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A scientometric study of the scientific output of top Iranian researchers in medical sciences

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Abstract

Scientometrics indicators are used to assess scientists, universities and research institutes for scientific policy-making. The aim of this research was to assess the status of top Iranian medical researchers using scientometric indicators. The study was carried out using scientometric methods. The statistical population included the top 500 Iranian researchers in the field of medicine who were ranked in the Iranian Scientometric Information Database (ISID) based on some scientometric indicators. The data were analyzed using SPSS 22 software and Pearson's correlation coefficient, stepwise regression analysis and Chi-square tests were applied for data analysis. Findings revealed that each researcher had an average h index of 24.04, g index of 40.15, and i10 index of 90.79. There was a positive significant relationship between the number of internationally-collaborated papers and the number of citations received ($r = .606, p < .01$). The stepwise multiple regression analysis showed that the three variables of paper number, citation counts and mean citation rate determined 72 % of the changes in the h-index. It can be concluded that researchers publishing more papers are more likely to be cited. However, their scientometric indexes are not always better than those of other scientists.

Keywords: Scientometric indicators, Top medical researchers, Iranian Scientometric Information Database (ISID), Iran
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1 Introduction

The main indicator of scientific publication and research output is to publish scientific papers in worldwide known indexing/abstracting databases. Scientific publications reflect knowledge level and professional information and have a basic role in the complex system of scientific interactions and sharing produced knowledge among scientific communities. Therefore, the evaluation of scientific output of individual authors, institutes and universities is both challenging and necessary [1].

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As a quantitative study and one of the main scientific evaluation and monitoring approaches, scientometrics tends to identify scientific communications and newly-emerged areas as well as depicting the scientific status of science production and research output [16, 20]. It studies the influence of the science on the human societies and provides progression and development criteria for science and technology [2]. In the past, the scientific rank of an individual scientific entity (such a researcher) was reflected quantitatively as the number of published papers. However, in recent years, the number of published papers as well as some qualitative scientometric indicators (such as citation counts) is conceived in this regard.

One of these indicators is h-index that was proposed by Hirsh in 2005 [17]. Measuring the research quality and reach, h-index reflects the influence of a scientific entity on science progression. However, it ignores highly-cited papers as well as lowly-cited ones. For modifying this index, some other indexes such as g-index [12] were suggested where the highly-cited papers are weighted proportionally [10]. Another Google Scholar-based indicator similar to h-index is h10 index showing the number of papers with at least 10 received citations [6].

Several scientometric studies have been conducted in different areas. Koorki1, Isfandyari–Moghaddam and Bayat determined the research outcomes of the faculty members of Hamadan University of Medical Sciences based on their h-indexes and m parameters indexed in Google Scholar until the end of year 2016. They found that the average of the h index and m parameter were average to high levels and fairly good comparing other medical science universities, but they were low than international indices both qualitatively and quantitatively [13].

Naderi found that the h-indexes of faculty members in Rafsanjan University of Medical Science in 2015 were lower than that of international level. The positive relationship was seen between h index and work length as well as academic ranking [17].

Mousavi-Chelak and Haddad-Araghi measured the Scopus-extracted h-index for the faculty members of Islamic Azad University, Tehran Sciences and Research Branch and found that about 75% of them had no h-index and the majority of them published few papers and received few citations [2].

Pitsolanti and colleagues evaluated the faculty members of 50 Greek Science and Engineering University Departments from a scientometric perspective. Departments of the same academic discipline were characterized by significant differences in the scientific outcome. The majority of the evaluated departments had a significant difference in h-index between academics who report scientific activity on the department website and those who do not. The correlation between the scholars' academic rank and h-index (or the number of their citations) was quite low in some departments [18].

Onoshagbegbe and colleagues examined the research productivity of 1073 academic staff of Nigerian universities. Research productivity was measured using Google Scholar h-index and i10-index. No statistically significant difference was seen between the research productivity of Federal, State and Private Universities. The mean rates of h-index and i10 index were 2.77 and 1.84, respectively [14].

Kalcioglu and colleagues ranked the top 100 physicians of otorhinolaryngology and head and neck surgery worldwide by using the Google Scholar h-index. They found that the average h-index rate was 37.83, in the range of $25-81$ [11].

Popovic analyzed the personal scientific production of Montenegrin sports sciences researchers, as well as trend of publication within Montenegrin sports sciences journals in the time span of 2002-2017. The sports sciences researchers rapidly increased the number of their publications from 2002 to 2017 and switch the writing language from Montenegrin to English, especially in last five years. The number of citations span from 100 and 2800 within most of researchers, while h-index and i10-index span from 4 to 30 in most cases in Google Scholar database, while the same researchers were cited quite lesser in Scopus and Web of Science databases [19].

