Scientometric Analysis of Medical and Non-Medical Highly Cited Papers of Iran in Essential Science Indicator (ESI)

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ABSTRACT

The aim of the present research is to study scientometric indicators (the number of articles and citations, the mean citation per paper, H-index, Y-index, and the national and international collaboration) of medical and non-medical highly cited papers of Iran in the Essential Science Indicators (ESI). The research population is all highly cited articles of Iran in ESI during 2005 to 2015. Data was retrieved from ESI and was analyzed using descriptive statistics. Findings show that Iran has achieved the 35th global rank in terms of the number of highly cited articles. This rank encompasses % 0.1 of the highly cited medical subject areas and % 0.6 of the global portion in non-medical areas. The growth of highly cited papers in non-medical subject areas is more than medical subject ones. Y-index indicates that the role of authors in most highly cited articles in both medical and non-medical subject areas is either as the corresponding or the first author, with an inclination towards the first author. Most of Iran's highly cited articles in the medical subject areas are based on international collaborations, but in the non-medical areas, they are based on national collaborations. The most international collaborations are with U.S, Canada and England, respectively. H-index of Iran is 141. As a whole, in quantitative and qualitative assessment, non-medical subject areas have a better status than medical subject areas. In general, it can be said that the status of scientific products and the international status of Iran is not satisfactory. Professional planning and policy should be taken into consideration by Iran**.**

Keywords: Scientometrics; Highly Cited Papers; Medical sciences; Non**-**Medical sciences; Essential Science Indicator

INTRODUCTION

The importance of scientific publications and its undeniable role in sustainable development is to the extent that many developed countries spend a large number of their national wealth on research progress and research institutes [1]; with proper costs management, program recognition and assessing the research status and the impact of researches in each country is essential for research planners and policy-makers as well as researchers. Scientometrics studies through using different indicators are the most efficient methods of research output survey. [2, 3, 4] In order to gather the necessary data in scientometrics studies, reliable databases are used. Essential Science Indicators database (ESI) is a unique collection among all databases of Institutes for

Scientific Information and is an analytical tool which is used in many researches to evaluate the scientific outputs with high accuracy.[5, 6, 7]**.** After calculating the number of citations per subject field in Web of Science (WOS), top 1% of articles per year in any subject area are indexed in ESI. In other words, highly cited articles in this database are among the top one percent of international researches. In addition, top 1% of organizations and authors and the top 50% of journals and countries in different subject areas are also listed in ESI. Choice of authors, journals or institutes for indexing in ESI is based on the number of citations they have received in the period of ten years. The lack of an author's name or institution, country or journal title in this database means that the threshold number of

citations is not enough to participate in ESI. In the Essential Science Indicators, 22 subject areas are designated which by searching in each of these subject areas, series of articles can be accessed. [8] Since ESI has covered the most highly cited articles, it can be said that the analysis performed on the data of this database is a kind of study on the articles that are of high quality and effectiveness. Science publication movement is the main concern of managers and scientific and research planners of Iran. For this purpose, a special place in the development plans and visions have been considered for it. Twenty-Year Vision of the Islamic Republic of Iran which has been prepared at the highest levels of government and with the participation of all sectors of beneficiaries are manifested in the scientific and technological system with duties and certain levels [9], clearly targeted by giving first economic and scientific place for Iran among the countries of Southwest Asia and has been noted to exit the current underdeveloped state, the inspiration among the Muslim world and constructive and effective interaction in international relations. What should be considered in this regard is publishing high quality articles which are placed in the cycle of science and are more effective through more received citations [10]. Also, it is necessary that continuous assessments of scientific publications of Iran and other countries be done so that their findings can be used in related planning. In this regard, Kharabaf and Abdollahi (2011) conducted a study entitled "Science Growth in Iran over the Past 35 years ". The results showed that the most prolific fields in Iran were chemistry with 16982 documents with the H -index of Iran being 101. He predicted that if the scientific growth continues in Iran, it is not surprising that Iran will be known as a powerful country in the world [11]. Also, in recent years, many researches have examined the scientific output of Iran in various subject areas [12, 13] and have compared the scientific output of Iran with other countries [1, 9, 14] but so far no study has been performed to assess the quality and quantity of Iranian scientific highly cited papers in all fields to address the comparison of medical and non-medical fields. So this study intends to evaluate

the Iranian most cited scientific papers (in the fields of medical and non-medical sciences) based on data from ESI; in this regard, a review of the number of publications, average and number of citations, subject areas of highly cited articles, Hirsch index , Y index and scientific collaboration in the publications has been done. Clarifying the status of qualitative and quantitative features of these products provides necessary data for policy making and planning for Iran to achieve worthy academic standing among nations.

