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Bibliometric Evaluation of the Scopus Indexed Scholarly Literature of Ministry of National Guard - Health Affairs, Saudi Arabia

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ABSTRACT

The research analysis output is one of the leading indicators to assess the quality of clinical care, education, and research in healthcare organizations. This study aims to evaluate the scholarly publication growth of the Saudi Arabian Ministry of National Guard – Health Affairs (MNG-HA), indexed in the Elsevier's Scopus database since 2002.

The study was performed using different bibliometric and visualization techniques. While the highest number of publications indicate King Saud bin Abdulaziz University for Health Sciences as an affiliated address, however, the publications from King Abdulaziz Medical City have the maximum citation impact. The 'Saudi Medical Journal' has been the most preferred journal at national level, while 'Studies in Health Technology and Informatics' from the Netherlands at the international level. Our results show that most collaborations are among the authors of the United States, Canada, and the United Kingdom at the international level. The growing numbers of publications, sound citation-impact, and international collaboration reflect the practical approach of MNG-HA management's leadership, and aspiring contribution of MNG-HA researchers.

Keywords; Research productivity, scholarly literature, research output, citation impact, Visualization, Bibliometric Evaluation, Saudi Arabia, Ministry of National Guard – Health Affairs

INTRODUCTION

Saudi Arabia (SA) is the largest country in the Gulf region and the 14th biggest in the world, with a total area of 2.15 million square kilometers. It is the land of more than 34 million people, with one-fifth of its population living in Riyadh (the capital). The country is blessed with natural resources like petroleum, natural gas, iron, gold, and copper. It owns 17% to 20% of the world's petroleum reserve, which accounts for half of the country's gross domestic product (GDP). SA has been spending 5.1% and 4.7% of its GDP in the education and health sectors, respectively. There are 2.39 physicians per 1000 population (Central Intelligence Agency, 2020).

Research and Development (R&D) has been given high priority in the aspiring goals set in the Kingdom's Vision 2030 (Haq, Al Fouzan, 2017; Zaher et al., 2018; Haq et al., 2020). Saudi Arabia is moving towards a knowledge-based economy relying on five factors, education, innovation, human capital, employment, and information & communication technology (Nurunnabi, 2017). The government is revisiting the policies of the social, economic and educational system, creating new job opportunities with the development and collaboration of private and industrial sectors and inspiring foreign investors in Saudi Arabia (Amirat & Zaid, 2020). The health status of the citizens has a direct relation with the sustainable economic and social development. The higher life expectancy and quality health of the human capital can influence the country's economic progress positively (Yildirim, Yildirim & Caliskan, 2020).

The Ministry of National Guard – Health Affairs (MNG-HA), established in 1982, is a dynamic healthcare system in the public sector spreading over the five major cities of Saudi Arabia (Riyadh, Jeddah, Al-Ahsa, Dammam, and Al-Madina). It provides multispecialty and integrated healthcare to the Saudi Arabian National Guard personnel, their dependents, and other eligible population. Since its establishment, it actively involves in developing an indigenous team of healthcare practitioners and researchers through outstanding academic opportunities, carrying out innovative research, and participating in community services for the provision of high-tech clinical care. It has three major constituent units;

1. Health service facilities consisted of; King Abdulaziz Medical City-Riyadh, King Abdulaziz Medical City-Jeddah, King Abdulaziz Hospital-Al Ahsa, Imam Abdulrahman Al Faisal Hospital-Dammam, Prince Mohammed bin Abdul Aziz Hospital-Al Madinah
2. King Saud bin Abdulaziz University for Health Sciences (KSAU-HS)
3. King Abdullah International Medical Research Center (KAIMRC)

KSAU-HS is an academic institution specializing in the health sciences education from undergraduate, graduate and post-graduate to allied health specialties. It has 14 colleges (three campuses) in Riyadh, Jeddah, and Al-Ahsa. Whereas KAIMRC is the nucleus of clinical and biomedical research, responsible for converting laboratory findings into products of eminence to enhance the quality of life. MNG-HA is a young and prosperous organization that has evolved to achieve immense accomplishment in a short period. All of its units are pursuing to make MNG-HA the leading healthcare facility in the region and at the global level (www.ngha.med.sa).

Participation in the research process is considered an essential factor for the expansion of knowledge. Further, sharing the findings through publishing for dissemination to the global community is more significant (Alhabshi, et al., 2020). Publishing helps to validate the research, refine and improve the existing theories, and enhance the prestige of the author, the affiliated institution and the country as well (Solomon, 2007). There are different indicators to evaluate the country's quality and progress, even the single organization, and the assessment of scholarly literature is one of the vital indicators.