The real ranking of researchers is of main concerns in scientometric studies. This study aimed to investigate the scientometric measures of the top Iranian researchers in the medical fields as well as determining some demographic and scientometric variables at work in affecting their h-indexes, g-indexes and i10 indexes.

2 Methodology

This applied research took a scientometric approach. Research population included the top 500 Iranian researchers in medical sciences who were ranked as having high h-indexes in the Iranian Scientometric Information Database (https://isid.research.ac.ir/), produced by the Ministry of Health and Medical Education, Deputy of Research and Technology, Scientific Publications and Information Development Center. Data extraction was done on 2022/6/21. A researcher-made checklist was prepared for data collection and Google Scholar, Scopus, PubMed and Web of Science (WoS) indexing/abstracting databases were consulted as complementary citation databases. $Pearson's$ correlation

Indexing databases				Scientometric indicators						
Google Scholar	Pubmd	Scopus	WoS	i10-Index	g-Index	h-Index	Internationally collaborated papers	Citation count	Number of paper	
0	5	25	0	0	21	18	0	760	25	Min
2243	917	1034	739	2467	205	77	441	44588	1034	Max
115992	55684	76029	13963	45394	20075	12022	16954	1291893	76029	Total
231.98	111.37	152.06	27.93	90.79	40.15	24.04	33.91	2583.75	152.06	Mean
Assistant professor		Associate professor		professor professor		Distinguished professor		Academic ranking		
58		107		316		19		Frequency		

Table 1: Descriptive statistics on the study variables

	Paper numbers	Citation counts	Mean citation rate per paper	Internationally-collaborated papers	h-index	g-index
Paper numbers	1					
Citation counts	0.600	1				
Citation mean	-0.058^{**}	0.563	1			
International papers	0.628	0.606	0.162	1		
h-index	0.748	0.765	0.213	0.602	1	
g-index	0.510	0.890	0.501	0.653	0.790	1

Table 2: Pearson's correlation test results between the scientometric indicators

coefficient, stepwise regression and Chi-square tests were applied for data analysis in SPSS 22 software.

3 Findings

Table 1 shows some descriptive statistics on the variables. The top 500 Iranian researchers in medical sciences contributed to 76,029 papers (152.06 papers per researcher), including 16,954 internationally-collaborated papers (33.91 internationally-collaborated papers per researcher). Total citation counts amounted to 1,291,893. The mean rates of researchers' h-index, g-index and i10-index were 24.04, 40.15 and 90.79, respectively. The mean rates of indexed papers in Google Scholar, Scopus, PubMed and WoS were 231.98, 152.06, 111.37, and 27.93, respectively. Considering the academic ranks, 19, 316, 107, 58 researchers were distinguished professors, professors, associate professors and assistant professors, respectively.

Table 2 shows the relationships among the scientometric indicators. Significant correlations can be seen between all indicators, but mean citation rate and paper numbers. The most strong relationship was between citation counts and g-index (r=.890) and citation counts and h-index (r=.765), respectively. A positive significant relationship was seen between h-index and g-index (r=.790), too. Other relationships were in the moderate level. An interesting finding was the lack of significant relationship between the number of published papers and the mean rate of received citations (r=-.058, $p > .01$).

A stepwise multiple regression analysis was used for predicting h-index and g-index of the researchers based on their some scientometric indicators (Table 3 and Table 4). Regarding h-index, at the first step, the first variable (citation counts) was added to the model (r=.765, $r^2 = .586$). By entering the second variable (paper number) at the second step, the coefficients increased (r=.846, $r^2 = .716$). With entering the third variable (mean citation rate) in the model at the third step, coefficients increased again (r=.848, $r^2 = .720$). Only one variable was deleted from the model. Therefore, 72% of change in h-index can be determined by the three variables: paper numbers, citation counts and mean citation rate per paper. As one unit of increase in SD of paper numbers and citation counts predicted .396 and 578 units of change in SD of h-index, and one unit increase in SD of mean citation rate per paper resulted in .089 units of decrease in SD of h-index, the citation count was the better predictor for h-index. Regression equation was as follows:

$$h - index = 17.438 + 0.001 + 0.026 - 0.034$$

However, only one of the variables was entered into the regression model when considering g-index (r=.890, $r^2 =$

p-value	F	R^2	R	Step pattern	Step No.	Indicator
0.000	704.18	0.586	0.765	Citation counts	1	h-index
0.000	627.37	0.716	0.846	Paper number	2	h-index
0.000	424.71	0.720	0.848	Mean citation rate	3	h-index
0.000	1897.54	0.792	0.890	Citation counts	1	g-index

