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A Bibliometric Analysis and Visualization of the Scientific Publications of Universities: A Study of Hamadan University of Medical Sciences during 1992-2018

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Abstract

The evaluation of universities from different perspectives is important for their scientific development. Analyzing the scientific papers of a university under the bibliometric approach is one main evaluative approach. The aim of this study was to conduct a bibliometric analysis and visualization of papers published by Hamadan University of Medical Science (HUMS), Iran, during 1992-2018. This study used bibliometric and visualization techniques. Scopus database was used for data collection. 3753 papers were retrieved by applying Affiliation Search in Scopus advanced search section. Excel and VOSviewer software packages were used for data analysis and bibliometric indicator extraction. An increasing trend was seen in the numbers of HUMS's published papers and received citations. The highest rate of collaboration in national level was with Tehran University of Medical Sciences. Internationally, HUMS's researchers had the highest collaboration with the authors from the United States, the United Kingdom and Switzerland, respectively. All highly-cited papers were published in high level Q1 journals. Term clustering demonstrated four main clusters: epidemiological studies, laboratory studies, pharmacological studies, and microbiological studies. The results of this study can be beneficial to the policy-makers of this university. In addition, researchers and bibliometricians can use this study as a pattern for studying and visualizing the bibliometric indicators of other universities and research institutions.

Keywords

Scientific publications; Bibliometric analysis; Visualization; Co-authorship

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Introduction

One main criterion for determining the scientific placement of a country is the scientific publications produced by its universities and research institutes (Archambault et al., 2008). Publishing scientific papers is an inseparable part of the academic life (Chan et al., 2009) and the main output of scientific performance (Jacobson, 1997). Thousands of papers are annually published by researchers worldwide. They can be evaluated in different levels, including author, institution, country and subject levels.

Bibliometrics is a common way of evaluating scientific publications from different perspectives. Before coining the term "bibliometrics", Hulme (1923) used "statistical bibliography" in 1923. He defined statistical bibliography as a method for studying the science and technology history with counting documents and papers. In *Aslib Annual Conference* in UK in 1948, S. R. Ranganathan used the term "librametry" and explained its application (Sengupta, 1999). In 1969, Pritchard (1969) replaced the term statistical bibliography with the term bibliometrics and conceived it as the application of mathematics and statistical methods to books and other media

of communication. In line with this definition, the *British Standard Glossary of Documentation of Terms* (1976) defined bibliometrics as studying the use of documents and publication patterns by applying mathematical and statistical methods (cf. Kannan & Thanuskodi, 2019). Ackermann (2005) defined bibliometrics as the quantitative analysis of scientific texts (documents) based on publication and citation data. Bibliometrics depicts the scientific communications among authors, institutions and countries (Özkose & Gencer, 2017). As a research field, it analyses the scientific publications, citations and references (Merigó et al., 2015). It is a tool for assessing the research state in a journal, field, research institution and country. It can bridge the possible gaps in scientific knowledge and demonstrate its trend and plays a main role in the management of / and decision-making on science and technology (Romanelli et al., 2018).

50 years after its emergence, bibliometrics is ever used for research evaluation. In the past, researchers used simple bibliometric analyses for journal papers, research fields, universities and institutes. In recent years, bibliometric analysis and visualization are simultaneously used as a mixed method for making better scientometric analyses. It appears that the traditional and simple bibliometric analyses are not enough for better mapping the scientific activity and some visualization is needed. Nowadays, many software packages have been designed for facilitating bibliometric analyses. As a new approach to bibliometric studies, this can be defined as "visualization of literature" or "visualization of information" (Milojevic, 2009).

Some scientific phenomena and communications are abstract and visualization tries to detect and depict such invisible notions in the structure of science in the form of a graphical multi-dimensional map. Visualization represents the importance or significance by using a size symbol (e.g. large symbols for main categories) or color (e.g. bright colors for low-important entities) (Synnestvedt & Chen, 2005). In addition, it applies a threshold (e.g. a citation threshold for 50 authors with high citations) for determining the categories that appear in the map. In general, visualization is a powerful tool for studying the structure and dynamics of research publications. It is complementary to bibliometrics, helpful in doing better evaluation and analysis of the scientific output (Özkose et al., 2017; Noyons, 1999; Noyons, 2004; van Eck et al., 2010).

Each university or research institute should continuously monitor its past and present states for mapping its future perspectives. As one of Iranian known medical universities, the Hamadan University of Medical Sciences (HUMS), located in Hamadan province, Iran started its work in medicine, nursing and hygiene fields with the help of Université de Montpellie (UM). With 10 colleges, 17 research centers, 3 research institutes, one business incubator, one central and 12 branch and hospital libraries, HUMS is active in more than 98 disciplines in medical, para-medical and basic sciences in different educational levels. It has about 5886 students and 458 faculty members (HUMS, 2019). The first paper of the university indexed in Scopus belonged to 1992. After then, about 2000 papers of the university were indexed in Scopus. As a result, an all-inclusive study needs to be conducted for analyzing all publications of HUMS. Such a study

helps in identifying the past and present states of its research output as well as determining its weaknesses and strengths in the scientific performance. The results of this study can be beneficial to policy-makers of this university. In addition, this bibliometric and visualization study can be a pattern for analyzing the scientific performance of other universities and research institutes worldwide.

Literature Review

Bibliometrics is a main research field with a long history. After being coined, bibliomerics changed in a topic of interest and many researchers used bibiometric techniques. These studies are in four main categories: bibliometric analyses of research fields, scientific journals, publishing countries and regions, and universities and research institutes.

Some studies analyzed research fields such as RFID' publications (de Oliveira et al., 2019); tuberculosis (Nafade et al., 2018); lncRNA (Zhai et al., 2018); urban education (Liang & Wang, 2018); environmental damage (Li et al., 2018); linguistics (Mohsen et al., 2017); information architecture (Taga et al., 2017); fuzzy research (Merigó et al., 2015); welding (Layus and Kah, 2015); computer science (Uddin et al., 2015); and entrepreneurship (Landström et al., 2012).