The escalating trend of publications reflects the quality of higher education, research and development as well as the justification of research allocation (Adams & Griliches, 2000; Latif 2015; Haq, Ullah and Tanveer, 2020). The method of assessing the publications' output is known as bibliometric. This term was coined by Alan Prichard in 1969, which was earlier known as 'statistical bibliography'. The pioneering study of assessing the publications was done by Cole and Eales (1917) who reviewed the growth of literature on the subject of 'comparative anatomy' published between 1543 to 1860. Since then, one way or the other, the process of evaluating the published material has been going on for multiple reasons. The outcome of these studies is useful for policy-making; formulating research programs; ranking of authors, professions, institutions, countries and regions; finding trends and patterns of published research and revisit the financial assistance for research. The practitioners and academics have to play a dual role in the organization like MNG-HA. An extraordinary practitioner provides healthcare to the patients and conducts research to solve the medical problems. Similarly, brilliant academics get involved in classroom teaching process and inculcate the research culture among the new generation by supervising and conducting research. Okubo (1997) opined that bibliometric analysis offers the scholarly increase of publications by country, institutions, researchers and their position in a broader perspective. The citation tracking databases did not provide the complete picture of publications output of any research organization but provided a suitable dataset to assess the trends and pattern of publications (Haq & Al Fouzan, 2017).

Two open access journals are being published quarterly from MNG-HA, the *Journal of Infection and Public Health* (ISSN: 1876-0341) having 2.44 impact factor, and *Health Professions Education* (ISSN: 2452-3011) indexed in Directory of Open Access Journals (DOAJ). KAIMRC compiled the data of publications record produced by the MNG-HA and its 2019 publication book revealed that MNG-HA researchers had 5,610 papers from 2007 to 2019, and the highest number of papers, 1,186 were published in 2019 (King Abdullah International Medical Research Center, 2020).

The prime aim of this paper is to evaluate the scholarly research productivity of MNG-HA as reflected in the Scopus database with the following objectives:

1. To identify the growth of scholarly publications (articles, review articles, conference papers, book chapters and books) and yearly citations with an annual growth rate
2. To segregate the share of publications and citations of each unit of MNG-HA
3. To point out the ten-most productive authors and organizations
4. To see the authorship pattern of MNG-HA researchers
5. To review the bibliographic coupling of journals and countries
6. To assess the most frequently used keywords
7. To see the relationship among keywords, country, and journal

LITERATURE REVIEW

The scholarly and scientific productivity can be produced by the concise efforts of practitioners, faculty members, research workers, and students, and these efforts are demonstrated as research findings published in journals, books, conferences or any other medium of communication (Gupta & Sonkar, 2019). Ahmad, Rehman and Ashiq (2021) reviewed 790,282 research publications produced by 22 Arabic-speaking countries, from 1980 to 2020 as indexed in the Web of Science database. The promising growth of publications (67%) was identified in the last decade of targeted period in the Arab World. Egypt (n=218,492) and Saudi Arabia (n=196,211) have emerged as the most productive countries. Saudi Arabia has the highest international collaborated research. The majority of research

was carried out on the subject of Engineering & Technology (n=278,386; 35.22%) and the share of clinical, pre-clinical & health publications was 207,848 (26.30%). Art and humanities (n=7,316) has been the least interesting area of research.

El Rassi et al., (2018) studied health science research in Arab countries from 2007 to 2016. Arab countries produced 76,978 papers, counted as 1.6% of the global publication productivity. Egypt and Saudi Arabia contributed significantly with 32% and 28% respectively and the rest of the 40% contributed by other 20 Arab countries. King Saud University has as emerged the most productive institution in the Arab World with 8,623 publications but the highest citation impact was gained by the American University of Beirut, Lebanon.

Earlier, Shehatta and Mahmood (2016) measured the research growth of Saudi Arabia over the period of 1980-2014. The study used the InCite feature of the Web of Science database to extract the dataset of 74,767 publications, one-third of the total publications (n=24,937; 33.4%) belonged to the subject category of 'Clinical, Pre-Clinical, and Health'. Meo, Hassan and Usmani (2013) stated that the research performance of Saudi Arabia has increased extraordinarily between 1996 to 2012. A total of 27,246 papers on medical and allied science were found and these papers received 181,999 citations with an average of 6.67 citations per paper.

Peter et al., (2019) used the PubMed database to assess the research output of healthcare professionals of Saudi Arabia from 2014 to 2018. A total of 33,872 documents were identified and 26.52% of documents were published in 2018. A slightly more than one-fourth of the total documents (n=8641; 25.51%) were published in the top 50 journals and the highest number of papers (n=680) were published in PLOS One, followed by Saudi Medical Journal (n=619). The ratio of single-author publications counted 2,192 (6.47%) and 59% documents were the results of more than four-authors' collaboration.

