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Highly Cited Papers in Medical Fields: Scientometric Indicators and collaboration in OIC countries

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Highly Cited Papers in Medical Fields: Scientometric Indicators and collaboration in OIC countries

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Abstract: *Some OIC countries have been growing rapidly in terms of international scientific publication.The purpose of this study was to determine the number of highly cited papers, the scholarly impact, H-index, Y-index, and the status of scientific collaboration among Islamic countries in medical fields. The research population included the highly cited papers in medical subject fields of all Islamic countries based on ESI. The Islamic world accounts for 1,338 (2.58%) of the world's highly cited papers in medical fields, showing a rising trend from 2007–2017. Turkey, Saudi Arabia, and Iran rank first to third, respectively, in terms of the number of highly cited papers and the H-index. Turkey, Saudi Arabia, and Pakistan rank in the top three in terms of citation. Iran has published the largest number of papers by the first author and corresponding author, while Turkey and Saudi Arabia rank second and third, respectively. Collaboration among Islamic countries is low. Most of the highly cited papers from Islamic countries are a result of international collaboration with other countries. The impact of scientific papers from Islamic countries is very low. In order To increase the effectiveness of the papers, planning and policymaking in these countries should be reviewed.*

Keywords: Highly cited papers; Islamic countries; scientific collaboration; scientometrics

1. Introduction

In the world today, the advancement and development of countries are based on science and knowledge [1] . The determination of scientific status and the basis for the comprehensive development of the various countries depends on the extent of their knowledge products and research as well as their global functional findings. It can be said with certainty that there is a direct relationship between research and technology, and the rate of advancement and development in these countries[2–4] . With 57 countries, the Islamic world holds about a quarter of the world's population and 70 percent of the world's oil and gas energy. Some of these countries have undertaken different plans in recent decades to increase their scientific presence worldwide and have been growing rapidly in terms of international scientific publication. For example, in recent

years, Turkey, Saudi Arabia, and Iran have been paying much attention to research output and have succeeded in increasing the number of their scientific publications (5) .

However, Schopper (2006) pointed out that in comparison to other countries, Islamic countries should take great steps to develop their science and technology; otherwise, they will be a risk of their lag from the global economy [6] . If a country desires to play a more effective role in the modern world, it should compete with other countries in terms of science and technology, and in this regard planning is not possible without the knowledge of the current state of scientific products of these countries[7,8] . Sustainable development in these countries, policymaking, and planning require the study of the status of scientific publications in these countries. Scientometric indicators can be used for this purpose [9,10].

In simple terms, scientometrics is the knowledge of measuring science, which includes all quantitative and qualitative methods related to the production and dissemination of knowledge and technology and, by analyzing these aspects, it contributes to a proper understanding of scientific research [11,12]. The Essential Science Indicators (ESI), a subset of the Web of Science (WOS), is a unique set and an analytical and research tool widely used by scientometric indicators for scientific evaluations of institutions and researchers. It also has high accuracy. After calculating the number of WOS citations in each research field, if the institute or scientist belongs to the top one percent of institutions and scientists, and the journal or country is one of the top journals and countries, it will be recorded in this database. In other words, highly cited papers in this database are among the top one percent of international publications.

The choice of authors, journals, or institutions to be recorded in the database of ESI is based on the number of citations over 10 years. The lack of the name of a scientist, institution, or journal in this database means that it did not meet the threshold for its presence in the ESI. Twenty-two research fields are determined in ESI. By searching each of these, we can have access to its set of highly cited papers.

The medical fields are of particular importance in promoting health, preventing and treating diseases. Many of these cases are represented in scientific papers. Therefore, the study of the scientific publications of these fields and this evaluation is of particular importance. The present

study intended to evaluate the scientific publications from Islamic countries in medical fields by simultaneously studying quantitative and qualitative scientometric indicators to provide the necessary data for the policymaking and planning of Islamic countries to achieve a desirable scientific position globally.

The scientometric indicators discussed in the present study were as follows:

Number of papers: This index measures the productivity of researchers or research groups widely used in evaluations [13–15].

Number of citations: This index is, in fact, a step beyond the number of papers and is used to measure the impact of papers, journals, and researchers on scientific communities. A large number of citations is an indicator of a prominent paper [13–16].

Average citation per paper: It is used to evaluate the quality and influence of scientific products. It allows a comparison of organizations and researchers with different research backgrounds and is obtained by dividing the number of citations by the number of papers [12].

H-index: This index is obtained from the combination of publications and citation data. The scientist, organization, or country index is H if its H papers have at least H citation. The H-index has a lot of advantages, including combination of both quantity (number of papers) and quality (impact or citations) and easy to calculate and understand[15] .

Y-index: It is used to study the authors' performance in scientific research. Given the central role of the first author and the corresponding author in scientific research and immorality in research, the Y-index is proposed for this purpose[17,18] .

The following formula is used to calculate a country's Y-index:

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

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

FP depicts the number of papers in which the first author is from the given country, and RP is the number of papers in which the corresponding author is from the given country.

The parameter j shows only the number of products based on the important positions of the authors, which is calculated on the basis of the number of papers by the first author and the corresponding

author in accordance with formula 1. A larger j in the studied unit (a country, university, educational institution, etc.) indicates that the authors of that university have produced more papers as the first or the corresponding author. The parameter h shows the distribution of the number of products by the first author and the corresponding author. When the number of products by the first author and the corresponding author is the same, the Y-index is at 45 degrees (h=0.7854). When h<0.7854, most of the products are shown to be related to the corresponding author, and if H>0.7854, most of the products are related to the first author. When h=0, j is equal to the first author's publications, and if H=∞, j is the number of the corresponding author's products[19].