Other studies considered scientific journals such as *Journal of Artificial Societies and Social Simulation* (Mokhtari, Roumiyani & Saberi, 2019); *Sustainability* (Tang et al., 2018a); *Journal of Infection and Public Health* (Krauskopf, 2018); *Journal of Psychology* (Tur-Porcar, 2018); *Journal of Knowledge Management* (Gaviria-Marin et al., 2018); *Journal of Religion and Health* (Şenel & Demir, 2018); *European Journal of Marketing* (Martínez-López, 2018); *International Journal of Fuzzy Systems* (Tang et al., 2018); *Journal of School Health* (Zhang et al., 2017); *European Journal of Operational Research* (Laengle et al., 2017); *Malaysian Journal of Library & Information Science* (Bakri & Willett, 2017); *Journal of Oral Research* (Corrales-Reyes et al., 2016); and *Electronic Library Journal* (Hussain, Fatima & Kumar, 2011).

The scientific publications of several regions and countries have been underwent bibliometric analyses, including among others Cuba (Corrales-Reyes et al. 2019); Iran (Chalak et al., 2018); Guatemala (Monge-Nájera & Ho, 2018); Ghana (Osei Boamah & Ho, 2018); Nicaragua (Monge-Nájera & Ho, 2017); Czech (Fiala & Ho, 2017); Spain (Bueno-Aguilera, et al, 2016); China (Jiang et al, 2014); Greek (Sachini et al., 2015); South America (Huamaní et al. 2014); Western Ghats (Saravanan, 2012); Africa (Chuang et al., 2011); South Africa (Kahn, 2011); Venezuela (Rojas-Sola & Jorda-Albinana, 2010); and Brazill (Da Luz et al., 2008).

In some bibliometric researches, the scientific publications of research institutes and universities have been studied. Some recent studies on the topic were summarized as follows.

Ahmed et al. (2019) conducted a bibliometric study, entitled as "*Bibliometric analysis of*

research publications of Al-Jouf University, Saudi Arabia, during the years 2006-2017". Using Scopus database, they found that the university published 801 papers in the studied years, with a considerable scientific growth during 2013-2017 when two-thirds of papers were published. The number of citations per paper was 4.53 with the highest citation rate amounted to 6.26 in 2016. The highest rate of national collaboration was with King Abdulaziz University. Five hundred ninety-one papers (73.78%) were authored with an international co-authorship pattern. Egypt (with 388 papers) and Malaysia (with 45 papers) ranked first and second in collaborating with the university, respectively. The most preferred journal for Al-Jouf University' authors was the *International Medical Journal*.

Darmadji et al. (2018) conducted a research under the title "*Research productivity and international collaboration of top Indonesian universities*" and identified top Indonesian universities' papers indexed in Scopus during 2001-2017. They found a significantly increased trend in the number of these papers during the studied period. The most prolific institute was the Bandung Institute of Technology with 7828 papers. Japanese researchers had the highest collaboration with co-authoring 3907 papers.

In a paper entitled as "*Research productivity at King Saud bin Abdul Aziz University for Health Sciences, Kingdom of Saudi Arabia: a bibliometric appraisal*", Haq (2017) analyzed 775 papers of the university that were indexed in Web of Science from its inception to 2015. The majority of papers (15.35%) were written on the subject of medicine. Most papers (178) were published in 2015. The majority of papers (46%) were published in the *Saudi Medical Journal*. Research cooperation with the universities of United States was the highest, with co-authoring 39 papers.

In a study titled as "*Publications of Banaras Hindu University during 1989-2016: a three-dimensional bibliometric study*", Dwivedi (2017) studied 16556 records indexed in the Web of Science. An exponential growth of publications was seen since 2005. Chemistry has maximum publications, followed by physics. Council of Scientific & Industrial Research was the main collaborator with 443 papers. The main collaborator country was the United States with 607 papers, followed by Germany with 471 papers.

Tsafe, Chiya and Aminu (2016) conducted a bibliometric research under the title "*Scholarly publications of librarians in universities in Nigeria: 2000-2012: A bibliometric analysis*". One hundred sixty five librarians from 16 universities of the country were taken for the study. Self-designed questionnaire was used for data collection. Total number of papers authored by the librarians was 373, mostly on information technology. The majority of them (56.9%) had published at least one paper. Male librarians published more (81.2%) than female librarians (18.8%).

In a paper titled as "*Bibliometric analysis of research publications of Maharshi Dayanand University (Rohtak) during 2000-2013*", Siwach and Kumar (2015) studied the research

contributions (1247 papers) of the university in terms of its publication output during 2000-2013 as reflected through Scopus database. Results showed that the average number of citations per paper was 6. The trends in published papers and received citations were increasing. The highest number of indexed papers (455 papers) belonged to chemistry. The most highly-productive journal was *Indian Journal of Heterocyclic Chemistry* with 71 papers.

Sweileh et al. (2014) published a paper titled as "*Assessing the scientific research productivity of the Palestinian higher education institutions: A case study at An-Najah National University, Palestine*". They analyzed growth, contribution, and impact of research carried out by the faculty members, researchers, or students of the university in the past 35 years. A total of 791 published papers were retrieved for this university in Scopus. Seventeen documents (2.1%) were published in *Acta Crystallographica Section E Structure Reports Online*, as the most productive journal. The majority of papers (146) were in medical field. The study identified 384 (25.8%) papers with 59 countries as foreign collaborators, with the United States as the first-ranked country with 94 papers.

In "*A bibliometric analysis of the research output of Sambalpur University's publication in Web of Science during 2007-2011*", Maharana and Sethi (2013) studied 170 papers of the university indexed in the database. Results showed that the majority of papers (47) were in chemistry. Most papers were published in *Astrophysics and Space Science Journal*. The highest indexed papers belonged to Indian Institute of Technology. The United States ranked first in collaboration with Sambalpur University.

In summarization, it can be said that considering the increasing trend in the scientific publication, evaluating the scientific performance of research institutes is necessary. Universities can use their bibliometric analyses for being informed of their strengths and weaknesses in the scientific production. By using the results of bibliometric analyses, researchers and decision-makers can detect the possible gaps, regulate grants and research resources based on these results and make correct decisions on future programs on the scientific development.

Materials and Methods

This study used bibliometric techniques and scientific visualization approaches. Scopus was applied for data collection, as the database has been used in many bibliometric studies due to its full coverage of scientific publications and citations (e.g. Sabah et al., 2019; Kamdem et al., 2019; Atayero et al., 2018; Ho et al., 2017; Kazerani et al., 2017; Rondanelli et al., 2016; Batooli et al., 2016; Zyoud et al., 2014; Zyoud et al., 2015; Yessirkepov et al., 2015; Zarei et al. 2015; Sa'ed et al., 2014).