Table 3: Table 3. The goodness of fit of the model

Indicator	Step no.	Step pattern	B	Beta	T	p-value
h-index	1	Constant	19.730	-	73.27	0.000
		Citation counts	0.002	0.765	26.54	0.000
h-index	2	Constant	16.754	-	56.32	0.000
		Citation counts	0.001	0.495	16.57	0.000
		Paper numbers	0.030	0.451	15.12	0.000
h-index	3	Constant	17.438	-	43.21	0.000
		Citation counts	0.001	0.578	12.92	0.000
		Paper numbers	0.026	0.396	10.70	0.000
		Mean citation rate	-0.034	-0.089	-2.50	0.013
g-index	1	Constant	27.102	-	54.63	0.000
		Citation counts	0.005	0.890	43.56	0.000

Table 4: Standardized and non-standardized coefficients of a stepwise multiple regression analysis for predicting the researchers' scientometric variables based on their h-index and g-index

.792). One unit of increase in SD of citation counts resulted in .890 units of increase in SD of g-index. Regression equation was as follows(Figure 1):

$$g - index = 27.102 + .005$$

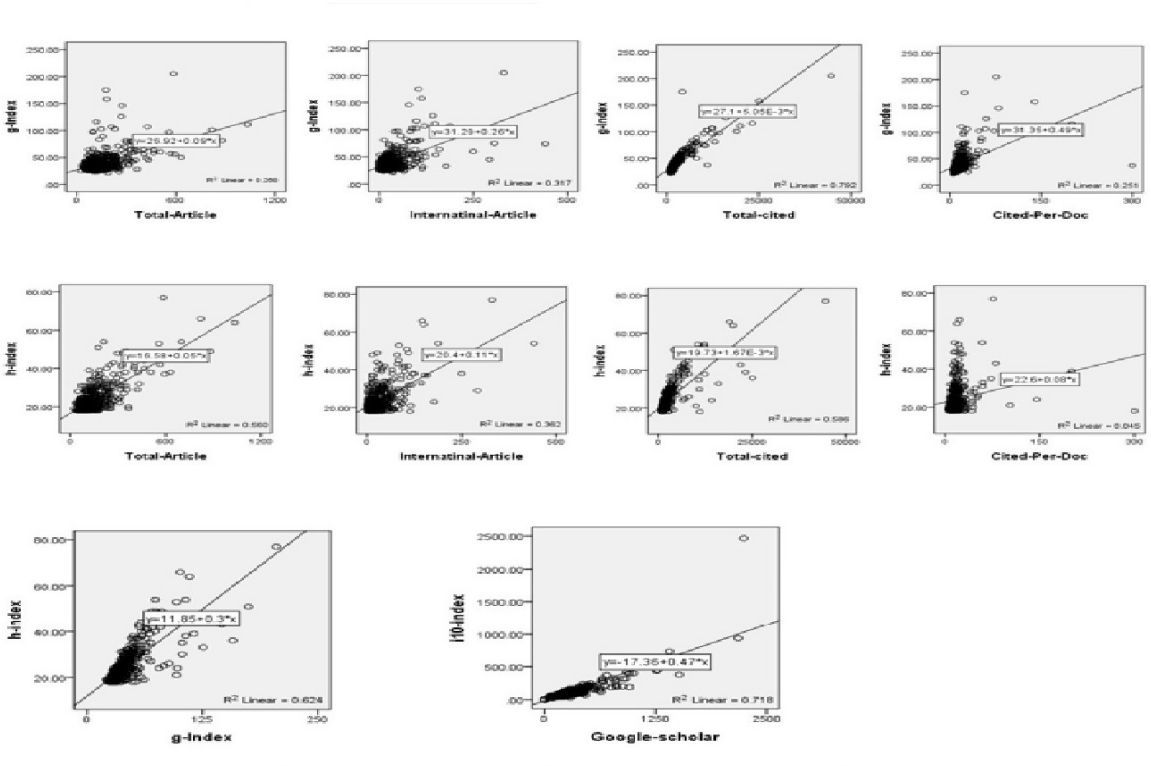

Figure 1: Correlations between the studied variables

Researchers' i10 indexes were measured. 16.8% of researchers had no i10 indexes. A strong positive correlation was found between the number of Google Scholar-indexed papers and researchers' i10 index (r=.847,$p < .01$). The studied researchers' performance in the four studied indexing databases showed that 346 researchers (69.2%) had no

