousseau 2008).

q^2 *index:* This index is calculated by taking geometric average of h and m indexes. The reason why h-index is taken is that it takes number of publications as base of productivity, and the reason why m index is taken is that it takes publication impact as base of productivity and that m index can be used in skewed citations. The developed index provides a more global point of view for scientific productivities of authors. When h and m index values are calculated, this index value can be obtained easily $q^2 = \sqrt{hm}$ (Cabrerizo et al. 2009). It gives a more detailed information when compared to h-index. An increase in h or m will cause increase also in q^2 automatically. As it is concerned with both quantitative and qualitative dimensions of the author, instead of using only h or only m index, by combining both, it provides more global decisions and more balanced assessments (Cabrerizo et al. 2009).

i10 index: Writer's total number of publications cited at least 10 times. It is easy to interpret and pretty easy to calculate. It can be calculated easily over Google scholar and it is free. But the index can only be used on Google scholar.

Tapered h index: Let's consider that the author has five publications and these publications have been cited 6, 4, 4, 2 and 1 times respectively. These values are known as Durfee square which is the biggest completed square of the points from top left in a graph named as Ferrers graph. H index is equal to the length of Durfee square. For this example h=3 (Anderson et al. 2008).

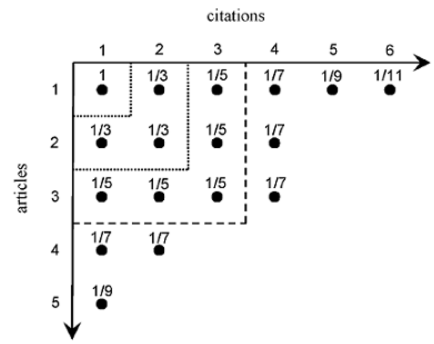

Fig. 3. Ferrers Graph [9]

As can be seen in Fig. 3., maximum number of citations takes place on x axis, and each publication number takes place on y axis. Numbers written on points (like 1/3) are obtained by dividing publication number by point number in the square. Namely for each publication it is divided by the width of Durfee square. For the above example scores of the five publications are 1,88; 1,01; 0,74; 0,29 and 0,11. When these scores are added together Tapered h-index is obtained. Mathematically it is calculated with below formula (Anderson et al. 2008).

$$H_{t(1)} = \sum_{i=1}^{n_1} \frac{1}{2i-1} = \frac{\ln(n_1)}{2} + o(1)$$

n_1, being the number of citations of the most cited publication, if the logarithm of $\ln(n_1)\, n_1$ is o(1) then n_1 is a mathematical term that approaches zero as it approaches infinite. Graph indicating the relation between n_1 and $H_{t(1)}$ is given in Fig. 4. (Zhang 2009).

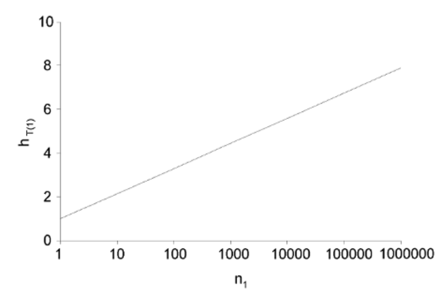

Fig. 4. Relationship between n_1 and $H_{t(1)}$

e-index: It has been developed as a simple complement to the *h*-index. The *e*-index was developed to represent very large number of citations ignored in the *h*-index and not considered in calculations. Index value is obtained from $e^2 = \sum_{j=1}^{h}(cit_j - h) = \sum_{j=1}^{h} cit_j - h^2$ equality. *h*-index and *e*-index can be shown in Fig. 5. (Zhang 2009).