Scopus was established in 2004 by Elsevier, one of the great international publishers in the World. It became one of the main famous citation databases. It provides the bibliographic

information and abstracts of papers as well as citation-related data of indexed journals and paper rankings based on their received citations (Falagas et al., 2008). By searching Scopus, influential authors, papers, institutions, countries and journals can be identified. It includes many items, including among others, journal articles, conference papers and proceedings, patents, books, editorial notes, letters to editor, reports, reviews and trade documents (Kulkarni et al., 2009).

For retrieving data, the "affiliation search" section in Scopus advanced search section was used for searching for all scientific publications of HUMS until 2018. As the researchers in this university used two forms for their affiliation, the following formula in advanced search section of Scopus was applied:

> AF-ID ("Hamedan University of Medical Sciences" 60006672) OR AF-ID ("Hamedan University of Medical Sciences Besat Hospital" 60089189) AND (EXCLUDE (PUBYEAR, 2019))

In total, 3753 papers were retrieved and their bibliographic data extracted. At first, the trends in publications and received citations were studied. Then, the annual citation structures as well as the h-indexes with and without self-citations were analyzed. In addition, the national and international collaborations were studied, followed by determining the more influential and highly-productive authors, highly-cited papers and highly-productive journals. At last, the main subjects of papers were depicted by the clustering technique. Excell and VOSviewer were used for data analysis. VOSviewer aims at facilitating bibliometric analyses and helpful in visualizing and mapping co-authorship, co-citation and co-occurrence patterns (Van Eck, 2009). It presents the scientific maps in various formats by focusing on specific determined aspects. Magnifying, scrolling and searching are some of its features.

Findings

Scientific publications and received citations

Figure 1 shows the frequency distribution of papers published by HUMS during 1992-2018. In total, 3753 papers published by the authors affiliated to the university. The first paper was published by H. Pour-Jafari in *Veterinary and Human Toxicology* and titled as "Alterations of libido in gased Iranian men". The highest number of papers (664) published in 2018. No paper was published in 1993. The lowest number of published papers belonged to 1992, 1995, 1996, 1997, 1999 and 2000, with only one paper in each. Three recent years (2016, 2017 and 2018) had the high numbers in published papers, including 49 percent of all papers. With an increasing trend, the number of papers increased from one paper in 1992 to 664 papers in 2018.

Figure 2 depicts the trend in citations received by the papers published by HUMS during 1992-2018. As can be seen, received citations showed an increasing trend, too. The number of received citations increased from 4 citations in 1992 to 4713 citations in 2018. As the citing process is time-consuming, the number of received citations in 2018 will certainly increase.

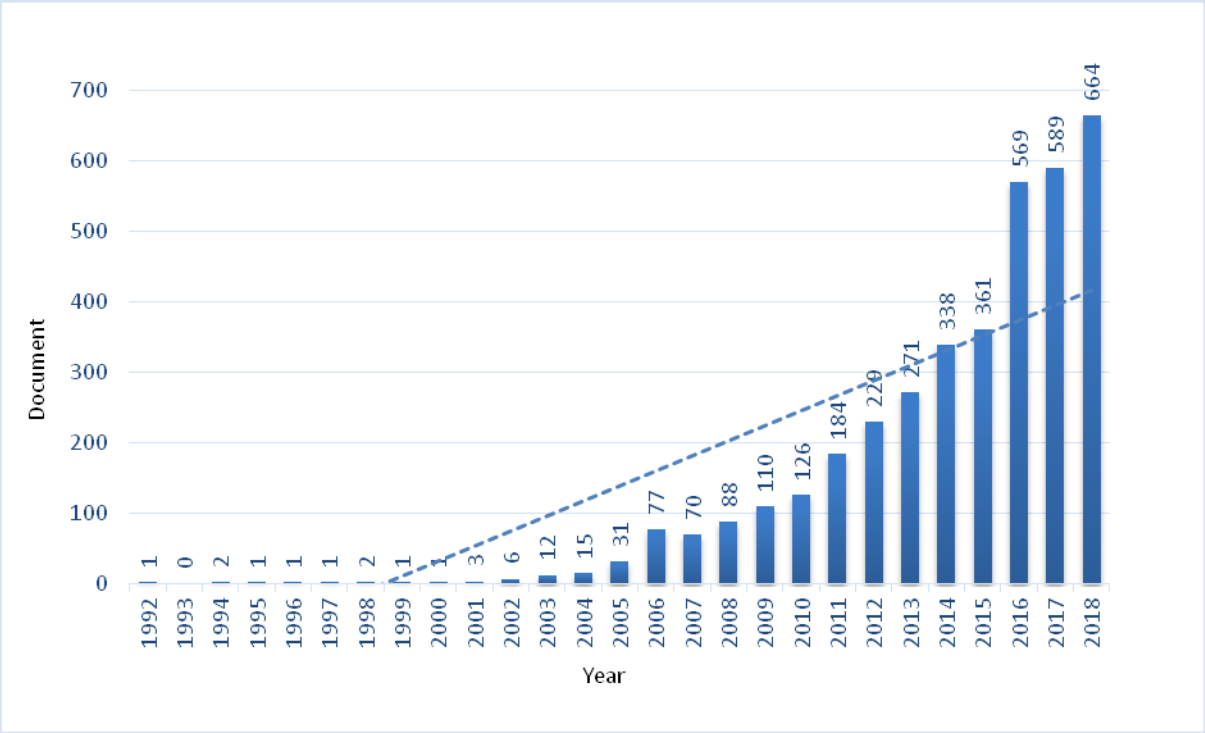

Figure 1. The frequency distribution of papers published by HUMS during 1992-2018