Haq et al., (2020) examined the 35,291 documents on various areas of health sciences contributed by Saudi Arabia from 2008 to 2017. KSAU-HS found the third most productive teaching institution in Saudi Arabia after King Saud University and King Abdulaziz University.

Haq and Al Fouzan (2017) scrutinized 775 documents produced by the authors of KSAU-HS from 2005 to 2015 with an average annual growth rate of 31.66. The data was collected from the Web of Science. Saudi Medical Journal was the most frequent option for publication of documents, followed by Annals of Thoracic Medicine. The United States and Canada were the top research collaborative countries and 6% of the publications were written by single authors. The research productivity on Oncology and dentistry by the researchers of KSAU-HS were also evaluated by Haq, Al Fouzan & Baladi (2017); Haq & Al Fouzan (2018).

A study evaluated the 8,420 research publications produced from 2006 to 2016 by the ten government hospitals' researchers geographically located in Riyadh, Saudi Arabia, as seen in the Scopus database. One-fourth of the publications (25.84%) was published in the last two years of study and 44% of the publications were generated by the authors of King Faisal Specialist Hospital. KAMC stood on the third rank with 1072 (12.73%) publications (Howaidi, Howaidi & Howaidi, 2017).

Zahur et al. (2018) retrieved the publication data of 15,709 documents from the Web of Science database produced by the seven healthcare institutions of Riyadh, Saudi Arabia, from 2006 to 2016. A majority of research (63%) was contributed by the authors of King Saud University followed by King Faisal Specialist Hospital and KAMC. Although the authors of King Khalid Hospital shared only 3% of the total research but achieved the highest citation impact with 15.12 cites/pub, followed by KAMC

14.89 cites/publications. Gazzaz et al., (2020) examined the 2600 documents on diabetes by Saudi Arabian authors from 2000 to 2019 and found that Saudi authors contributed 0.83% of the global share on diabetes research.

Various bibliometric studies on different categories of medical and allied health sciences were conducted from Saudi Arabian perspective. Saquib et al. analyzed 295 papers on cardiovascular disease research published from 1986 to 2015. Alhibshi et al. examined 1564 papers on neuroscience research published between 2013 to 2018 and KSAU-HS ranked 6th with 67 (4.27%) papers. Alshahrani and Al Owaifeer (2020) examined 2178 papers on ophthalmology from 1980 to 2019 and stated that Saudi Arabia is on leading contributor in ophthalmology research in the Arab World. Haq et al. (2019) measured the dental research of the Arab world from 1998 to 2017. A total of 6416 documents were identified and 2,427 (38%) of the total dental research was contributed by Saudi Arabia. Alhaider, Ahmed and Gupta (2015) wrote a paper on pharmacological research in Saudi Arabia from 2001 to 2010. A total of 1,386 papers were found and Egypt, the United States and India were the top three collaborating countries.

A bibliometric study on MNG-HA journal, Journal of Infection and Public Health, was conducted by Krauskopf (2018). The study examined 586 documents published from 2008 to 2016. Almost one-fifth of the documents were contributed by Saudi Arabia while the international share was counted as 80% of the total documents. The highest number of contributions (n=41) is from KSAU-HS, followed by KAMC-Riyadh and at number 9th, MNG-HA was positioned with 12 documents. Two bibliometric studies were found in the Saudi Medical Journal and one study discussed the comparison of bibliometric indicators of three Saudi journals. (Tanveer et al., 2020a; Tanveer et al., 2020; Alanazi, Baladi & Haq, 2018).

METHODOLOGY

The bibliometric research method was applied on scholarly literature produced by MNG-HA on January 5th, 2021. The Elsevier's Scopus database was used to extract the targeted dataset of 18 years for analysis. The Scopus database provides comprehensive coverage from more than 40,000 journals and other source publications.

Scopus provided the dataset of 5,111 documents, with affiliations to MNG-HA units. We limited our search to articles, review articles, conference papers, book chapters, and books only. We did not apply language, geographical or date filters. The data of publications by at least one author with affiliation to any units of MNG-HA were selected. The initial search results the 5,111 documents, based on inclusion and exclusion criteria. We excluded 352 documents consisted of editorials, corrections, letters, notes, book reviews, and short survey types from the analysis. The selected 4759 records were exported into MS Excel format. The accuracy of the data was ensured by repeating the process by two team members of the research group. The four-phase flow chart of data extraction and filtration has been shown in Figure-1. Data analysis was performed using various tools and software, including MS Excel (v16.0), VOS viewer (version 1.6.15), Biblioshiny (version 2.0), and Gephi.