IJCSI
www.IJCSI.org

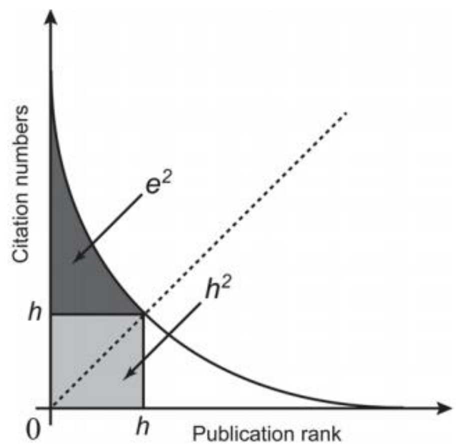

Fig. 5. H and e index (Zhang 2009)

Out of these above mentioned indexes, there are indexes developed time-dependently. Some of these indexes are trend *h*, dynamic *h* type, *k* index, specific impact *s* index, *f* index etc.

2.2. A New index "*Hos*"

Indexes commonly used in literature for the purpose of academic performance assessment have been explained shortly above. In this study, Hos index which is a new index for academic performance is recommended. By this index all publications of the scientist are taken into consideration. In this index, the weight or importance given to publications, varies according to the number of citations. Firstly, scientist's publications are grouped according to number of citations, and then each group is multiplied by a weighing coefficient and the values obtained are summed. Lastly, this value is divided by duration of publication. The duration of publication is difference between the publishing start date and recent publishing date of the scientist whose hos index will be calculated. In addition the lower and the upper limit values of these groups are determined by considering the median and mean values of the distribution of citations. Because this index coefficient can be take decimally values, it provides possibility for a better comparison of persons.

3. Results

For the purpose of obtaining *Hos* index formula, process has been started with Web of Metrics data primarily (http://www.webometrics.info/en/node/72). In this site there are Google scholar citations and academic performances of both scientists as individuals and corporations like universities are published. These information are revised and updated twice a year. Furthermore information related to scientists in many countries at many continents can easily be accessed. In published information, short profiles of authors, h-index value, i10 index value, publications and number of citations to these publications and total number of citations take place. However there may be incorrect results in these information sometimes. That is to say information of writers with the same name and surname may get mixed. Because author may make additions or change Google scholar information. That's why while developing *Hos* index, scientist from stratums designated to be in proportion with the person number taking place in Web of Metric site and taking place in list from countries from different continents have been selected randomly. Therefore 45 scientists from Turkey, 30 from Mexico, 41 from Saudi Arabia, 60 from Israel and 34 from New Zeland have been selected for sampling. Stratified grouping sampling method has been used in this sampling. Continents have been considered as stratums and a country from 5 different continents has been selected as a group. In group selection, countries including a large number of scientist and being heterogeneous have been taken into consideration. These groups (each of the countries) has been distributed into 3 different stratums. These stratums are scientists with low *h*-index value (those with *h*-index between 8-15), medium (those with *h*-index between 15-50) and high (those with *h*-index >50). Afterwards scientists have been selected from these stratums with at least 10 scientist from each. Web of Science search engine has been used to access better information of selected persons. In this site number of publications and number of citations of selected persons have been obtained. Number of citations of each scientist have been transferred to a separate column in SPSS (ver. 21). The purpose of these processes is to assess distributions of number of citations, and descriptive statistics of 210 scientists in total who were selected for sampling and to designate suitable citation intervals according to these information and to obtain weighting values of intervals. By selecting a few samples among scientists whose *h*-index value is high, medium and low, when distribution of number of citations is examined with histogram graph, shapes of distribution in Figure 6 have been obtained. These distributions are similar to chi-square with 1 degree of freedom. Number of citations took place on x axis, and the number of publications corresponding the number of citation is on y axis of the graphs. Distribution of citations to publications of scientists who take place in different countries and who has similar *h*-index values, has been found similar to each other. Even distribution of citations of scientists who has different *h*-index values has been similar to each other and generally indicated right-skewed distribution (Fig. 6).