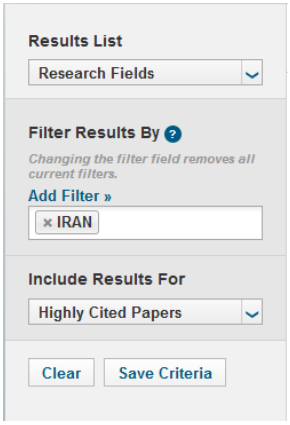
Scientific collaboration: By studying each paper and extracting the names of countries from the affiliation of authors, the degree of scientific collaboration of Islamic countries—both among each other and with other countries— is determined.

2. Materials and Methods

This research was conducted using scientometric approach. The research population included the highly cited papers of all Islamic countries indexed in the ESI in medical fields. The data were collected in October 2017. The collected data covers a ten-year and eight-month period from January 1, 2007 to February 28, 2017.

The research fields were selected based on the adaptation of 22 subject fields of the ESI with NLM classification. The research fields mentioned in the NLM classification were considered as the research fields in the present study. These fields included clinical medicine, pharmacology and toxicology, neuroscience and behavior, molecular biology and genetics, immunology, microbiology, psychiatry/psychology, and biology and biochemistry. The names of the Islamic countries were extracted from the website of the Organization of the Islamic Conference (OIC).

To search for the medical highly cited papers from these countries, we used the ESI. At first, we search and select the subject fields; then we filter the name of each Islamic country from the countries list in the "Add Filters" section, and the "Highly Cited Papers" option as follow:



The retrieved records saved in Excel. The authors' organizational affiliation, the affiliation of the first and corresponding authors, the subject area of the paper, and the numbers of citations per paper were extracted from the retrieved records. Data were analyzed using SPSS, and descriptive statistics results were recorded in tables and figures. To calculate the total number of papers from Islamic countries in the different fields, the repeated papers among the different countries were removed, and each paper was calculated only once.

Given that in each of the two subject fields of biology and biochemistry, and psychiatry/psychology, only a part of the biochemistry and psychiatry is related to medicine and science and is classified in NLM classification. We first referred to JCR to distinguish these fields, and by adapting the research area of the journals that published the highly cited papers in the mentioned fields, the biochemistry and psychiatry papers were separated from biology and psychology respectively. In the cases in which a journal was divided into both research areas, the title of the paper was reviewed and its subject area was determined with the opinion of the subject specialist. Finally, the exact number of highly cited papers in the two fields of biochemistry and psychiatry was extracted.

3. Results

The total number of Islamic countries that are members of the OIC was 57. A search of the ESI revealed that 30 Islamic countries (52.6%) have highly cited papers in the ESI medical fields. The status of the highly cited papers from the Islamic countries in the different medical fields has been reported in Appendix 1.

The number of highly cited papers from the Islamic countries in the medical fields reached 234 in 2016 from 50 in 2007 (Fig. 1). Also, the findings showed that the total number of highly cited papers

worldwide in the medical field was 51,830, of which Islamic countries, with 1,338 highly cited papers, had a share of 2.58%.

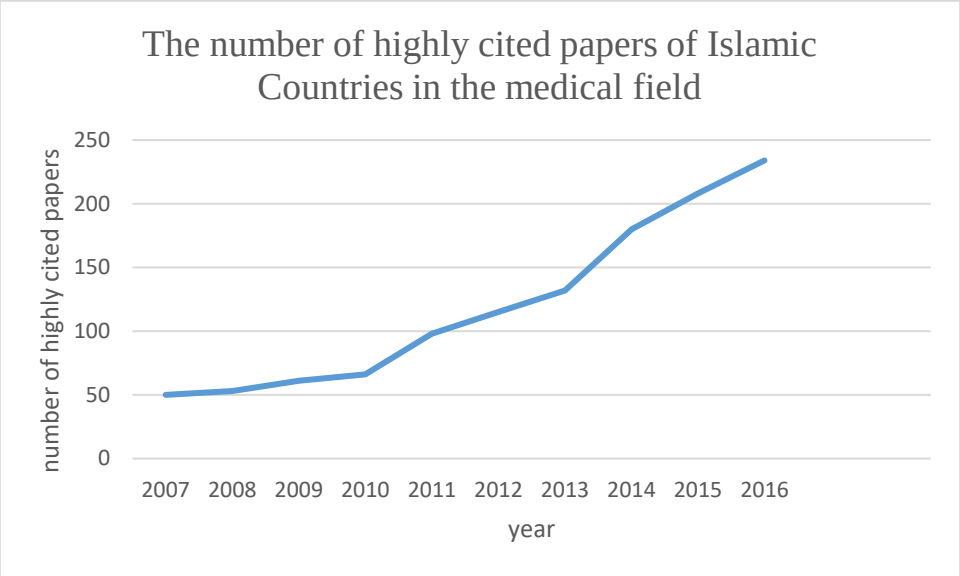


Fig. 1 - The trend of the number of highly cited papers in the medical field during 2007–2016

Table 1 shows that in terms of the number of papers and received citations, the field of clinical medicine and, in terms of average citation, the field of molecular biology and genetics has the best status. Also, a comparison of the number of highly cited papers in each field compared to the total number of highly cited papers indicated that the fields of pharmacology and toxicology, and biochemistry have the highest and lowest percentage of papers from Islamic countries respectively.

Table 1- The frequency of highly cited papers, the number of citations, and the average number of citations per paper from Islamic countries in the medical fields in ESI

Research Field	HCP of Islamic counties	citations	citations /HCP
Clinical Medicine	744	204.86	152422
Molecular Biology and Genetics	126	400.35	50445
Immunology	110	144.06	15847
Microbiology	55	147.2	8096
Neuroscience and Behavior	46	133.45	6139
Pharmacology and Toxicology	167	90.75	15156
Psychiatry	30	171.06	5132
Biochemistry	60	128.05	7683

Sum	1338	260920	195

Fig. 2 also shows the share of Islamic countries' papers to the world's highly cited papers in various medical fields. According to this figure, the fields of pharmacology and toxicology, and immunology have a higher share among the world's highly cited papers.