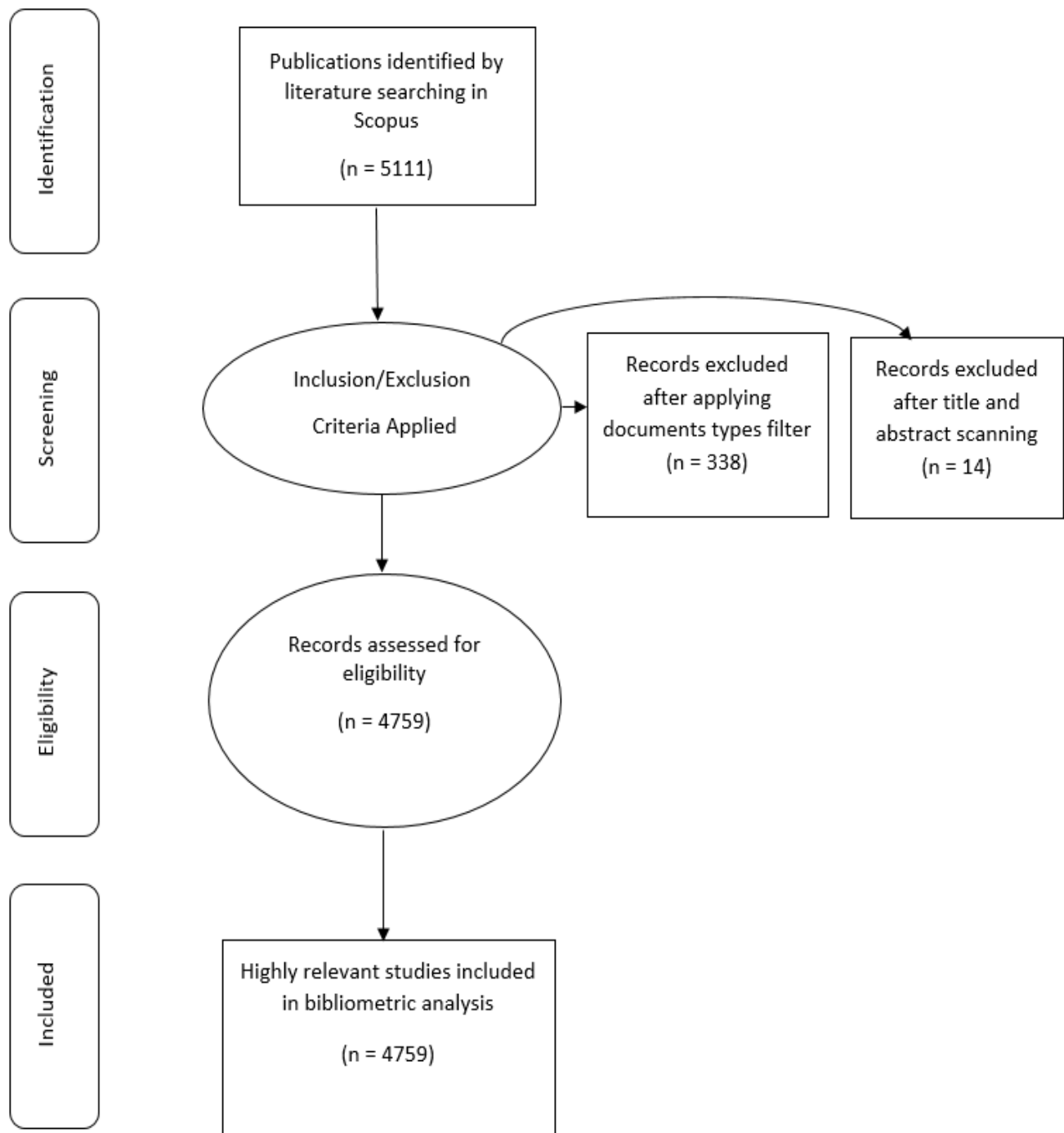


Figure 1. Four phase flow chart of data extraction and filtration process.

RESULTS

Publications and Citations Trend

A total of 4,759 publications were published with an average annual growth rate of 115.88 (see figure 1). These publications received 64,777 total citations with an average of 13.61 citations per publication. The highest number of publications (n=899) were published in the year 2020, whereas the highest citation impact (35.10) was noted in year 2014.