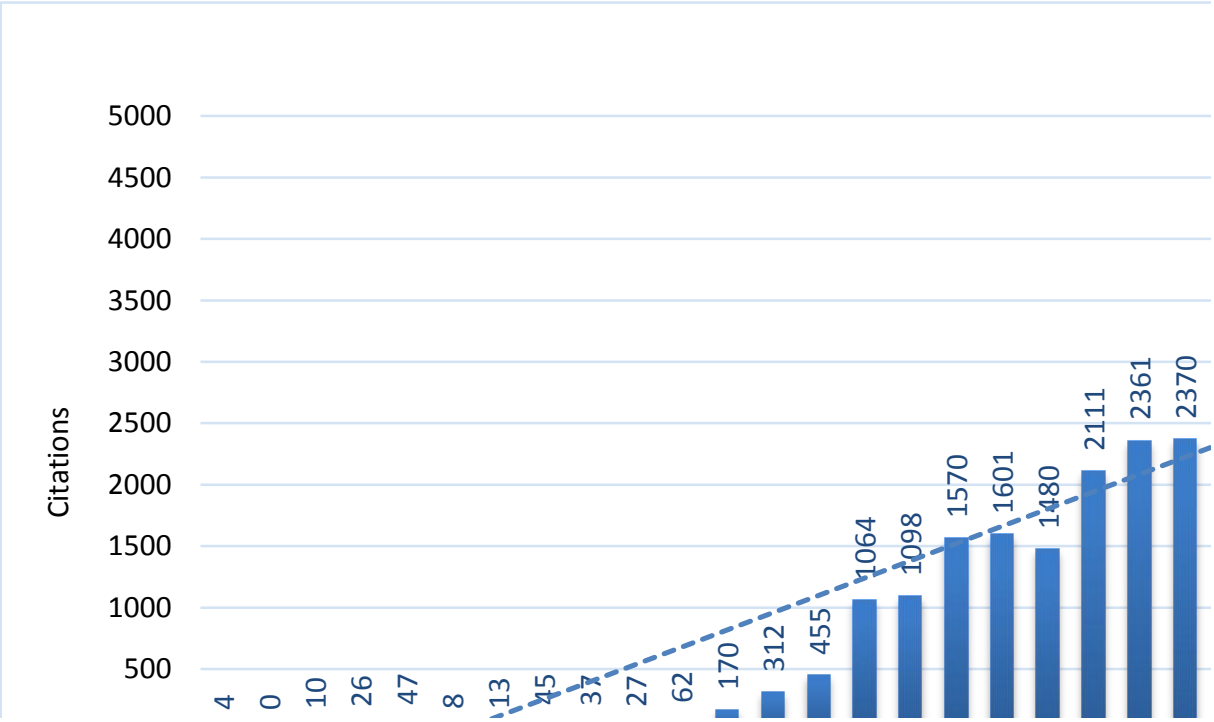

Figure 2. The frequency distribution of citations received by published papers of HUMS during 1992-2018

The annual citation structure

Table 1 shows the annual structure of citations received by HUMS's published papers in the studied period. Out of 3753 published papers, 2863 papers (76.29%) received one or more citations. In other words, only 23.71 percent of papers received no citations. Cited papers received 29650 citations in total (7.90 citations per paper). Fifteen papers (.40%) received ≥100 citations.

Table 1. Annual citation structure of citations received by HUMS's published papers during 1992-2018

Year	≥100	≥50	≥40	≥30	≥20	≥10	≥1	0	TP	TC	CPP
2018	3	2	1	1	5	15	315	322	664	1656	2.49
2017	5	1	1	2	5	47	351	177	589	4713	8.00
2016	1	2	2	8	12	78	337	129	569	3154	5.54
2015	0	1	4	11	26	53	212	54	361	2777	7.69
2014	0	0	1	6	22	68	186	55	338	2478	7.33
2013	0	5	5	12	11	43	155	40	271	2370	8.75
2012	2	3	6	3	19	44	117	35	229	2361	10.31
2011	1	3	3	8	15	50	81	23	184	2111	11.47
2010	1	3	2	8	8	20	69	15	126	1480	11.75
2009	1	4	3	3	8	31	49	11	110	1601	14.55
2008	1	3	7	4	14	15	33	11	88	1570	17.84
2007	0	3	3	6	8	18	29	3	70	1098	15.69
2006	0	4	4	2	7	21	31	8	77	1064	13.82
2005	0	3	2	0	1	6	13	6	31	455	14.68
2004	0	1	1	3	3	1	5	1	15	313	20.87
2003	0	1	0	1	0	2	8	0	12	170	14.17
2002	0	0	0	1	0	1	4	0	6	62	10.33
2001	0	0	0	0	1	0	2	0	3	27	9.00
2000	0	0	0	1	0	0	0	0	1	37	37.00
1999	0	0	1	0	0	0	0	0	1	45	45.00
1998	0	0	0	0	0	1	1	0	2	13	6.50
1997	0	0	0	0	0	0	1	0	1	8	8.00
1996	0	0	1	0	0	0	0	0	1	47	47.00
1995	0	0	0	0	١	0	0	0	1	26	26.00
1994	0	0	0	0	0	0	2	0	2	10	5.00
1993	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	1	0	1	4	4.00
Total	15	39	47	80	166	514	2002	890	3753	29650	7.90
%	0.40	1.04	1.25	2.13	4.42	13.70	53.34	23.71	100.00		

TP: Total Papers; TC: Total Citations; CPP: Citations per Paper

H-indexes of papers with and without self-citations

Table 2 shows the h-indexes of published papers of HUMS during 1992-2018 before and after removing self-citations. Of 29650 received citations, 6934 (23.38%) were self-citations, i.e. citations received by the authors affiliated to HUMS. The highest h-index before excluding self-citations was 25 and belonged to 2015. The lowest h-index before excluding self-citations was 1 and belonged to years 1992, 1995, 1996, 1997, 1999 and 2000. As no papers were published in 1993, the h-index in this year was 0.

For detecting the effect of self-citations on annual h-indexes, it is needed that the h-indexes are compared with and without self-citations. As table 2 shows, after excluding self-citations, the highest h-index decreased from 25 to 20. This not the case in the lowest h-index amounted to 1. The highest h-index after excluding self-citations was 21 and belonged to the years 2012 and 2013 and the lowest h-index was 1 and belonged to the years 1992, 1995, 1996, 1997, 1999 and 2000.