	WoS	PubMed	Scopus	Google Scholar
WoS	1			
PubMed	0.357	1		
Scopus	0.333	0.922	1	
Google Scholar	0.299	0.698	0.758	1

Table 5: Pearson's Correlational matrix of indexing databases

Variable	K^2	Phi	p-value
h-index	215.27	0.379	0.000
g-index	633.89	0.650	0.000
i10-index	324.95	0.465	0.000

Table 6: Chi-square test results for comparing the researchers' scientometric indicators with their academic rankings

WoS-indexed papers and 84 researchers (16.8%) had no recorded papers in Google Scholar. The correlational matrix of the four studied indexing databases (Table 5) showed that the number of indexed papers correlated significantly in the studied databases. The strongest and the weakest correlations belonged to those of Scopus-PubMed (r=.922) and Google Scholar-WoS (r=.299), respectively. Chi-square test was conducted for possible correlation between researchers' academic ranks and their h index, g-index and i10 indexed (Table 6). As can be seen, the variables for all ranks significantly correlated (K^2= 215.27 for h-index, K^2=633.89 for g-index and K^2=324.95 for i10 index, $p < .01$).

4 Discussion and Conclusion

This study aimed at investigating the scientific performance of the top Iranian researchers active in medical sciences based on several scientometric indicators such as their scientic papers, internationally-collaborated papers, citation counts and mean citation rates per paper as well as their h-index, g-index and i10 index. The mean rate of citation counts per paper (=2538.75) reflects quantitatively good level of citedness of the papers published by these researchers. As expected, full professors were in the highest rank as top researchers (63.2%). The researchers' mean rates of h-index, g-index and i10 index were acceptable and amounted to 24.04, 40.15 and 90.79, respectively. These rates are more than those found in previous studies in which the mean rates of h-index amounted to 2.24 [4] and 2.77 [14] and that of i10 index that amounted to 1.84 [14]. However, Kalcioglu found h-index of 37.38 worldwide [11].

The correlations among all variables, but paper numbers and mean citation rates were significant. A strong positive relationship was found between paper numbers and citation counts. It can be concluded that highly productive researchers are highly-cited. This finding is in line with the finding in previous studies [7, 19]. We found that 22.3% of researchers collaborated in an international level and international papers were cited more. The international collaboration is another factor in scientific production as highly-collaborating researchers worldwide increased their paper numbers from 11.1% of total papers in 1996 to 19.5% of total papers in 2015 [8]. The reason is that internationally-collaborated papers re mostly published in highly prestigious and influential journals where they may be highly cited [8, 15].

As other studies [1, 7, 9], we found that h-index is significantly influenced by scientific production numbers and received citation counts. As a qualitative-quantitative balancing indicator, h-index considers both scientific production and its influence. However, it disregards highly-cited papers. As g-index more weights highly-cited papers, it is a complementary to h-index. Therefore, it can be expected that these two indicators are interrelated. We found the strongest positive relationship between these two influential indexes. Other studies found such a result [5, 7].

Regarding i10 index, it was found that its minimum rate amounted to 23. A positive significant relationship was seen between scientific productions indexed in Google Scholar and i10 index. Such a result was reported in another study [19]. Therefore, ones with more papers may achieve high citations and consequently, high i10 index.

One of main concerns researchers have after authoring their papers is to publish them in journals indexed in known indexing databases. Publishing papers in such databases increases the visibility and consequent citation of a published paper and reflects its research quality. We traced the presence of the studied researchers' papers in Google Scholar, Scopus, PubMed and WoS databases and found that the presence of the papers were significantly higher in Google Scholar and lower in WoS. The mean rate of presence of the papers in Scopus and PubMed was relatively similar. The main reason for this coverage difference is embedded in the indexing policies obeyed by indexing databases and journals' taking these criteria into account can be helpful in increasing the chance of their published papers to be indexed in these databases [3].

There was a significant moderate relationship between researchers' academic rankings and their h-index, g-index and i10 index. Some studies found such a correlation with some slight differences [1, 2, 4, 9, 17, 18].

Evaluating scientific output made by researchers is important due to performing academic promotion and assigning research grants in many universities and research institutes. A wide range of benchmarking scientometric criteria are used for this evaluation. Using known databases and new scientometric approaches can be helpful for science policy-makers in identifying top researchers in a certain area. Comparing Iranian researchers' performance in medical sciences with that of top international researchers in the field can depict a better picture of Iranian researchers' contribution to the world's scientific development.

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