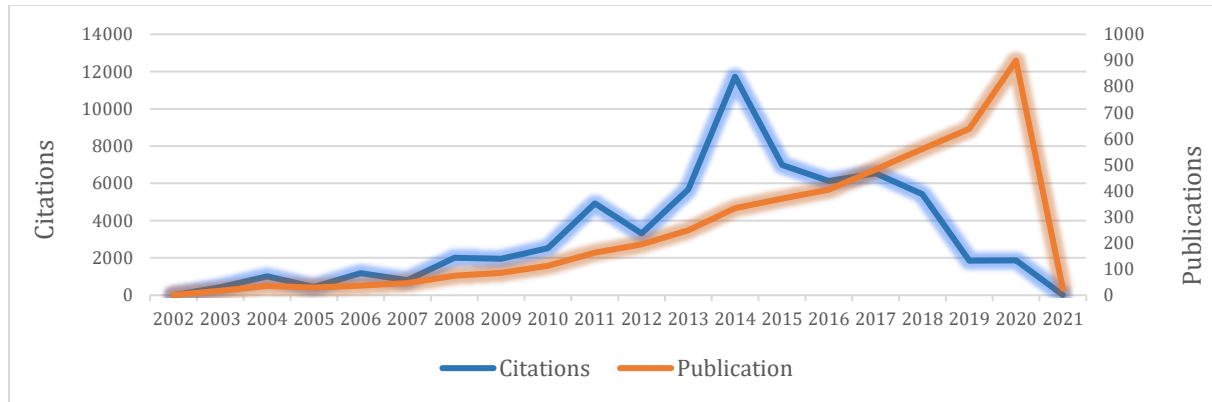


Figure 2: Publications and citation trends from 2002 to January 5, 2021

Affiliations Statistics

Table-1 presents the total number of publications with other bibliometric indicators against the affiliated address. Most of the authors wrote two or three affiliations in their publications because all MNG-HA units are connected and collaborate with each other. The highest number of publications (n=3,420) mentioned KSAU-HS as an affiliated address followed by KAMC (n=2,541). The maximum citation impact was gained by the publications from KAMC (15.81) followed by KAIMRC (14.50). About three-fourth of the total publications of KAMC and KSAU-HS have been cited. Figure-3 demonstrates the comparison of citations by years. The highest number of citations was received during the period of 2013 to 2016 as the three peaks of KAIMRC, KAMC and KSAU-HS. The publications with the affiliated address of MNG-HA received a fewer number of citations as compared to other units.

Table 1: Total publications and citations for affiliated address of authors

Affiliated Address	TP	TC	ACPP	Cited Docs (%)	Non-cited Docs (%)
Ministry of National Guard - Health Affairs	1,704	14,858	8.72	1,176 (69.01%)	528 (30.99%)
King Abdulaziz Medical City	2,541	40,174	15.81	1,893 (74.50%)	648 (25.50%)
King Saud bin Abdulaziz University for Health Science	3,420	46,448	13.58	2,535 (74.12%)	885 (25.88%)
King Abdullah International Medical Research Centre	1,576	22,849	14.50	1,103 (69.99%)	473 (30.01%)

This table shows dispersion of total publications (TP), total citations (TC), average citations per publications (ACPP), and percentage of cited and non-cited documents by affiliated address