METHODS

The Method of this applied study is descriptive survey with the scientometrics approach. The study population consisted of Iran's highly cited articles which have been indexed in ESI during 10 years and 8 months (1 January 2005 to 31 August 2015). Searching the Database of Essential Science Indicators was done in November 2015. By selecting Country / Territory, different countries were determined based on the number of highly cited papers and then among retrieved countries, Iran was selected and documents related to Iran were retrieved. The number of highly cited papers retrieved with at least one of its authors in its own organizational affiliation mentioning the name of Iran was 982 articles. (Due to the disruption of the database, there was no possibility to restore data in the subject areas of "psychiatry & psychology" and "biology & biochemistry"). The number of highly cited papers in these fields was 18.
These articles were reviewed through analysis facilities of database itself and more analysis being saved in Excel files. Data analysis was performed by using descriptive statistics and Excel software. Articles in 20 subject areas of ESI were divided into 2 essential subject areas of medical sciences and its related sciences and non – medical subject areas. Iran status was reviewed by the number of indexing articles in WOS, number of highly cited articles in ESI, and number and average citation of these two databases. Iran's articles h-index and scientific collaboration status and Nationalization Index (NI) and Internationalization Index (INI) and Y index were also evaluated. The limitation of this

study was related to 2 subject areas: "Biochemistry and Molecular Biology" (15 highly cited papers); and "Psychiatry and Psychology" (3 highly cited papers). In these two fields, some articles belong to medical and some belong to non-medical subject areas (Biochemistry and Psychiatry in medical, and Molecular Biology and Psychology in non-medical areas). Thus, we needed to divide articles

$$INI = \frac{\text{Number of International co-authorship articles}}{\text{Total number of articles}} \times 100$$

Nationalization Index (NI): It is an indicator to measure the output of nationalization of the articles. [15]

$$NI = \frac{\text{Number of nationa co-authorship articles}}{\text{Total number of articles}} \times 100$$

Y- index: Y- index is an indicator with two parameters j and h, the formula is as follows:

$$j = FP + RP. \qquad (1)$$

$$h = \tan^{-1}\left(\frac{RP}{FP}\right). \qquad (2)$$

FP is the number of articles in which the first author of the country is concerned and RP is the

based on article title. As there was no access to the articles in these subject areas at the data gathering time, we omitted them form the study population.

Internationalization Index (INI): It is an indicator to measure the output of internationalization of the articles. (15)

Table 1. Number of Articles, citations, citation per paper of Iran in the WOS and ESI

Indicators Databases	Total Publication (rank)	Total citations (rank)	Average citation per paper
WOS	180085(22)[1]	1046651(31)	5.81(136)
ESI	982(35)	83807	85.34

number of articles in which the corresponding author of the country is concerned. [16]

RESULTS

As shown in table 1, Iran with a total of 180,085 articles is dedicated to rank 22 in terms of number of articles, rank 31 for the number of received citations and 136 in terms of average citations per document in WOS and have achieved rank 35 among all countries in the world in the terms of highly cited articles in ESI.

Investigation showed that the total number of highly cited articles of countries of the world in ESI (153 countries) is 237009 titles as that in the meantime, Iran with 982 highly cited articles has 0.4% share of global as well. 0.5% Iranian articles in Web of Science were recognized as the most cited articles.
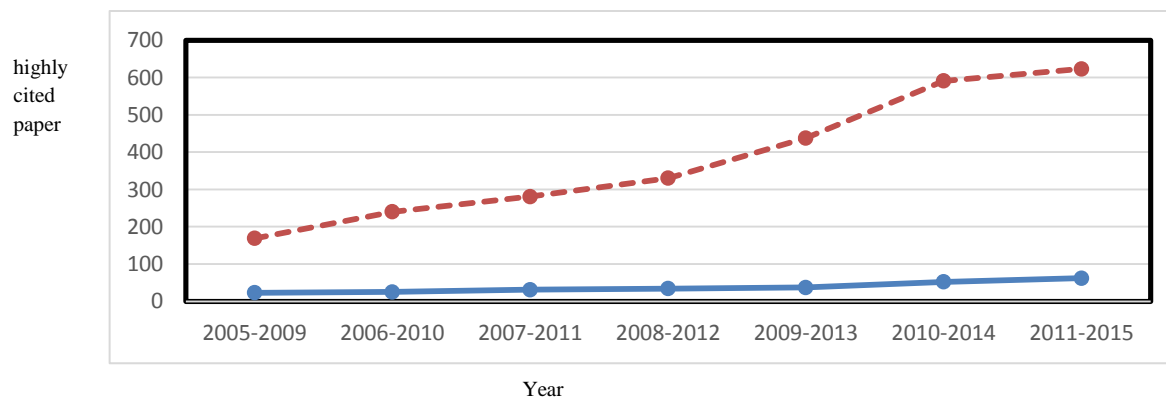
Figure 1. The flow of highly cited papers in the medical and non-medical fields during 2005 to 2015