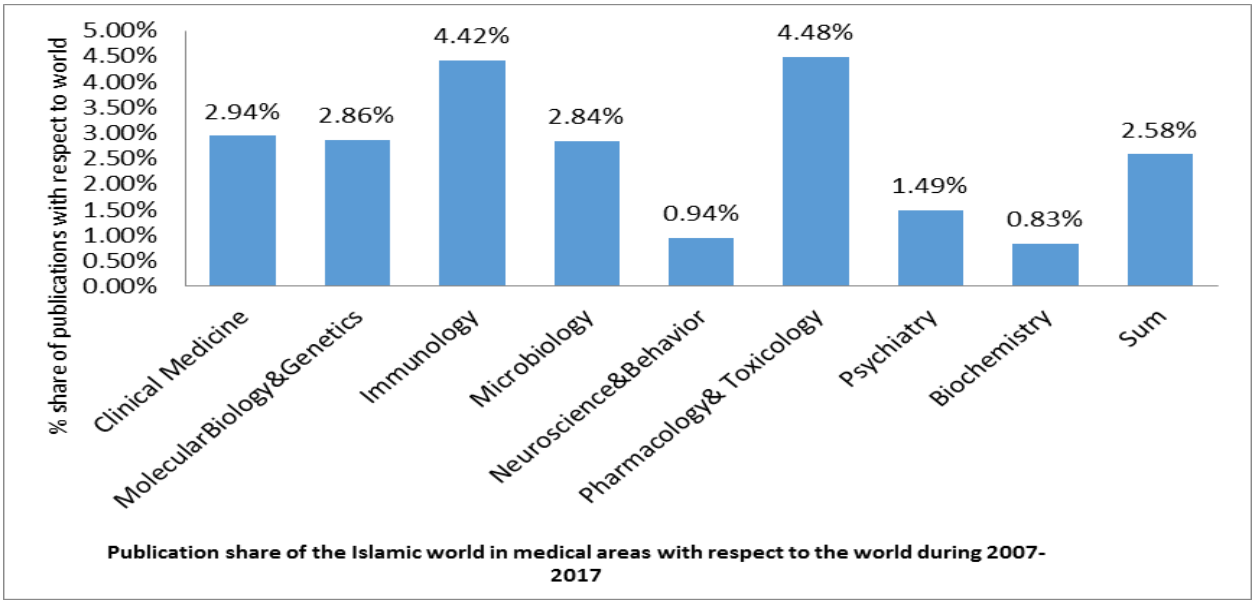


Fig. 2- The global share of highly cited papers from Islamic countries in the medical fields

In the findings, Turkey, Saudi Arabia, and Iran were ranked first to third in terms of the number of papers, H-index and the HCP ratio of Islamic countries to HCP of all the countries. In terms of the number of citations received, Turkey, Saudi Arabia, and Pakistan, in terms of the average citation per paper, Sudan, Syria, and Mozambique, and in terms of the number of WOS papers, Turkey, Iran, and Egypt were the top ones. Also, a very small percentage of papers from Islamic countries in WOS was highly cited (Table 2).

Table 2- The number of papers, citations, and the H-index of Islamic countries in different medical fields

Country	WOS (rank)	HCP (rank)	HCP/WOS	% of HCP to the all HCPs	Citations (rank)	Citations/HCP (rank)	H-INDEX (rank)
Turkey	118253(1)	347(1)	0.29 %	0.31 %	70551(1)	203.32(17)	214(1)
Saudi Arabia	27558(4)	270(2)	0.97 %	0.24 %	56082(2)	207.71(15)	195(2)
Iran	62283(2)	174(3)	0.27 %	0.15 %	32105(4)	184.51(20)	178(3)

Pakistan	19315(6)	160(4)	0.82 %	0.14 %	43126(3)	269.53(11)	143(5)
Egypt	30669(3)	143(5)	0.46 %	0.13 %	20375(6)	142.48(27)	121(6)
Malaysia	20331(5)	133(6)	0.65 %	0.12 %	20388(5)	153.29(26)	157(4)
Bangladesh	4217(11)	88(7)	2.08 %	0.08 %	17854(9)	202.88(18)	74(10)
Uganda	4049(10)	86(8)	2.12 %	0.07 %	24024(8)	279.34(9)	73(11)
Nigeria	10356(8)	82(9)	0.79 %	0.07 %	25037(7)	305.32(7)	71(13)
Lebanon	5548(9)	80(10)	1.44 %	0.07 %	17784(10)	222.3(14)	77(9)
Qatar	2981(16)	66(11)	2.21 %	0.06 %	11388(13)	172.54(22)	72(12)
United Arab Emirates	3659(15)	58(12)	1.58 %	0.05 %	10757(14)	185.46(19)	78(8)
Indonesia	4202(13)	57(13)	1.35 %	0.05 %	17188(11)	301.54(8)	90(7)
Tunisia	10769(7)	39(14)	0.36 %	0.03 %	10752(15)	275.69(10)	68(14)
Gambia	897(23)	37(15)	4.12 %	0.03 %	9667(16)	261.27(12)	38(21)
Morocco	3739(12)	36(16)	0.96 %	0.03 %	5672(19)	157.55(24)	74(10)
Jordan	4019(14)	31(17)	0.77 %	0.02 %	9623(18)	310.41(6)	58(16)
Mozambique	725(26)	30(18)	4.13 %	0.02 %	13957(13)	465.23(3)	38(21)
Cameroon	2234(18)	30(18)	1.34 %	0.02 %	4814(20)	160.46(23)	43(18)
Mali	787(25)	27(19)	3.43 %	0.02 %	3477(23)	128.77(28)	46(17)
Kuwait	2764(17)	22(20)	0.79 %	0.02 %	3426(24)	155.72(25)	41(19)
Senegal	1404(19)	22(20)	1.56 %	0.02 %	2253(26)	102.4(29)	33(23)
Oman	1260(20)	18(21)	1.42 %	0.01 %	4425(21)	245.83(13)	40(20)
Iraq	867(24)	17(22)	1.96 %	0.01 %	3528(22)	207.52(16)	30(24)
Sudan	1207(21)	13(23)	1.07 %	0.01 %	9830(17)	756.15(1)	38(21)
Burkina Faso	713(27)	7(24)	0.98 %	0.006 %	2443(25)	349(5)	21(27)
Gabon	348(28)	7(24)	2.01 %	0.006 %	610(29)	87.14(30)	36(22)
Algeria	966(22)	5(25)	0.51 %	0.004 %	2093(27)	418.6(4)	61(15)
Syria	128(30)	3(26)	2.34 %	0.002 %	2055(28)	685(2)	27(26)
Benin	280(29)	2(27)	0.71%	0.001 %	367(30)	183.5(21)	29(25)