Table 2. The frequency distribution of papers, citations, self-citations and h-indexes of papers published by HUMS during 1992-2018

Year	Total papers	Total citations	H-index with self-citations	Self-citations	Citations without self-citations	H-index without self-citations
1992	1	4	1	0	4	1
1993	0	0	0	0	0	0
1994	2	10	2	0	10	2
1995	1	26	1	13	13	1
1996	1	47	1	1	46	1
1997	1	8	1	0	8	1
1998	2	13	2	1	12	2
1999	1	45	1	6	39	1
2000	1	37	1	20	17	1
2001	3	27	2	8	19	2
2002	6	62	4	10	52	3
2003	12	170	7	14	156	6
2004	15	313	9	56	257	8
2005	31	455	11	88	367	10
2006	77	1064	19	182	882	18
2007	70	1098	20	180	918	18
2008	88	1570	22	267	1303	20
2009	110	1601	19	269	1332	18
2010	126	1480	21	204	1276	19
2011	184	2111	23	462	1649	19

2012	229	2361	23	461	1900	21
2013	271	2370	24	539	1831	21
2014	338	2478	22	590	1888	18
2015	362	2777	25	845	1932	20
2016	568	3154	21	922	2232	18
2017	589	4713	17	1235	3478	13
2018	664	1656	15	561	1095	12
Total	3753	29650	53	6934	22716	47

National and International Collaborations

The frequency distribution of national collaborations made by HUMS's researchers is shown in Table 3. The first rank belonged to Tehran University of Medical Sciences collaborating in authoring 740 papers, followed by Shahid Beheshti University of Medical Sciences with 503 papers and Iran University of Medical Sciences with 291 papers. About 41 percent of HUMS's national collaboration was with these three universities.

Table 3. Top 20 national institutions collaborating with HUMS during 1992-2018

Rank	Afflation	Total papers	%
1	Tehran University of Medical Sciences	740	19.72
2	Shahid Beheshti University of Medical Sciences	503	13.40
3	Iran University of Medical Sciences	291	7.75
4	Kermanshah University of Medical Sciences	240	6.39
5	Kurdistan University of Medical Sciences	173	4.61
6	Bu-Ali Sina University	141	3.76
7	Isfahan University of Medical Sciences	139	3.70
8	Tabriz University of Medical Sciences	131	3.49
9	Shiraz University of Medical Sciences	98	2.61
9	Zahedan University of Medical Sciences	98	2.61
10	Ahvaz Jundishapur University of Medical Sciences	92	2.45
11	Ilam University of Medical Sciences	87	2.32
12	Tarbiat Modares University	85	2.26
12	Qom University of Medical Sciences	85	2.26
13	Baqiyatallah University of Medical Sciences	84	2.24
14	Islamic Azad University	83	2.21
15	Mashhad University of Medical Sciences	78	2.08
16	University of Tehran	71	1.89
17	Pasteur Institute of Iran	66	1.75
18	Mazandaran University of Medical Sciences	65	1.73
19	Guilan University of Medical Sciences	64	1.71
20	Islamic Azad University, Hamedan Branch	64	1.71
20	Rafsanjan University of Medical Sciences	62	1.65

The frequency distribution of international collaborations made by HUMS's researchers is shown in Table 4. It collaborated with 121 countries worldwide. The United States ranked first by authoring 107 papers (2.85%) in collaboration with HUMS, followed by the United Kingdom (1.64%) and Switzerland (1.57%). The lowest collaboration belonged to Barbados, Cyprus, Equatorial Guinea, Gambia, Hungary, Jamaica, Malawi, Mauritania, and Sudan, each with one paper (.02%).

Table 4. Countries collaborating with HUMS during 1992-2018 and the share of their contribution

Country	Total papers	%	Country	Total papers	%	Country	Total papers	%
United States	107	2.85	Bangladesh	15	0.39	Palestine	11	0.29
United Kingdom	69	1.84	Colombia	15	0.39	Zambia	11	0.29
Switzerland	59	1.57	Estonia	15	0.39	Argentina	10	0.26
Australia	58	1.55	Ghana	15	0.39	Kazakhstan	10	0.26
Malaysia	55	1.47	Indonesia	15	0.39	Kuwait	10	0.26
Canada	50	1.33	Lebanon	15	0.39	Tunisia	10	0.26
Italy	38	1.01	Mexico	15	0.39	Liberia	9	0.23
Japan	37	0.99	Nepal	15	0.39	Burundi Darussalam	8	0.21
Germany	36	0.96	Peru	15	0.39	Namibia	8	0.21
Sweden	36	0.96	Romania	15	0.39	Bhutan	7	0.18
Finland	28	0.75	United Arab Emirates	15	0.39	Slovenia	7	0.18
India	28	0.75	Viet Nam	15	0.39	Yemen	7	0.18
France	26	0.69	Austria	14	0.37	Armenia	6	0.15
South Korea	26	0.69	Bahrain	14	0.37	Morocco	6	0.15
Netherlands	24	0.63	Benin	14	0.37	Thailand	6	0.15
Turkey	24	0.63	Cameroon	14	0.37	Uganda	6	0.15
Brazil	23	0.61	Chile	14	0.37	Georgia	5	0.13
Norway	23	0.61	Kyrgyzstan	14	0.37	Oman	5	0.13
South Africa	23	0.61	Luxembourg	14	0.37	New Caledonia	4	0.10
China	22	0.58	Panama	14	0.37	Trinidad and Tobago	4	0.10
Pakistan	22	0.58	Philippines	14	0.37	Botswana	3	0.07
Belgium	21	0.55	Afghanistan	13	0.34	Libyan Arab Jamahiriya	3	0.07
Hong Kong	20	0.53	Anguilla	13	0.34	Malta	3	0.07
Denmark	19	0.50	Congo	13	0.34	Myanmar	3	0.07
Spain	19	0.50	Federated States of Micronesia	13	0.34	Togo	3	0.07
Iraq	18	0.47	Ireland	13	0.34	Burundi	2	0.05
Poland	18	0.47	Israel	13	0.34	Chad	2	0.05

Saudi Arabia	18	0.47	Mozambique	13	0.34	Cote d'Ivoire	2	0.05
Ethiopia	17	0.45	Qatar	13	0.34	Papua New Guinea	2	0.05
New Zealand	17	0.45	Slovakia	13	0.34	Syrian Arab Republic	2	0.05
Nigeria	17	0.45	Sri Lanka	13	0.34	Uruguay	2	0.05
Egypt	16	0.42	Ukraine	13	0.34	Barbados	1	0.02
Jordan	16	0.42	Bulgaria	12	0.31	Cyprus	1	0.02
Kenya	16	0.42	Costa Rica	12	0.31	Equatorial Guinea	1	0.02
Portugal	16	0.42	Ecuador	12	0.31	Gambia	1	0.02
Russian Federation	16	0.42	Iceland	12	0.31	Hungary	1	0.02
Serbia	16	0.42	Rwanda	12	0.31	Jamaica	1	0.02
Singapore	16	0.42	Tanzania	12	0.31	Malawi	1	0.02
Taiwan	16	0.42	Croatia	11	0.29	Mauritania	1	0.02
Algeria	15	0.39	Greece	11	0.29	Sudan	1	0.02