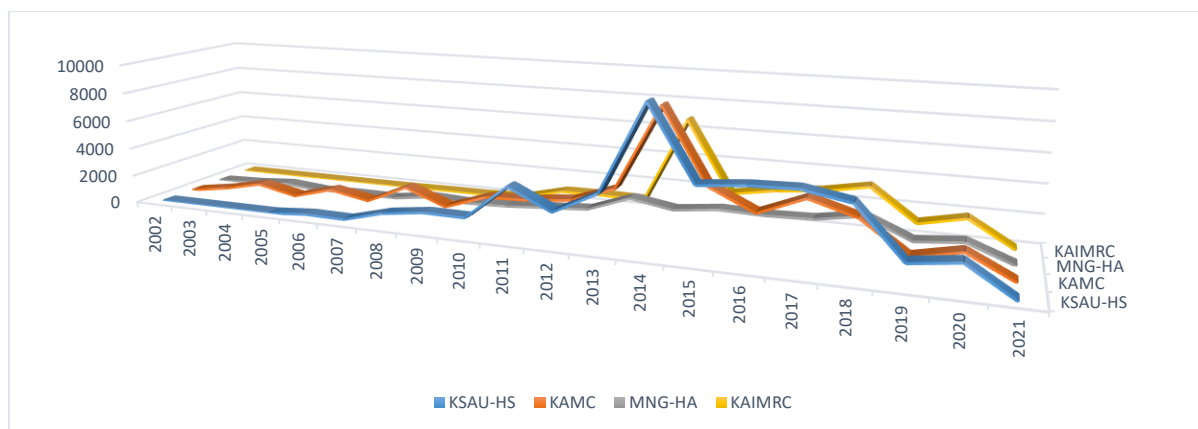


Figure-3 Comparison of citations by different units of MNG-HA by year

Influential Authors

The analysis of top-10 most influential authors reveals that Yaseen M. Arabi is found a most productive and influential author with 273 publications and 12,520 citations with a mean of 45.86 cite/pub. He also gained the highest (n=55) h-index publications, followed by Hanan H. Balkhy and Al-Fadhel, Majid with 123 and 117 publications, respectively. The top-four authors produced more than 100 publications each. Al Memish, Ziad has gained the highest citation impact (76.85). His 89 publications received 6840 total citations with an average of 76.85.

Table 2: Most influential authors with affiliations

Rank	Authors	Affiliation	TP	TC	CI	<i>h</i> -index
1	Yaseen M. Arabi	King Abdulaziz Medical City	273	12520	45.86	55
2	Hanan H. Balkhy	King Abdualziz Medical City	123	5293	43.03	37
3	Majid Al-Fadhel	King Saud bin Abdulaziz University for Health Sciences	117	1697	14.50	20
4	Hamdan H. Al-Jahdali,	King Saud bin Abdulaziz University for Health Sciences	101	1571	15.55	17
5	Al Memish, Ziad	Ministry of Health Saudi Arabia	89	6840	76.85	38
6	Al-Dorzi, Hasan M.	King Abdullah International Medical Research Center	79	1379	17.46	17
7	Jazieh, Abdul Rahman M.	King Abdulaziz Medical City	63	428	6.79	13
8	Hussein Algahtani	King Abdulaziz Medical City	73	375	5.13	9
9	Ali H. Hajeer	King Saud bin Abdulaziz University for Health Sciences / King Abdullah International Medical Research Center	67	1208	18.02	17
10	Anwar E. Ahmed	King Saud bin Abdulaziz University for Health Sciences / King Abdullah International Medical Research Center	54	326	6.03	10

This table lists top 10 authors from Ministry of National Guard – Health Affairs, their affiliated institution and country with total publications (TP), total citations (TC), citation impact (CI) and *h*-index.

Authorship Pattern

The authorship pattern breakdown (figure 4) reveals that only 246 (5.16%) publications are single-authored, while 4,513 (94.84%) were the results of collaborative research. More than 10 authors' collaboration pattern has been found the most frequently used authorship pattern (n=733; 15.40%), followed by a five-author pattern with 630 (13.23%) publications. Citations data shows that highest numbers of citations were gained by 733 publications written by more than 10-author pattern with an average of 41.6 citations per publication, followed by ten-author pattern, with 11.5 citation impact and single-author publications with 10.2 citation impact. Interestingly, single-author publications received the third highest citation impact. A positive correlation (0.646193) has been found between the authorship pattern and citation impact.