The findings of Table 3 show that in the medical fields, the highly cited papers are the result of international collaboration with non-Islamic countries. Most papers written by an author (5%) were in the field of biochemistry. The most national collaboration and collaboration among Islamic countries was in the field of pharmacology and toxicology. The most collaboration with non-Islamic countries (about 83%) was in the field of microbiology, and in total, the most international collaboration was in the field of molecular biology and genetics.

Table 3- The frequency of national and international collaboration and highly cited papers from Islamic countries in various medical fields

Research Field	National Collaboration N(P)	International Collaboration (I.C.)				One Author N(P)
		Islamic Countries N(P)	Non-Islamic Countries N(P)	Islamic &Non Islamic Countries N(P)	Total I.C. N(P)	
Clinical Medicine	25 (3.36 %)	3 (0.4 %)	560 (75.27 %)	151 (20.30 %)	714 (95.97%)	5 (0.67 %)
Molecular Biology & Genetic	4 (3.18 %)	0 (0%)	88 (69.84 %)	34 (26.98 %)	122 (96.83%)	0 (0%)
Immunology	0 (0%)	0 (0%)	66 (60%)	44 (40 %)	110 (100%)	0 (0%)
Microbiology	3 (5.45 %)	0 (0%)	46 (83.64%)	6 (10.91 %)	52 (94.55%)	0 (0%)
Pharmacology & Toxicology	57 (34.13 %)	9 (5.39%)	87 (52.10 %)	6 (3.59%)	102 (61.08%)	8 (4.79%)
Neuroscience & Behavior	5 (10.87 %)	0 (0%)	37 (80.43 %)	4 (8.70%)	41 (89.13%)	0 (0%)
Biochemistry	9 (15 %)	2 (3.33 %)	38 (63.33%)	8 (13.34 %)	46 (80%)	3 (5 %)
Psychiatry	4 (13.33 %)	0 (0%)	21 (70%)	5 (16.67%)	26 (86.67%)	0 (0%)
Sum	107 (7.99 %)	14 (1.05 %)	943 (70.48)	258 (19.28)	1215 (90.80%)	16 (1.20%)

Table 4 shows the status of national and international collaboration of various Islamic countries. Iran had the highest levels of national collaboration (23.56%). Malaysia had the most collaboration with Islamic countries (4.02%). Turkey had the highest collaboration with non-Islamic countries (65.7%), and Kuwait had the highest percentage of papers written by one author (4.54%).

Table 4- The frequency of National and International Collaboration of Islamic Countries in Medical Fields

Country	National Collaboration N (P)	International Collaboration (I.C.)				One Author N(P)
		Islamic Countries N(P)	Non-Islamic Countries N(P)	Islamic &Non Islamic Countries N(P)	Total I.C. N(P)	
Turkey	29 (8.35 %)	1 (0.28 %)	228 (65.7 %)	86 (24.78%)	315 (90.77%)	3 (0.86 %)
Saudi Arabia	5 (1.85 %)	1 (0.4 %)	176 (65.18%)	88 (32.59 %)	265 (98.14 %)	0
Iran	41 (23.56%)	2 (1.14 %)	63 (36.2 %)	61 (35.05 %)	126 (72.41 %)	7 (4.02 %)
Pakistan	4 (2.5 %)	1 (0.62%)	64 (40 %)	91 (52.29 %)	156 (97.5 %)	0
Egypt	12 (8.39%)	4 (2.79 %)	57 (39.86 %)	67 (46.85 %)	128 (89.51 %)	3 (2.09 %)
Malaysia	9 (6.76 %)	4 (3 %)	66 (49.62 %)	53 (3.98 %)	123 (92.48 %)	1 (0.75 %)
Bangladesh	3 (3.4%)	1 (1.13 %)	25 (28.4 %)	59 (67.04 %)	85 (96.59 %)	0
Uganda	0	0 (0 %)	45 (52.32 %)	41 (47.67 %)	86 (100 %)	0
Nigeria	0	0 (0%)	26 (31.70%)	56 (68.29 %)	82 (100 %)	0
Lebanon	2 (2.5 %)	1 (1.25 %)	33 (41.25 %)	44 (55 %)	78 (97.5 %)	0
Qatar	1 (1.51 %)	0	34 (51.51 %)	31 (46.96 %)	65 (98.48 %)	0
United Arab Emirates	0	0	26 (44.82%)	32 (55.17 %)	58 (100%)	0
Indonesia	0	0	27 (47.36 %)	30 (52.63 %)	57 (100 %)	0
Tunisia	0	0	14 (35.89 %)	25 (64.1 %)	39 (100%)	0