The number of highly cited papers in non-medical subject areas ━ ━ ━

The number of highly cited papers in medical subject areas ━━━

According to Figure 1, highly cited articles in non-medical subject areas from 2005 to 2015 shows a growing trend while most cited articles in the medical subject areas show almost no growth.

Table 2. The subject Areas of Iran's highly cited papers in WOS and ESI

General subject Area	Specific subject Area	Number of Articles WOS(rank)[1]	Number of Citations WOS(rank)	Citation Per Paper in WOS	Highly cited paper in ESI	Number of Citations in ESI(rank)	Citation per Paper in ESI	% of highly cited paper in ESI to the all highly cited papers of the subject area	% of highly cited paper in ESI to the WOS articles
Medical	Clinical Medicine	21362(1)	107952(1)	5.05	58	12006	207	0.1 %	0.27 %
	Pharmacology &Toxicology	5485(2)	34588(2)	6.31	16	2106	131.6	0.32 %	0.29
	Molecular Biology & Genetics	2153(5)	17728(3)	8.23	8	1772	221.5	0.08 %	0.37 %
	Immunology	1731(6)	12017(5)	6.94	3	404	134.6	0.06 %	0.17 %
	Neuroscience & behavior	2391(4)	17611(4)	7.37	3	336	112	0.03 %	0.12 %
	Microbiology	2716(3)	9153(6)	3.37	1	187	187	0.03 %	0.03 %
Non-Medical	Engineering	32216(3)	157496(2)	4.89	366	19801	54.10	2.56 %	1.13 %
	Chemistry	35925(2)	287753(1)	8.01	115	15768	137.11	0.59 %	0.32 %
	Mathematics	80231(1)	30168(7)	3.76	107	4768	44.56	2.07 %	0.13 %
	Physics	13930(5)	89627(4)	6.43	95	11789	124.05	0.38 %	0.68 %
	Agricultural Sciences	7081(7)	34958(5)	4.94	57	2505	43.94	1.02 %	0.8 %
	Computer Science	5257(9)	20963(11)	3.99	44	2561	58.2	0.9 %	0.83 %
	Material Science	14242(4)	93217(3)	6.55	33	3863	117.03	0.36 %	0.23 %

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[1] . Rank of subject area among medical or non-medical subject fields.

General subject Area	Specific subject Area	Number of Articles WOS(rank)[1]	Number of Citations WOS(rank)	Citation Per Paper in WOS	Highly cited paper in ESI	Number of Citations in ESI(rank)	Citation per Paper in ESI	% of highly cited paper in ESI to the all highly cited papers of the subject area	% of highly cited paper in ESI to the WOS articles
	Geo Science	4084(10)	21860(9)	5.35	18	1285	71.38	0.19 %	0.44 %
	Environment/ Ecology	3649(11)	21042(10)	5.77	16	-[1]	-	0.18 %	0.43 %
	Social Sciences	3518(12)	14263(12)	4.05	11	1119	101.75	0.08 %	0.31 %
	Plant & Animal Science	8616(6)	29523(8)	3.43	10	567	56.7	0.08 %	0.11 %
	Economics & Business	410(14)	1351(14)	3.30	2	33	16.5	0.02 %	0.48 %
	Space Science	907(13)	6072(13)	6.69	1	7	7	0.01 %	0.11 %
	Multidisciplinary sciences	74(15)	188(15)	2.54	0	0	0	0 %	0 %
All Medical subject areas		35838	199048	5.55	89	6005	67.47	0.1 %	0.24 %
All non-Medical subject areas		137932	808481	5.86	875	64066	73.21	0.6 %	0.63 %
All Medical and non-Medical subject areas		173770	1007529	5.79	964	70071	82.68	0.4 %	0.55 %

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[1] .Due to the disruption of the database, there was no possibility to restore data to this section.