Figure 3 depicts the co-authorship map of countries with at least 20 papers coauthored by HUMS's researchers. These countries include: United States, United Kingdom, Switzerland, Australia, Malaysia, Canada, Italy, Japan, Germany, Sweden, Finland, India, France, South Korea, Netherlands, Turkey, Brazil, Norway, South Africa, China, Pakistan, Belgium and Hong Kong. In the co-authorship map, the size of circles demonstrates the magnitude of the publication number and line thickness does that of the co-authorship rate. As can be seen, the high rates of co-authorship belonged to the United States (107 papers), the United Kingdom (69 papers), Switzerland (59 papers), Australia (58 papers) and Malaysia (55 papers).

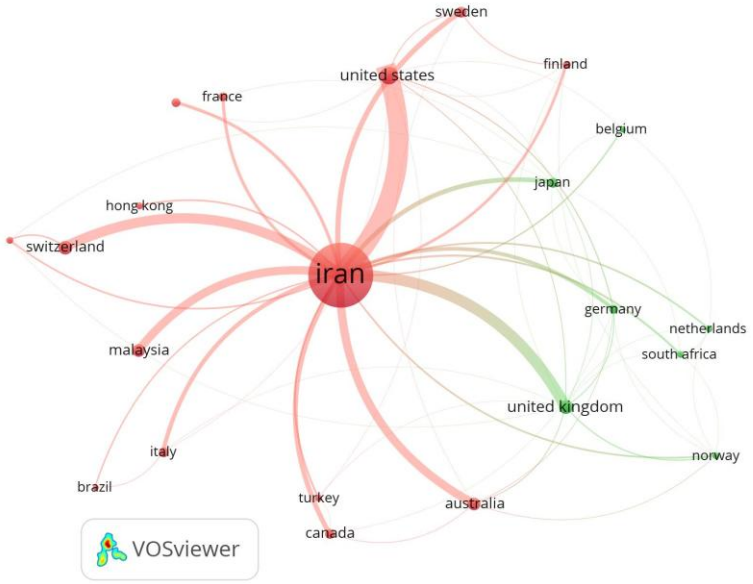

Figure 3. The co-authorship map of countries collaborating with HUMS during 1992-2018

Highly productive and more influential authors

The top 20 highly productive authors in HUMS are shown in table 5 according to the number of their published papers. The table includes author names, departments, and the number of coauthors, papers and citations, as well as h-indexes. The most highly-productive author was S. Khazaei with 141 papers and 356 received citations and h-index of 9. J. Poorolajal with 140 papers and M. Saidijam with 107 papers ranked second and third, respectively.

Table 5. Top 20 authors of HUMS in terms of number of their papers

Rank	Authors	Department	Total papers	Total citations	H-index	Co-authors
1	Khazaei, S.	Health Sciences Research Center	141	356	9	158
2	Poorolajal, J.	School of Health	140	1412	19	348
3	Saidijam, M.	School of Medicine	107	1258	18	346
4	Alikhani, M.Y.	School of Medicine	99	855	15	279
5	Karami, M.	School of Health	98	772	12	2136
6	Komaki, A.	School of Medicine	89	918	19	171
7	Goodarzi, M.T.	School of Medicine	88	1075	18	232
8	Shahidi, S.	School of Medicine	81	1019	20	127
9	Moghimbeigi, A.	School of Health	78	576	13	211
10	Ayubi, E.	School of Medicine	72	576	11	146
10	Mahjub, H.	School of Health	72	597	14	153
11	Roshanaei, G.	School of Health	71	283	10	208
11	Tavilani, H.	School of Medicine	71	1029	19	158
12	Mansori, K.	School of Medicine	68	190	7	137
13	Hajilooi, M.	School of Medicine	65	642	14	203
14	Asgari, G.	School of Health	61	709	15	125
15	Khodadadi, I.	School of Medicine	60	413	11	133
16	Bahrami, A.	School of Health	56	523	13	93
16	Shobeiri, F.	School of Nursing and Midwifery	56	404	13	75
16	Soltanian, A.R.	School of Health	56	551	14	270
17	Salehi, I	School of Allied Medical Sciences	55	617	16	153
18	Sarihi, A.	School of Medicine	54	641	16	101
19	Ghaleiha, A.	School of Medicine	53	659	15	184
20	Farhadian, M.	School of Health	52	116	5	154

The co-authorship map of highly-productive authors of HUMS was depicted in figure 4. The top 50 authors were included in the map. The map includes several clusters. Authors with more co-authorship with each other were included in the same cluster. The size of circles shows the magnitude of the paper number and the thickness of lines shows that of the co-authorship rate. The co-authorship map of HUMS consists of 6 clusters. The first cluster (in red) has 20 authors, with J. Poorolajal as the core author with 140 papers. The second cluster (in green) includes 8 authors with M. Saidijam as the core author with 107 published papers. The third cluster (in blue) has 7 authors in which A. Ghaleiha is the core author with 53 papers. The fourth cluster (in yellow) has 6 authors. The fifth cluster (in violet) has 5 authors and the sixth one (in bright blue) has 4 authors.