Gambia	0	0	8 (21.62 %)	29 (78.37 %)	37 (100 %)	0
Morocco	0	0	5 (13.88 %)	31 (86.11 %)	36 (100 %)	0
Jordan	0	0	5 (16.12 %)	25 (80.64%)	30 (96.77%)	1 (3.22 %)
Mozambique	1 (3.33 %)	1 (3.33 %	7 (23.33 %)	21 (70 %)	28 (93.33 %)	0
Cameroon	0	0	6 (20 %)	24 (80%)	30 (100%)	0
Mali	0	0	5 (18.51%)	22 (81.48%)	27 (100%)	0
Kuwait	0	0	10 (45.45 %)	11 (50 %)	21 (95.45 %)	1 (4.54 %)
Senegal	0	0	13 (59.09 %)	9 (40.9 %)	22 (100 %)	0
Oman	0	0	3 (16.66 %)	15 (83.33 %)	18 (100%)	0
Iraq	0	0	2 (11.76 %)	15 (88.23 %)	17 (100 %)	0
Sudan	0	0	1 (7.69 %)	12 (92.3 %)	13 (100 %)	0
Burkina Faso	0	0	1 (14.28 %)	6 (85.71 %)	7 (100 %)	0
Gabon	0	0	4 (57.14 %)	3 (42.85 %)	7 (100 %)	0
Algeria	0	0	1 (20 %)	4 (80 %)	5 (100 %)	0
Syria	0	0	0	3 (100 %)	3 (100 %)	0
Benin	0	0	1 (50 %)	1 (50 %)	2 (100 %)	0

Fig. 3 shows that the first author or the corresponding author was from Iran in only 50% of the papers. Table 5 shows that the first author or the corresponding author was from an Islamic country in only a few highly cited papers. Compared to other countries, Iran had more papers by the first author or the corresponding author, and had higher scores in terms of parameter J. Turkey and

Saudi Arabia ranked second and third respectively. The obtained value of parameter h for the countries showed that in 13 countries, most of the main products were related to the first author, with the highest value for Turkey, followed by Iran and Lebanon.

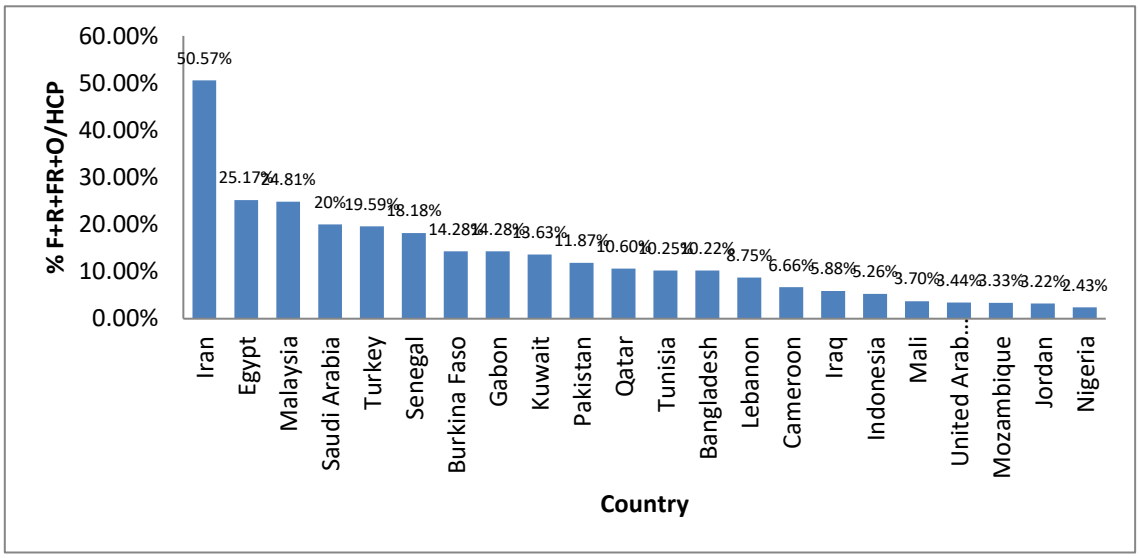


Fig. 3- The Major Roles of Islamic Countries in Highly Cited Medical Papers

Fig. 4 shows that in 69.46% of the papers in the field of pharmacology and toxicology, the first author or the corresponding author was from an Islamic country. As Table 6 shows, in terms of the J index score, the papers in this field have a better status than the other studied fields. The value obtained for the h parameter for different fields also showed that the authors' tendency of the Islamic countries was toward the first author in all fields except for biochemistry, and the highest value of this parameter was related to the field of pharmacology and toxicology.

Also, in 347 papers (25.93%) of the highly cited papers, the authors from Islamic countries appeared in the main roles (the first or corresponding author).

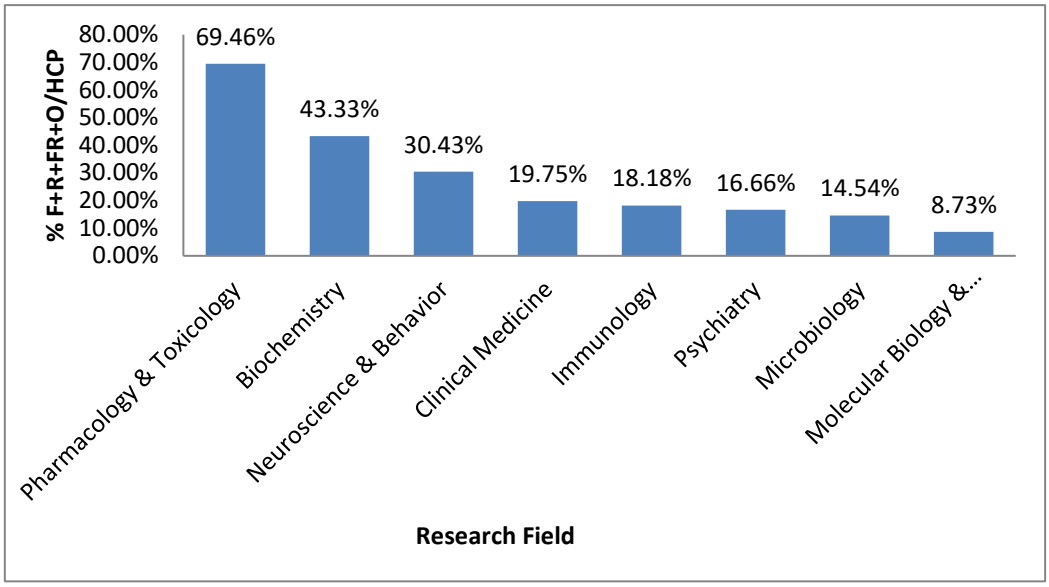


Fig. 4- Major Roles in Highly Cited Medical Papers in Islamic Countries

4. Discussion

The study results showed that the number of publications has been growing during the studied years.