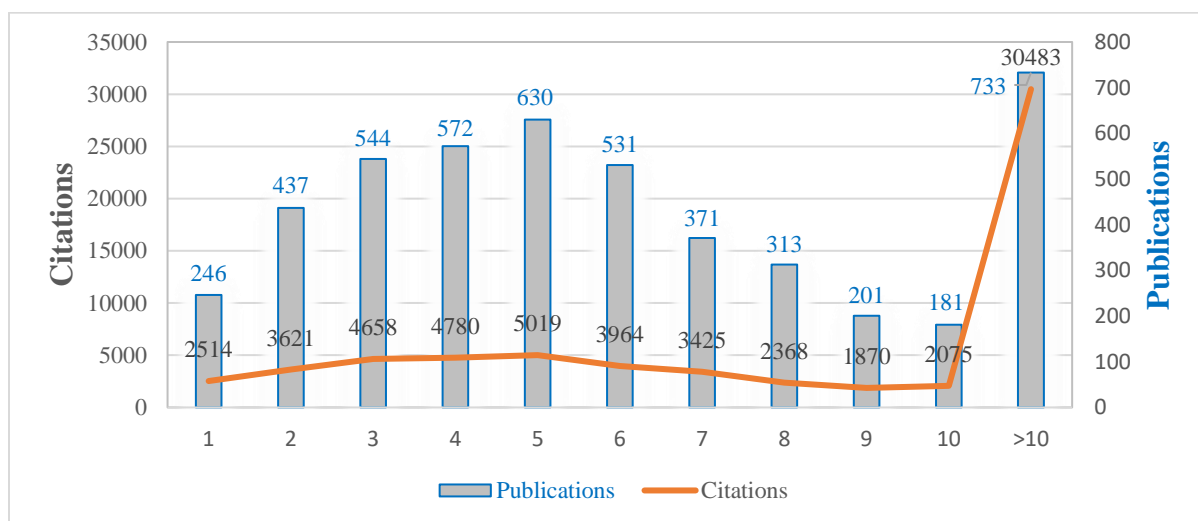


Figure 4. Authorship pattern with number of publications and citations

Average number of authors against each units of MNG-HA

The total number of authors against each publication was segregated by their affiliated address to assess the ratio of average author (Table-3). The proportion of average authors per publication showed that KAIMRC has recorded the highest ratio of authors, 1,576 publications were contributed by 18,458 authors including multiple counts, with an average of 11.71 authors per publication, followed by KAMC with 10.88 authors per publication.

Table-3. Authors' Research Output from Units of MNG-HA

Organizations	TP	AU	AAU/P
King Abdullah International Medical Research Centre	1576	18458	11.71
King Abdulaziz Medical City	2541	27644	10.88
Ministry of National Guard Health Affairs	1704	14620	8.58
King Saud bin Abdulaziz University for Health Science	3420	30370	8.88

This table shows total publications (TP), Authors (AU), and average authors/ publication (AAU/P) from four units of MNG-HA

Frequently used journals

All the 4,759 publications were published in 1,755 journals or other sources. Table-4 presents the ten most frequently used journals with the total number of published documents by MNG-HA authors and total citations received by these documents. Seven national journals are included in this list. A total of 725 (15.23%) publications were published in these journals and these publications received 4,510 (6.96%) citations. Two journals each are being published by Saudi Arabian Armed Forces Hospital, Wolter Kluwer Medknow Publications and Elsevier. The Saudi Medical Journal, the oldest medical journal of Saudi Arabia, has been the top-most preference with 145 publications, followed by Annals of Saudi Medicine, Annals of Thoracic Medicine, and Journal of Infection and Public Health with 90, 87, and 80 publications, respectively.

Table 4: Ten Most influential journals

Rank	Journal	TP	TC	IF	Q	Publisher/Country
1	Saudi Medical Journal	145	619	1.195	3	Saudi Arabian Armed Forces Hospital, Saudi Arabia
2	Annals of Saudi Medicine	90	739	0.917	4	King Faisal Specialist Hospital and Research Centre
3	Annals of Thoracic Medicine	87	750	1.456	4	Published by Wolters Kluwer (India) on behalf of Saudi Thoracic Society, Saudi Arabia
4	Journal of Infection and Public Health	80	666	2.447	2	Published by Elsevier (Netherland) on behalf of Ministry of National Guard Health Affairs, Saudi Arabia
5	Studies in Health Technology and Informatics	70	279	NA	NA	IOS Press, Netherland
6	Saudi Journal of Kidney Diseases and Transplantation	62	343	NA	3	Published by Wolters Kluwer (India) on behalf of Saudi Center for Organ Transplantation, Saudi Arabia
7	Plos One	54	693	2.74	2	Public Library of Science, United States
8	Journal of The Saudi Heart Association	48	179	NA	3	Saudi Heart Association, Saudi Arabia
9	Neurosciences	46	203	0.592	4	Saudi Arabian Armed Forces Hospital, Saudi Arabia
10	International Journal of Surgery Case Reports	43	39	NA	3	Elsevier BV, Netherlands

This table lists the top journals with total publication (TP), and total citations (TC). It also shows journal's impact factor (IF), quartile (Q), publishers, and country.

Bibliographic Coupling of Journals

The common subject matter amongst journals (if they refer to a third common publication) is measured by bibliographic coupling and figure-5 explains this phenomenon for the MNG-HA research output in the journals indexed in Scopus., out of 1,755 journals, 12 journals with a minimum of 30 publications each, meet the criteria of bibliographical coupling as shown in Figure-5. The concept of bibliographic coupling was proposed by Kessler in 1963. It is a suitable technique to assess the relevance of citation. It constructs the relation of the two citing paper by the third cited paper. In more cited papers the two

citing papers have, the higher relevance. This method approaches to filter the irrelevant citations of the documents and supplement relevant un-cited documents citations to build the citation network.