IJCSI International Journal of Computer Science Issues, Volume 14, Issue 3, May 2017
ISSN (Print): 1694-0814 | ISSN (Online): 1694-0784
www.IJCSI.org https://doi.org/10.20943/01201703.7886

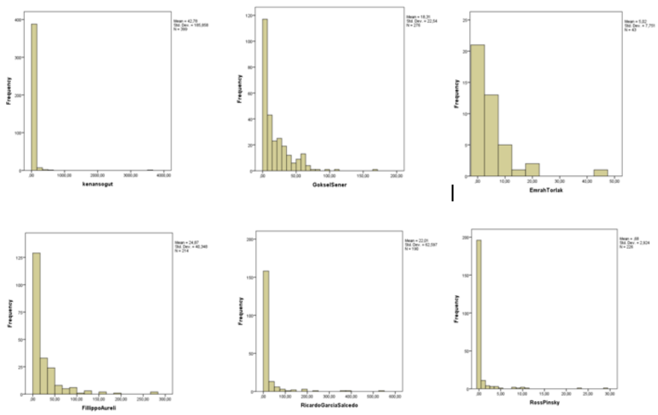

Fig. 6. Distributions of citations of all publications of some researchers who have various h-index

As distribution form of number of citations of 210 scientists in total selected to sampling did not change according to countries and indicated a right-skewed distribution. Number of citations of scientists taken into sampling have been gathered one under other after only one variable is obtained, descriptive values belonging this variable have been calculated. Mean±SD (standard deviation) of the citations to 31375 publications in total of 210 scientists in sampling has been calculated 22.5±84.5, and their median has been calculated as 6. Difference between mean and median values is another indicator that number of citations show a skewed distribution. Distribution of number of citations of 31375 publications is given in Fig. 7.

The highest number of citation in the sampling has been obtained as 5512. Various percentile values of number of citations of publications taken as sampled due to skewed distribution have been calculated and obtained findings has been presented as a whole in Table 1. According to selected percentiles intervals of number of citations taking place in numerator of formula of *Hos*-index recommended in this study and multiplication coefficient of these intervals (weighing values given to intervals) have been determined. When Table 1 is examined, it has been observed that number of citations are zero up to 30th percentile value, namely when 30% of 31375 publications which had the least citation is put aside, the most cited publications among these have 1 citation. Thus number of publications with have not cited have been multiplied with 0.30 coefficient. Publications which are found between 30% and 50% percentile of the distribution have been cited between 1 and 5, and these number of publications taking place in that interval has been multiplied by 0.50 coefficient. Publications which are found between 50% and 75% percentile of the distribution have been cited between 6 and 20, and these number of publications taking place in that interval has been multiplied by 0.75 coefficient. Publications taking place in interval between 75% and 90% of distribution have been cited between 21 and 50, these number of publications has been multiplied by 0.90 coefficient. Publications taking place in interval between 90% and 95% of distribution have been cited between 51 and 100, these number of publications has been multiplied by 0.95 coefficient. Finally among publications sorted ascendingly according to number of citations, the most cited 5% publications have been observed to be cited 100 times and number of publications cited more than 100 times have been multiplied with 1 coefficient. Publications taking place in top segments of the distribution namely those been cited in large numbers, is few, percentile limits have been designated with narrower intervals.

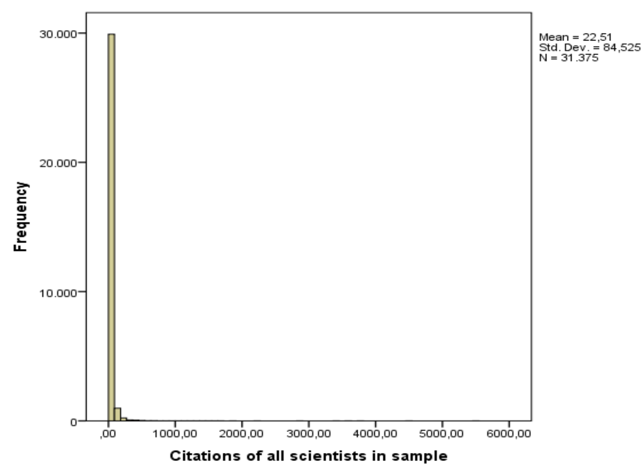

Fig. 7. Distributions of citations of all publications of 210 researchers in sample

Table 1. Descriptive values of citations of all scientists

Number of Publications = 31375	
Percentiles	Number of Citation
1	0
5	0
10	0
15	0
20	0
25	0
30	1
50	6
75	21
90	52
95	86
100	5512