Only 30 countries (52.6%) from OIC countries had highly cited papers, the total of which was 1,338, which accounted for 2.58% of the global share. It should be noted that these countries do not have a share in all medical fields. For example, Turkey, Iran, and Saudi Arabia have had highly cited papers in eight areas, and countries like Sudan and Lebanon, only in two to three fields.

There are several reasons for the great difference among the Islamic countries in the production of scientific papers. The Islamic countries are different in terms of research and economic production structure. Some countries have economic plans based on oil while others have it based on agriculture. This affects the distribution of investment in research and development. In addition, the policies of the development of scientific disciplines in the Islamic countries affect this, revealing the fact that, in general, Islamic countries need serious investments in research and development. In terms of the population structure, the number of educated people and researchers in Islamic countries is also much lower than that in advanced countries [20]. Also, some Islamic countries that have been at the bottom of the present study tables, such as Sudan, Iraq, and Syria, have been involved in wars in recent years, and this affects scientific development.

Among the OIC member countries, many (n=27) are not present in the production of medical science globally. Perhaps the factors behind this are the very poor economic status, as well as cultural poverty and lack of literacy in these countries. Even in the Islamic countries—especially those in the Persian Gulf—whose income is based on oil, which have a better economic status and financial resources at their disposal, few can manage scientific research and development for a global presence [9,10]. Butler (2006) reviewed the research and development budget of the Islamic countries and showed that on average, the research and development budget of Islamic countries was 0.34% of the GDP[20]. The global average is 2.36% and this small investment by OIC countries in research shows its effect on the low level of scientific publications at the global level. Another important factor is the official language of the studied countries. In most of the Islamic countries, the official language is Arabic, while most of the indexed papers in the WOS database are published in English. Due to the weakness of the Islamic countries in this field, they cannot successfully translate their scientific publications into English and should pay more attention to this [21].

Sarwar and Hassan (2015) pointed out that the citation rank of the Islamic countries is much lower than the rank of these countries in terms of publication, the level of scientific citation, and the impact of these countries compared to advanced countries, and if they want to reduce this gap, they should have short- and long-term plans to increase research internationally[9]. The same is stated in the Appendix 1 of the present study. For example, the rank of papers of Turkey and Iran is 39 and 25 respectively, and the citation rank of these countries is 22 and 13 respectively, which indicates a lower citation rank than the publication. This could be due to the authors' distrust in the papers published from these countries and the need for more attention to these countries to publish higher-quality products. In that case, the papers of these countries can also authorize entry to ESI by obtaining more citations. Sarwar and Hassan have also pointed out that more than 50% of the publications from countries like Malaysia, Iran, and Saudi Arabia have received no citation[9]. This means that unlike the rapid growth of scientific outputs in these countries, the quality of these outputs is not desirable. In Iran, the development of graduate disciplines and the increase in the number of PhD students in recent years have made the publication of valid papers as the thesis's defense requirement, leading to an increase in the number of scientific papers in the country. However, the quality of these outputs is still not acceptable. Ho (1999) also noted that there is no

shortage of scholars and educated people in the Muslim world, but there is a severe shortage of professional researchers[5]. Although some of these countries have well-known researchers and research projects, they have little ability to nurture a native researcher. Many graduates who study higher education courses are attracted to administrative jobs or immigrate to other countries. Inadequate facilities and lack of access to information reduce the scientific outcomes of researchers. Efforts to create research capacities at universities, research institutes, ministries, nonprofit centers, and companies have been rarely successful. Also, applied research units in state ministries have become highly paying jobs for appointments that have no interest or ability for research.

The findings showed that in addition to the number of highly cited papers, in terms of the H-index, too, Turkey, Saudi Arabia, and Iran were ranked first to third respectively. In a study conducted by Benamer and Bakoush (2009) on biomedical research in Arab and non-Arab countries of the Middle East in the SCI database, Turkey, Saudi Arabia, and Egypt ranked among the top three in terms of the H-index [22]. In the present study, Turkey and Saudi Arabia have their position and Iran improved in terms of the H-index. Of course, in terms of the number of citations, Iran fell to the fourth rank and Pakistan got the third rank.

According to the study results, the publications of OIC countries have been the result of international collaboration, of which the highest levels of collaboration have been with non-Islamic countries. But collaboration among the Islamic countries has a low percentage. The low-level regional collaboration of the OIC countries in the field of science and technology has a prominent history in the Islamic world. The meetings that have been held in the past decade to coordinate the research in the region had a great slogan and little action. Some oil-rich countries, like Kuwait and Saudi Arabia, have a shortage of researchers, while Pakistan and Egypt have a shortage of export researchers. In addition, the similarities among the research needs and priorities, such as solar energy, desertification, and desalination, provide the same interests, which can be a good potential for collaboration [5]. Scientific collaboration among Islamic countries is necessary as part of international collaboration. As Sarwar and Hassan noted, it is one of the ways to accelerate scientific growth [9] and increase the incoming citation received [23–25].

The Y-index findings also showed that the share of Islamic countries' authors in important roles (first author and corresponding author) is faded and they should try to be more pronounced in their publications.

Regarding the evaluation indicators, the findings of the present study confirmed the findings of past research that referred to the small share of OIC member countries in the production of knowledge and technology [9,10,26].

Finally, it can be said that the few scientific achievements of OIC countries are due to several factors. Some of these factors have been mentioned in the discussion as well as by authoritarian governments. These include the neglect of research by governments, the absence of active specialized associations, low level of international communication by universities, a technology transfer pattern, mistrust among elites and academic institutions. All these have a negative impact on the development of indigenous capacities [5,27].