Findings of Table 2 shows that generally, Iran in 22 reviewed subject areas has had 173,770 articles in WOS , 1,007,529 citations, 5.79 average citation per documents, 964 highly cited articles , 70071 citation to ESI articles , 0.4% highly cited articles global share and 0.55 % the highly cited articles share to total WOS articles. In particular, medical subject areas were allocated to 0.1% global share and in non-medical subject areas 0. 6% of the world share in terms of total highly cited articles. Also, in terms of the total number of articles in WOS, medical subject areas had 0.6% global share and in non-medical subject area 1.29% of global share. In terms of average citations per article of highly cited articles, the number was 67.47 citation in medical subject areas and 75.9 citations in non- medical subject

areas. Also, Table 2 shows that only 0.24% of WOS articles of Iran in the medical fields are among top 1% of articles. But the situation is better in non-medical fields and this rate reaches to 0.63%. Among the non-medical fields, engineering fields with more than 1% of WOS publications have had the highest share of highly cited articles. The computer science and physics subject areas were in the next rank. In the medical fields, the field of molecular biology and genetics with 0.37% accounted for the largest share of highly cited articles. Further investigation revealed that the most highly cited article in the ESI received 1437 citation in chemistry. Iran's low-cited article in this database with the 4 citation was in math and both articles are related to 2015. By reviewing all highly cited papers, Hirsch index showed 141 for Iran.

Table 3. Information related to Y-index in medical and non-medical subject areas of Iran's highly cited papers in ESI

No	Subject Area	All of highly cited paper	First Author	Corresponding Author	One Author	Overlap	J	h
1	**Medical**	89	35	31	1	21	66	0.749
2	**Non-Medical**	875	676	623	58	360	1299	0.760
3	**All subject Areas**	964	711	654	59	381	1365	0.660

Table 3 shows that Iran has generally had 982 highly cited articles in which Iranian researchers have been the first author of the 711 articles, corresponding author in 654 articles, and 59 single-authored articles; J in Iran was 1365 and h was 0.66 which indicates that in most highly cited papers of Iran, more papers have been related to the first author. However, in particular, J components of Iran obtained 66 in the medical subject areas which means that among the 89

highly cited articles that Iran has in the medical fields, 66 articles has been related to the first author or corresponding author. Also, this component in non medical fields was 1299 which infers the same prior result in medical subject areas. By calculating h component in the medical and non-medical fields, it can be inferred that the highest publication in these subject areas is related to the first author.

Table 4. National and international co-authorships in medical and non-medical scientific publications of Iran in ESI

Subject areas	Number of single-author Articles	% of single-author Articles	Number of national collaboration	NI	Number of international collaboration	INI
Medical	1	1.12 %	19	21.35 %	69	77.53 %
Non-medical	58	6.63 %	435	49.71%	382	43.66 %
All subject Areas	59	6.12 %	454	47.09%	451	46.78%

Findings of Table 4 shows that papers which have been published in the medical field by Iran has been more through international collaboration, but in non-medical subject areas it has been more through international collaboration. It also showed that the highest rate of participation in the international co-authorship has been for America, Canada and Great Britain, respectively.

DISCUSSION

According to the findings of this study, the highly cited researchers' publications of Iran showed a growing trend during 2005 to 2015. Except for "multidisciplinary sciences", Iran had at least 1 highly cited article in all subject areas of ESI. Based on previous researches the rank of "multidisciplinary sciences" publications was 14th in the world, but the present study indicates that none of them is within the category of highly cited papers. [17]. Iran has achieved 22nd rank of the world according to WOS database articles,31st rank globally in terms of the number of citations and 136th rank in terms of the average citation per document and in comparison to previous studies it shows an increasing number within WOS articles. The comparison of the publication and citation rank shows that the citation rank is less than document rank and this indicates the necessity for improving the quality of publications. [17] Also, Iran was ranked 35th worldwide in terms of number of highly cited papers in ESI which includes 0.4% of the world highly cited articles. The number of highly cited papers has increased in the comparison to the study of Nowrouzi Chackoli and Hassanzadeh. [18]. This amount of highly cited articles was 0.1% of global share in medical subject areas and 0.6% of global share of non-medical subject areas. Percentage index of cited documents is an indicator of how the scientific output of an institution, individual or country has quality stability. Given that the indicator is calculated by Percentage, it has been less influenced by confounding variables. [19]. Average citation to articles in medical fields in WOS and ESI was 5.55 and 67.47, and in non-medical fields is 5.86 and 73.21, respectively, hence, no significant differences exists. However, comparison of the percentage of highly cited articles in medical and