Below equation has been used in *Hos* index calculation.

$$Hos\ index = \frac{(N_0 \times 0.30) + (N_{1-5} \times 0.50) + (N_{6-20} \times 0.75) + (N_{21-50} \times 0.90) + (N_{51-100} \times 0.95) + (N_{>100} \times 1.0)}{(Oldest\ publication\ year - Newest\ publication\ year)}$$

In this formula;

N_0: Number of publications with no citation
N_{1-5}: Number of publications with citation between 1-5
N_{6-20}: Number of publications with citation between 6-20
N_{21-50}: Number of publications with citation between 21-50
N_{51-100}: Number of publications with citation between 51-100
$N_{>100}$: Number of publications with citation more than 100

and 0.30, 0.50, 0.75, 0.90, 0.95 and 1.0 values are the top percentile value of the related interval.

As scientists assessed in this study have been selected in a way to represent general population, this indicates that citation intervals taking place in the formula can be used commonly in performance assessment. Additionally *Hos* index taking fractional values is an indicator that it will reflect difference between persons better. Besides as effect of duration of publications is eliminated, young and experienced scientists will be compared more accurately. By calculating *Hos* index separately for each science discipline, the impact due to science discipline can be eliminated. However distribution according to science discipline of citation intervals taking place in the formula must be examined separately. Scientists selected in this study have been selected without considering science discipline. For the purpose of presenting calculation steps of *Hos* index and its difference with respect to h-index, among scientists taken as sampling in the study, according to scanning results made in web of science, 8 scientists with different h-index value have been selected. Hos index and h-index values of these scientists have been given as a whole in Table 2. When Table 2 has been examined, h-index value of scientists whose first publication year is old has been observed to be high. Additionally as highly cited number of publications increases *Hos* index value has been observed to increase but h-index value has observed not to get effected directly from this increase. When data bases have been examined, number of citation of publications published before periods when internet is intensively used, have been observed to be much lower than publications especially after year 2000. This situation effects *h*-index values of related writers negatively. However hos index takes also these publications into consideration in performance assessment.

4. Discussion and Conclusion

For the purpose of academic performance assessment of scientists many index coefficients have been recommended and it is observed that at the present time still there is no index to be called as the best index. When criteria assessing the academic performance have been examined, it is seen that many index coefficients existing in the literature and being used in practice, intensify the calculations on cited number of publications (Hirsch 2009; Egghe 2006; Jin et al. 2007; Alonso et al. 2010; Kosmulski 2006; Bornmann et al. 2008; Egghe and Rousseau 2008; Cabrerizo 2009; Anderson 2008; Zhang 2009).

Hos index recommended in the study, by including un-cited publications and the impact of duration of publication in calculations during academic performance assessment, provides a more sensitive calculation possibility than the other indexes. While assessing academic success of a scientist, contribution of un-cited publications to performance shall also be taken. Because a publication not being cited does not mean that this publication's quality is low. The reason of being un-cited of a publication may be being published in a local media organ, in a specific language, being a new published paper or being studied in a specific discipline. Additionally due to technological developments and accessibility, number of citations of publications before 1990 are much more lower than number of citations of publications especially after year 2000. In addition as some of the media organs give importance to having newly dated publications in references of publications, problems can be faced in citation of old dated publications. In addition, the opinion that an un-cited publication does not have scientific value is wrong. *Hos* index takes all published of the researcher into consideration. In the *Hos* index, by multiplying number of un-cited publications by 0.3, number of publications cited between 1 and 5 by 0.50, number of publications cited between 6 and 20 by 0.75, number of publications cited between 21 and 50 by 0.90, number of publications cited between 51 and 100 by 0.95, and number of publications cited over 100 by 1, by giving points to yet un-cited publications even if it is low, contribution to index will be provided. As it can be understood also from the coefficients, as it is more difficult to obtain high numbers of citations when compared to obtaining low numbers of citations, with regards to bigger effect of publications with high number of citations on performance, multiplication coefficient has been selected higher. Thus difficulty situation will provide positive contribution in scientist's performance.