Judging the scientific ability of a nation is important for the country's scientific policymakers; it provides them with the opportunity to decide and prioritize [10]. Hence, the findings of this study can be used to determine part of the scientific ability of Islamic countries. To flourish and develop in this regard, the development of specialist human resources and the allocation of funds for research and development in the short term should be considered. Also, more collaboration with Islamic and other countries is suggested, and so is playing the role of the first or the corresponding author.

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References

1. King DA. The scientific impact of nations. Nature. 2004;430:311–6.
2. May RM. The Scientific Wealth of Nations. Science (80-). 1997;275(5301):793–6.
3. Bollen J, Van de Sompel H, Hagberg A, Chute R. A principal component analysis of 39 scientific impact measures. PLoS One. 2009;4(6).
4. Hodhodinezhad N, Zahedi R, Ashrafi-rizzi H, Shams A. A scientometric study of general

internal medicine domain among Muslim countries of Middle East (1991-2011). Acta Inform Medica. 2013;21(1):55–9.

5. Ho SKM. Operations and Quality Management. International Thomson Business Press; 1999. (ITBP Textbooks Series).
6. Schopper H. Islam and science: Where are the new patrons of science? Nature. 2006;444(7115):35–6.
7. Collazo-Reyes F. Growth of the number of indexed journals of Latin America and the Caribbean: The effect on the impact of each country. Scientometrics. 2014;98(1):197–209.
8. Archambault A, Mongeon P, Larivière V. On the effects of the reunification on German researchers' publication patterns. Scientometrics. 2017;
9. Sarwar R, Hassan S-U. A bibliometric assessment of scientific productivity and international collaboration of the Islamic World in science and technology (S&T) areas. Scientometrics. 2015;105(2):1059–77.
10. Estes RJ, Tiliouine H. Development Trends in Islamic Societies : From Collective Wishes to Concerted Actions. Soc Indic Res. 2014;116(1):67–114.
11. Repanovici A. Measuring the visibility of the University's scientific production using GoogleScholar, "Publish or Perish" software and Scientometrics. Sci Technol Libr. 2010;(July 2011):1–14.
12. Franceschini F, Maisano D. The Hirsch spectrum: A novel tool for analyzing scientific journals. J Informetr. 2010;4(1):64–73.
13. Link AN, Vonortas NS. Handbook on the Theory and Practice of Program Evaluation. Edward Elgar Publishing; 2013. 249-323 p. (Elgar Original Reference Series).
14. Durieux V, Gevenois PA. Bibliometric indicators: quality measurements of scientific publication. Radiology. 2010;255(2):342–51.
15. Hirsch JE. An index to quantify an individual's scientific research output. Proc Natl Acad Sci U S A. 2005;102(46):16569–72.
16. Kulkarni A V, Aziz B, Shams I, Busse JW. Comparisons of Citations in Web of Science ,. Jama. 2009;302(10):1092–6.
17. Mattsson P, Sundberg CJ, Laget P. Is correspondence reflected in the author position? A bibliometric study of the relation between corresponding author and byline position. Scientometrics. 2010;87(1):99–105.
18. Ho YS. Classic articles on social work field in Social Science Citation Index: A bibliometric analysis. Scientometrics. 2014;98(1):137–55.
19. Ho YS. The top-cited research works in the Science Citation Index Expanded. Scientometrics. 2013;94(3):1297–312.
20. Butler D. Islam and Science: The data gap. Nature. 2006;444(7115):26–7.
21. Mehrad, Jafar; naseri M. The Islamic World Science Citation Center : A New Scientometrics System for Evaluating Research Performance in OIC Region. 2016;(March).
22. Benamer HTS, Bakoush O. Arab nations lagging behind other Middle Eastern countries in biomedical research: a comparative study. BMC Med Res Methodol. 2009;9(1):26.
23. Moed HF. Citation Analysis in Research Evaluation. Springer Netherlands; 2006. (Information Science and Knowledge Management).
24. Rousseau R. Are multi-authored articles cited more than single-authored ones? Are

collaborations with authors from other countries more cited than collaborations within the country? A case study. In Berlin: Gesellschaft für Wissenschaftsforschung; 2001.

25. Van Raan A. The influence of international collaboration on the impact of research results: Some simple mathematical considerations concerning the role of self-citations. Scientometrics. 1998;42(3):423–8.
26. Mehrad J, Gazni A. Scientific impact of Islamic nations. Int J Inf Sci Manag. 2010;8(2):39–56.
27. Potrafke N. Democracy and countries with Muslim majorities: A reply and update. Public Choice. 2013;154(3–4):323–32.

Appendix 1- The status of highly cited papers from Islamic countries according to different medical fields in ESI

Fields / country	Clinical Medicine				Molecular Biology &Genetic				Immunology				Microbiology				Pharmacology & Toxicology			
	WOS[1]	HCP	C[2]	C/P[3]	WOS	HCP	C	C/P	WOS	HCP	C	C/P	WOS	HCP	C	C/P	WOS	HCP	C	C/P
Turkey	78022 (13)[4] (22)[5]	236	47246	200.19	3155 (29)[4] (36)[5]	33	12177	369	2271 (26)[4] (35)[5]	21	4630	220.47	2233 (28)[4] (41)[5]	2	255	127.5	6007 (19)4 (26)[5]	19	1905	100.26
Iran	26165 (25)[4] (39)[5]	85	21004	247.1	3073 (30)[4] (46)[5]	13	3423	263.30	2229 (27)[4] (42)[5]	4	460	230	3489 (16)[4] (38)[5]	2	336	168	7318 (15)[4] (22)[5]	57	4324	75.85
Saudi Arabia	11641	128	27277	213.1	1948 (38)[4]	49	20540	419.18	1026	22	2392	108.72	1347	15	1102	73.46	3431	23	1778	77.3
Pakistan	8229	110	30385	276.22	1100	20	6737	336.85	616	9	3836	432.88	995	6	912	152	3372	7	632	90.28
Egypt	12912 (35)[4] (42)[5]	96	11759	122.48	1248	6	4524	754	1062	9	706	78.44	1762 (32)[4] (42)[5]	-	-	-	4833 (22)[4] (32[5])	27	2531	93.74
Malaysia	8851	80	13936	174.2	1337	8	1650	206.25	778	6	1233	205.5		5	164	32.8	2775	20	1920	96
Nigeria	5172	56	16496	294.57	210	8	4460	557.5	673	3	75	25	657	2	473	236.5	1469	1	187	187
Uganda	1971	65	20852	320.8	84	4	891	222.75	1438 (37)[4] (39)[5]	9	1058	117.5	315	7	1154	164.85	161	1	69	69
Lebanon	2946	51	11858	232.5	348	5	1421	284.2	280	4	403	100.75	121	-	-	-	302	4	501	125.25