non-medical areas in the world showed that non-medical subject areas compared with medical subject areas had better performance in term of highly cited articles in the world. Given that the top one percent of papers in each subject area is listed in the ESI, it can be said that Iranian engineering publications have good quality, and 1.13% of these papers in WOS have been able to gain the necessary citations to enter ESI. Unfortunately, the remarkable situation is not observed in medical fields and less than 0.3% of publication in these subject areas has been able to gain necessary citation to enter ESI. According to the budget spent on education and research in these fields in our country, this issue needs more investigations and education and research policy makers at the Ministry of Health and Medical Education should pay more attention to this issue and promote quality of scientific publications in the medical subject areas. This issue applies to the publication of other subject areas in which a small percentage of their products are known as highly cited articles. In researches done in recent years [19-22], chemistry is known as the most prolific fields in Iran, while in this study mathematic is known as prolific subject area and chemistry was the most highly cited subject area in WOS; mathematics achieved ranked first in ESI for the number of highly cited papers and chemistry has earned second place. Moreover, by reviewing each highly cited article, it was shown that Iran's h-index was 141while this number was 31 in 2009. [11, 23]. This shows a quality increase in scientific publications of Iran. Guan and Cronin in their research showed that h-index is a function of the number of citations and by increasing the number of citations and subject areas this index also increases [24-25]. Therefore, it can be said increasing the quality of scientific publications which leads to more citations can increase the h-index. As a result, more attention to the quality improvement of scientific publications must be considered in planning and policy. Findings of the present study show that in the most highly cited articles of Iran, authors have appeared in the role of corresponding author or first author; however, the Iranian authors are more inclined to be first author. Since the first author and corresponding author are the most

important individuals among the authors of an article, [26] it can be said Iran is in relatively good status and a small number of highly cited articles of Iran is due to sub collaboration of researchers with other countries. The findings suggest that highly cited papers of Iran in the medical fields have been more of the result of international collaboration, while in non-medical areas it has been the result of national collaboration. Single-author papers constitute a small percentage of highly cited articles of Iran.

Furthermore, in relation to international collaboration, the highest level of participation has been with the countries of America, Canada and Great Britain, respectively. The other studies that were conducted in the medical fields show more collaboration corresponding to America. [27- 30]**.** Since one of the important elements that can help to promote quality of research is international scientific collaboration [31-32], the development of scientific collaboration at the international level for scientific planning and policy making should be considered.

CONCLUSION

To sum up, the results of the research indicate that assessment of the quality and quantity of non-medical fields has more favorable status than the medical ones. However, there are various reasons for this difference in these fields. One important reason is the difference in the subject areas covered by the two groups. It is a fact that the citation patterns differ from one subject area to another. For example, articles in the field of molecular biology and genetics are normally cited more than 500 times to pharmaceutical articles and no citation to humanities articles [33]. In this regard, Ebrahimi and Hayati stated that as the fields of medical sciences are professional fields where the development of science is associated with action, many medical articles are frequently studied and are practically used to improve diseases; however, in the Science Citation Index, there is the possibility of not to be cited for such articles. In this case, judgment is very difficult to introduce such articles as the low-quality articles and this issue is one of the limitations to use Scientometric indicators, including citation in assessing the scientific quality of researches.

They also noted that the deficiency of laboratory facilities and novel medical technologies could be one reason for decreasing the quality of scientific publications in comparison to the other fields [21]. For this reason, it can be said that the Ministry of Health and Medical Education and medical universities should pay more attention to providing facilities and funds for researches, and planning and policy making for producing more high quality papers. It is worth mentioning that the limitation of this study was related to 2 subject areas: "Biochemistry and Molecular Biology". The fact that we divided the papers into medical or non-medical subject areas could not change the outcome. According to the findings, it can be said the scientific publications and presence of Iran in the international standing is not in the merit of our country and it should be noted the effectiveness in the global science structure is taken into consideration and has been emphasized in many upstream documents, including the 20-year-old visions of the Islamic Republic of Iran [28]. For this purpose, Islamic Republic of Iran should provide specialized planning in this context.

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