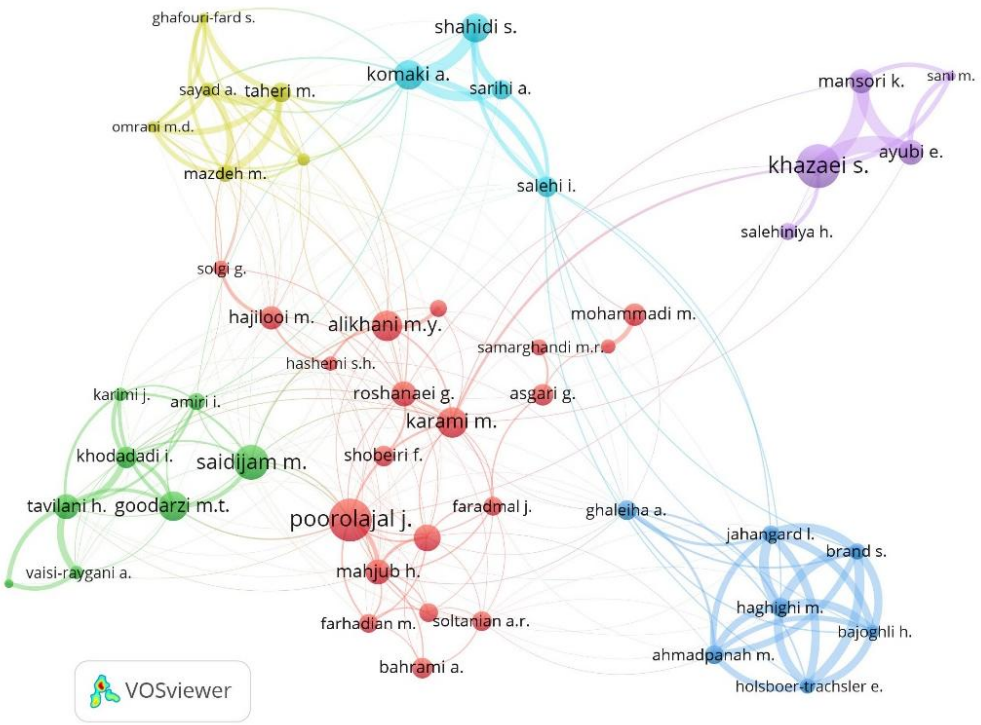

Figure 4. The co-authorship map of highly-productive authors of HUMS during 1992-2018

Top publishing journals

Table 6 shows the top ten journals publishing the papers authored by HUMS's researchers during 1992-2018. Most papers of the university were published in the *Journal of Research in Health Sciences*, followed by *Iranian Journal of Public Health* and *Journal of Mazandaran University of Medical Sciences*. Of these journals, 5, 2 and 3 journals are in Quartiles 2, 3 and 4, respectively. Of them, 8 journals are from Iran.

Table 6. Top ten journals publishing papers of HUMS during 1992-2018

Rank	Journal Title	Total papers	Publishing country	Cite Score (2018)	Cite Score Quartile (2018)
1	Journal of Research in Health Sciences	114	Iran	1.34	Q2
2	Iranian Journal of Public Health	77	Iran	0.93	Q3
3	Journal of Mazandaran University of Medical Sciences	67	Iran	0.47	Q3
4	Iran Occupational Health	55	Iran	0.32	Q4
5	Asian Pacific Journal of Cancer Prevention	50	Iran	1.47	Q2
6	Desalination and Water Treatment	43	USA	1.36	Q2
7	Acta Medica Iranica	41	Iran	0.91	Q2
8	Journal of Clinical and Diagnostic Research	37	India	0.82	Q3
9	Iranian Red Crescent Medical Journal	36	Iran	1.16	Q2
10	International Journal of Pediatrics	31	Iran	0.08	Q4

Highly-cited papers

Table 7 shows some features of top ten highly-cited papers authored by HUMS's researchers. Entitled as "Health effects of overweight and obesity in 195 countries over 25 years", the most highly-cited paper was published in 2017 in the *New England Journal of Medicine*, with M. Shamsizadeh as a coauthor from HUMS. It is interesting that all highly-cited papers were published in Q1 journals.

Table 7. Top ten highly-cited papers authored/co-authored by HUMS during 1992-2018

Rank	Paper title	Author from HUMS	Journal Title	Impact Factor	Cite Score	Pub. Year	Cited by
1	Health effects of overweight and obesity in 195 countries over 25 years	M. Shamsizadeh	New England Journal of Medicine	70.76 Q1	16.1 Q1	2017	794
2	Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: A systematic analysis for the Global Burden of Disease Study 2016	M. Shamsizadeh	The Lancet	59.102 Q1	10.28 Q1	2017	787
3	Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or	M. Shamsizadeh	The Lancet	59.102 Q1	10.28 Q1	2017	547

	clusters of risks, 1990-2016: A systematic analysis for the Global Burden of Disease Study 2016						
4	Global, regional, and national burden of neurological disorders during 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015	M. Shamsizadeh	The Lancet Neurology	28.755 Q1	8.81 Q1	2017	276
5	Structure and molecular mechanism of a nucleobase-cation-symport-1 family transporter	M. Saidijam	Science	41.037 Q1	15.21 Q1	2008	259
6	The properties and applications of chlorhexidine in endodontics	Z. Mohammadi	International Endodontic Journal	3.331 Q1	3.57 Q1	2009	214
7	Global, regional, and national under-5 mortality, adult mortality, age-specific mortality, and life expectancy, 1970-2016: A systematic analysis for the Global Burden of Disease Study 2016	M. Shamsizadeh	The Lancet	59.102 Q1	10.28 Q1	2017	200
8	Properties and applications of calcium hydroxide in endodontics and dental traumatology	Z. Mohammadi	International Endodontic Journal	3.331 Q1	3.57 Q1	2011	198
9	Equilibrium two-parameter isotherms of acid dyes sorption by activated carbons: Study of residual errors	Mahdi Hadi	Chemical Engineering Journal	8.355 Q1	8.47 Q1	2010	162
10	Effect of Body Mass Index on Breast Cancer during Premenopausal and Postmenopausal Periods: A Meta-Analysis	J. Poorolajal	PLoS ONE	2.766 Q1	3.01 Q1	2012	141

Clustering papers

63,362 terms were used in the titles and abstracts of the papers published by HUMS's researchers. As a threshold, the terms with at least 50 frequencies were included in the clustering map. As figure 5 depicts, 4 clusters appeared. The first cluster (in red) includes the terms such as Iran, age, man, life, age group and death. This cluster can be named as "epidemiological studies". The second cluster (in green) consists of terms such as rat, cell, animal, and mechanism. This cluster can be entitled as "laboratory studies". The third cluster (in blue) was named "pharmacologic studies" with terms such as concentration, effect, efficiency, and removal. In the fourth cluster (in yellow), there are terms such as gene, strain, polymorphism, bacterium, and infection. The cluster can be labeled as "microbiologic studies".