Additionally except AR index, in indexes existing in the literature, the impact of the age has not been considered in index calculation (Jin et al. 2007). However adjusting according to age of the researcher may not be correct. A researcher who started to publish at late ages must not be disadvantaged when compared to the researcher who started to publish at young ages. Furthermore when a young and an old two researchers who started to publish at the same age are compared, the old one will become more advantaged. That's why it will be more appropriate to consider "publication period" in index calculation. Including this period in calculations is realised by finding "publication period" for that researcher by taking the difference of first publication year from last publication year. Weighted point according to the period is calculated by dividing Hos index calculation formula by publication period. Thus the impact of difference between scientists due to publication age will be eliminated. The limitation of this study is that the performance evaluations of the scientists in the sample considered are not divided into science branches. However, in order to eliminate the difference caused by the branches of science, a sample consisting of researchers can be selected separately in each science branch, and the distribution of the citation numbers for that science branch can be found. This distribution, divided by the values of the percentile, can be categorized by area, cited in the form described above.

Table 2. Calculation of *Hos* index

Scientists	publication year		Total publication in WOS*	Parameters in Formula of *Hos*						*Hos* index	*h*-index in WOS*
	1st	Last		N_0	N_{1-5}	N_{6-20}	N_{21-50}	N_{51-100}	$N_{>100}$		
Handan C. Ankarali	2001	2016	184	45	56	60	18	3	2	7,17	22
Vasif Hasirci	1981	2016	182	29	29	57	43	21	3	3,65	38
Serdar M Değirmencioğlu	1995	2016	48	22	11	4	5	3	3	1,21	13
Fillippo Aureli	1987	2016	215	51	34	50	52	19	9	4,95	40
Gilles Levresse	2002	2016	60	19	24	12	4	0	1	2,24	11
Yaseen Arabi	1980	2016	301	147	63	41	27	9	14	4,26	35
Zeenath Jehan	1994	2016	44	19	8	10	4	2	1	1,08	13
Eytan Ruppin	1981	2016	247	42	60	58	52	20	15	4,77	43
Ross Pinsky	1975	2016	292	211	47	22	9	2	1	2,79	14

*WOS: Web of Science

References

[1] Hirsch JE (2009). An index to quantify an individual's scientific research output. Proc Natl Acad Sci U S A 102(46), 16569-1672.
[2] Egghe L (2006) Theory and practise of the g-index. Scientometrics 69(1): 131–152.
[3] Jin BH, Liang LM, Rousseau R, Egghe L (2007) The R- and AR-indices: Complementing the h-index Sci. Bull 52(6): 855-863.
[4] Alonso S, Cabrerizo FJ, 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(2): 391-400.
[5] Kosmulski MA (2006) A new Hirsch-type index saves time and works equally well as the original h-index. ISSI Newsletter 2(3): 4-6.
[6] Bornmann L, Mutz R, Daniel HD (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. J Am Soc Inf Sci Technol 59(5): 830-837.
[7] Egghe L, Rousseau R (2008) An h-index weighted by citation impact. Inf Process Manag 4(2): 770-780.
[8] Cabrerizo FJ, Alonso S, Herrera-Viedma E, Herrera F (2009) q2-Index: quantitative and qualitative evaluation based on the number and impact of papers in the Hirsch core. J Informetr 4(1): 23-28.
[9] Anderson TR, Hankin KSH, Killworth PD (2008) Beyond the Durfee square: Enhancing the h-index to score total publication output. Scientometrics 76(3): 577-588.
[10] Zhang CT (2009) The e-index, complementing the h-Index for excess citations PLoS ONE 4(5): 1-4.

First Author Born in Adana-Turkey, Ph.D., Professor in Biostatistics. Her research interests include data mining, text mining and all biostatistics methods.

Second Author Born in İstanbul-Turkey, MsC. Her research interests basic biostatistics methods and cluster analysis.

Third Author Born in Kayseri-Turkey, MD, Professor in Physiology. His research interests include Human Physiology.