[1] Number of WOS papers
[2] Number of Citations of HCP
[3] Citation/HCP
[4] Rank of WOS documents among all countries in the world (This section is only for a few more ranked countries)
[5] Rank of WOS Citations among all countries in the world (This section is only for a few more ranked countries)

Tunisia	4135	25	6775	271	681	1	26	26	517	6	2862	477	824	-	-	-	862	3	454	151.33
Indonesia	1591	45	15580	346.22	258	1	5	5	472	5	814	162.8	349	5	774	154.8	479	-	-	-
United Arab Emirates	2256	43	7898	183.67	378	5	1539	307.8	192	3	302	100.66	105	2	299	149.5	449	1	188	188
Bangladesh	1549	55	14034	255.16	259	3	726	242	645	20	1068	53.4	371	4	1393	348.25	509	5	563	112.6
Qatar	2096	42	8502	202.42	297	10	2088	208.8	205	6	493	82.16	-	-	-	-	216	5	141	28.2
Jordan	2196	26	7603	292.42	175	2	1898	949	-	-	-	-	102	-	-	-	625	-	-	-
Mozambique	448	28	12135	433.39		-	-		277	2	1822	911	-	-	-	-	-	-	-	-
Kuwait	1940	14	2302	164.42	119	1	126	126	174	3	483	161	132	-	-	-	223	2	316	158
Morocco	2450	23	3802	165.3	234	3	314	104.66	258	7	1220	174.2	194	1	53	53	356	1	90	90
Sudan	602	10	8538	853.8	96	2	1117	558.5	209	1	175	175	153	-	-	-	147	-	-	-
Cameroon	993	21	3421	162.9		3	853	284.3	433	2	75	37.5	327	4	465	116.25	481	-	-	-
Gambia	371	17	4169	245.23	71	5	5292	1058.4	373	15	206	13.73	82	-	-	-		-	-	-
Oman	826	15	3910	260.6	133	2	486	243	-	-	-	-	-	-	-	-	194	1	29	29
Senegal	669	14	1320	94.28	89	2	161	80.5	398	6	772	128.6	248	-	-	-	-	-	-	-
Mali	399	9	2306	256.2	51	2	755	377.5	274	15	347	23.13	63	1	69	69	-	-	-	-
Iraq	719	13	3087	237.46	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gabon	-	-	-	-	-	-	-	-	201	2	179	89.5	147	5	431	86.2		-	-	-
Burkina Faso	-	-	-		82	2	290	145	356	4	2084	521	197	1	69	69	78	-	-	-
Algeria	-	-	-		129	1	26	26	154	3	1851	617	247	1	216	216	366	-	-	-
Benin	-	-	-	-	-	-	-	-	166	1	29	29	114	1	338	338	-	-	-	-

Syria	-	-	-	-	-	-	-	-		45	3	2055	685	-	-	-	-	83	-	-	-
Sum	17914 9	130 7	30202 6	231.08	15555	191	71525	374.47	1572 2	191	3163 0	165.6	14574	64	850 3	132.8	34736	177	1562 8	88.29

Appendix 1- The status of highly cited papers from Islamic countries according to different medical fields in ESI… continued

Fields / Countries	Neuroscience & Behavior				Psychiatry				Biochemistry			
	WOS	HCP	C	C/P	WOS	HCP	C	C/P	WOS	HCP	C	C/P
Turkey	6463 (20)[4] (30)[5]	19	3008	158.31	3828	4	491	122.75	6223	13	839	64.53
Iran	3059 (29)[4] (39)[5]	3	661	220.33	1098	1	25	25	7377	9	1872	208
Saudi Arabia	1083 (42)[4] (45)[5]	9	855	95	195	1	39	39	3346	23	2099	91.26
Pakistan	347	2	190	95	194	1	96	96	2134	5	338	67.6
Egypt	838	2	123	61.5	218	1	74	74	3789	2	658	329
Malaysia	768	7	539	77	439	1	39	39	2472	6	907	151.16
Nigeria	307	1	344	344	411	10	2403	240.3	523	1	599	599
Lebanon	343	-	-	-	239	15	3555	237	365	1	46	46
Tunisia	382	1	186	186	139	2	143	71.5	1545	1	306	
Indonesia	105	0	-	-	-	-	-	-	474	1	15	15
United Arab Emirates	279	4	531	132.75	-	-	-	-	-	-	-	-
Bangladesh	80	-	-	-	-	-	-	-	402	1	70	70
Qatar	167	3	164	54.66	-	-	-	-	-	-	-	-
Jordan	203	1	5	5	-	-	-	-	359	2	117	58.5
Kuwait	176	2	199	99.5	-	-	-	-	-	-	-	-
Morocco	247	1	193	193	-	-	-	-	-	-	-	-

Iraq	-	-	-	-	74	4	441	110.25	-	-	-	-
Oman	107	-	-	-	-	-	-	-	-	-	-	-
Uganda	80	-	-	-	-	-	-	-	-	-	-	-
Algeria	70	-	-	-	-	-	-	-	-	-	-	-
Sum	15104	55	6998	127.23	6835	40	7306	182.65	29009	65	7866	121.01