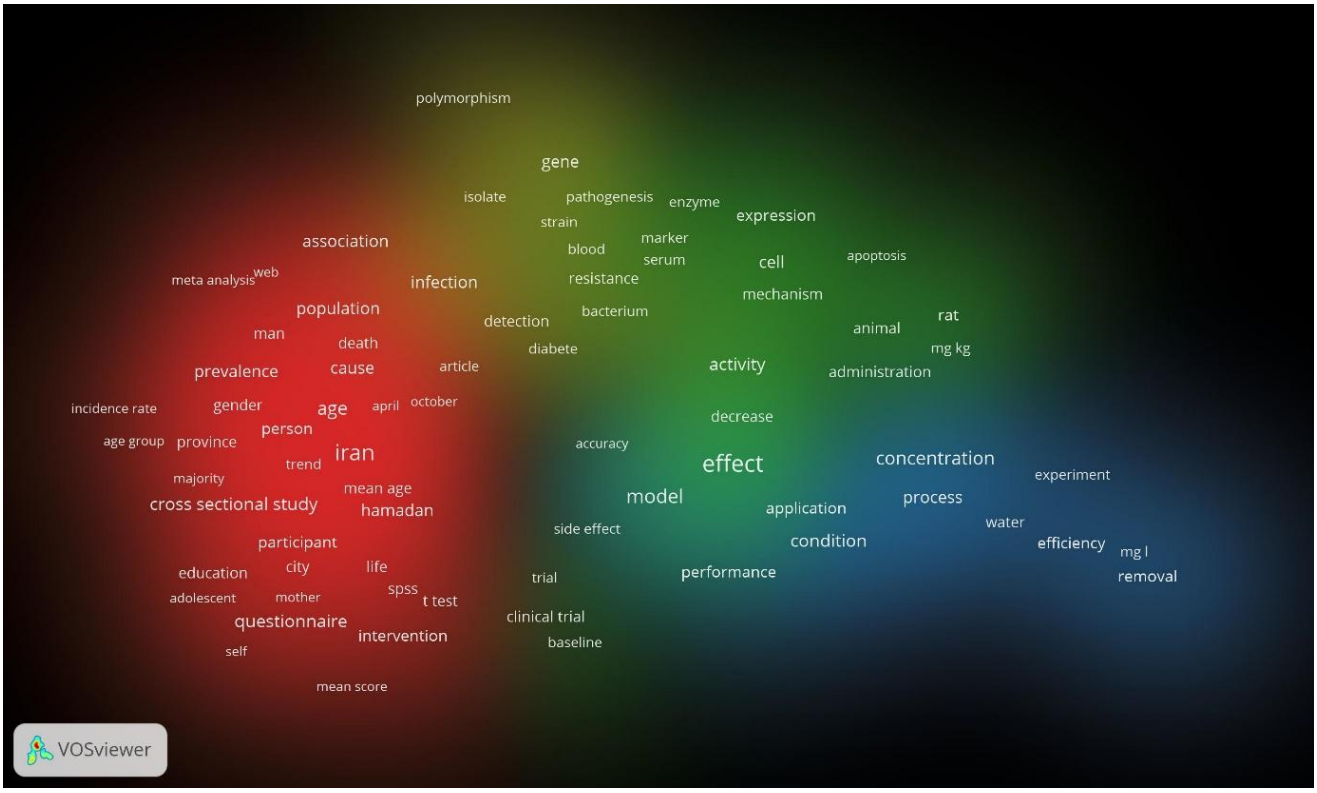

Figure 5. Term clustering of papers authored/co-authored by HUMS during 1992-2018

Discussion and Conclusion

As influential institutions in society, universities have the protective role in scientific, technological, economic, social and cultural development by producing scientific knowledge in different fields. Therefore, they need to be evaluated from different perspectives. This study is one of the first studies regarding the total scientific production of a medical university in Iran as a developing country and aimed to study the publications of HUMS from a bibliometric aspect. It was found that the growth trend in publications was increasingly, especially in three recent years (2016-2018). This clearly indicates that the university has found its way in research production and considered the importance of externalizing research findings. This is in line with a study by Ahmed et al. (2019) where they found that the two-third publications of Al-Jouf University, Saudi Arabia were produced during 2013-2017. Siwach and Kumar (2015) and Dwivedi (2017) found such a trend in Maharshi Dayanand University and Banaras Hindu University.

HUMS's received citations had an increasing trend with having at least one citation in about 77 percent of its published papers. This is a sign of the university's influence on scientific development. This finding accords with the study by Siwach and Kumar (2015) in case of Maharshi Dayanand University. However, the average citations per paper indicator was 7.90 in HUMS in comparison with those of Maharshi Dayanand University with 6 (Siwach & Kumar,

2015) and Al-Jouf University with 4.53 (Ahmed et al., 2019). This difference may be due to the type of studied universities as medical vs. non-medical universities. As the self-citation rate of HUMS was about 23 percent, it is better that the researchers of the university consider citing other universities and research institution in order to reduce the self-citation rate.

Considering the collaboration of 121 worldwide countries with HUMS, it can be said that the university has a reasonable international collaboration with other countries. However, the collaboration with Asian and Middle-eastern countries needs to be emphasized. In line with the findings by Dwivedi (2017) for Banaras Hindu University, Sweileh et al. (2014) for Najah National University, and Maharana and Sethi (2013) for Sambalpur University, we found that HUMS's researchers had the highest collaboration with the USA's authors.

More than 50 percent of HUMS papers were authored by top 20 highly-productive authors. This result reminds us of the Pareto Principle or 80/20 law (Crawford, 2001).

Researchers in HUMS published their papers in 160 journals, no one in Q1. In addition, 8 journals out of top 10 publishing journals were from Iran. This is in accordance with the findings of study by Ahmed et al. (2010) that showed that the most favorable journal for Al-Jouf University's authors was a journal in Q3, i.e. the *International Medical Journal*. Therefore, researchers in developing countries tend to publish in low-level journals and policy-maker should consider and facilitate their attitude to publishing in high-level Q1 journals.

All highly-cited papers of HUMS were published in Q1 journals, such as *New England Journal of Medicine*, *the Lancet*, *the Science* and so on. As a result, researchers who want to be highly-cited are recommended to publish in high-level and famous journals.

Term clustering of HUMS papers showed that the researchers in the university considered important medical fields and subfields ranging from epidemiological to microbiological studies. However, some subfield needs to be emphasized, including among others lifestyle medicine, traditional medicine, medical informetrics and local cancer research.

This study can be a pattern for studying and visualizing the bibliometric indicators of other universities and research institutions worldwide. In addition, policy-makers in HUMS can use the finding for better future policy-making for its more scientific development.

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