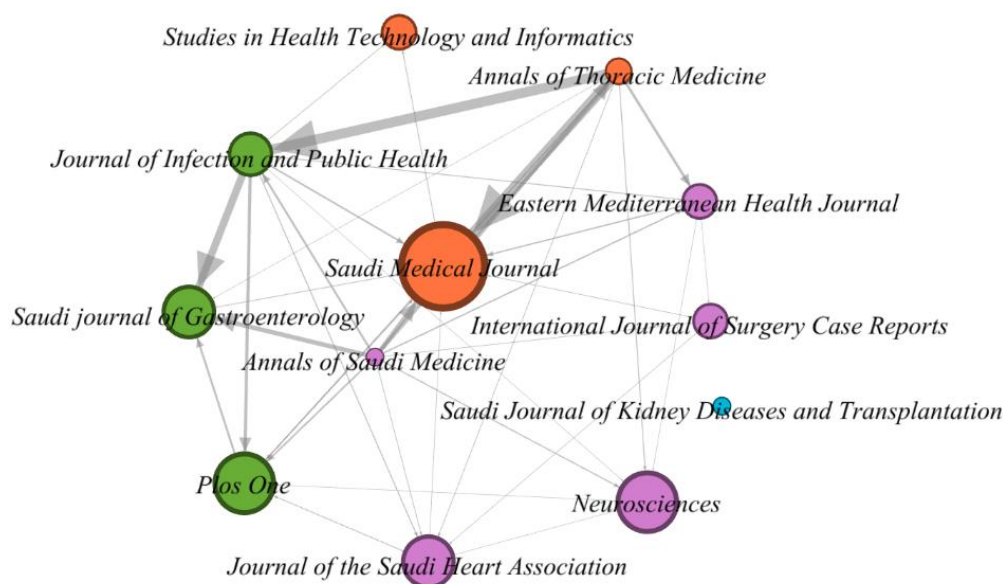


Figure 5. Bibliographic coupling of journals

Most Frequently used Keywords

The 30 most frequently used keywords with the total number of publications, citations and an average number of citations have been presented in Table-5. The word “Saudi Arabia” has been used 471 times during the last 18 years in 4,759 Scopus indexed scholarly publications, followed by Mortality (n=64), children (n=62) and prevalence (n=58). Although “Covid-19” is a new area of research but this keyword has been used 52 times. The top five keywords have been used more than 50 times. As far as the number of citations and its impact is concerned, the highest number of total citations (n=4141) were received by the keyword “Saudi Arabia,” but the highest citation impact (38.70) was received by “mechanical ventilation”, followed by mortality (36.08), Intensive care (34.93), and critical care (32.91). The scrutiny of keywords co-occurrence with a minimum of 30 times, 17 keywords meet the threshold as shown in figure-5.

Table 5. Most Frequently used keywords

Rank	Keywords	TP	TC	CI	Period-1	Period-2	Period-3
					2002-2010	2011-2015	2016-2021
1	Saudi Arabia	471	4141	8.79	31	113	327
2	Mortality	64	2309	36.08	12	26	26
3	Children	62	455	7.34	8	14	40
4	Prevalence	58	733	12.64	2	20	36
5	Covid-19	52	578	11.12	0	0	52
6	Critical Care	47	1547	32.91	10	10	27
7	Cancer	42	329	7.83	2	4	36

8	Saudi	41	238	5.80	1	12	28
9	Risk Factors	39	331	8.49	2	10	27
10	Epidemiology	38	1117	29.39	5	15	18
11	Guidelines	37	1036	28.00	2	18	17
12	Breast Cancer	36	513	14.25	1	14	21
13	Diabetes	34	318	9.35	0	10	24
14	Lung Cancer	34	177	5.21	15	10	9
15	Outcome	34	714	21.00	4	18	12
16	Knowledge	33	144	4.36	0	5	28
17	Obesity	33	332	10.06	2	9	22
18	Treatment	31	442	14.26	5	16	10
19	Education	30	284	9.47	1	12	17
20	Pediatric	30	158	5.27	1	7	22
21	Vitamin D	29	411	14.17	0	10	19
22	Apoptosis	28	307	10.96	2	8	18
23	Intensive Care	28	978	34.93	9	4	15
24	Colorectal Cancer	27	143	5.30	0	2	25
25	Diagnosis	27	390	14.44	1	13	13
26	Mechanical Ventilation	27	1045	38.70	4	8	15
27	MERS-Cov	27	647	23.96	0	3	24
28	Sepsis	27	501	18.56	4	9	14
29	Middle East	26	273	10.50	2	8	16
30	Attitude	25	188	7.52	0	6	19

Keywords co-occurrences

Figure-6 illustrates the co-occurrences of keywords used in the publication output of MNG-HA. Closely related keywords used in MNG-HA units' research output are classified into four clusters, and quantitative network indicators describe connections between these clusters as shown in the figure 6.

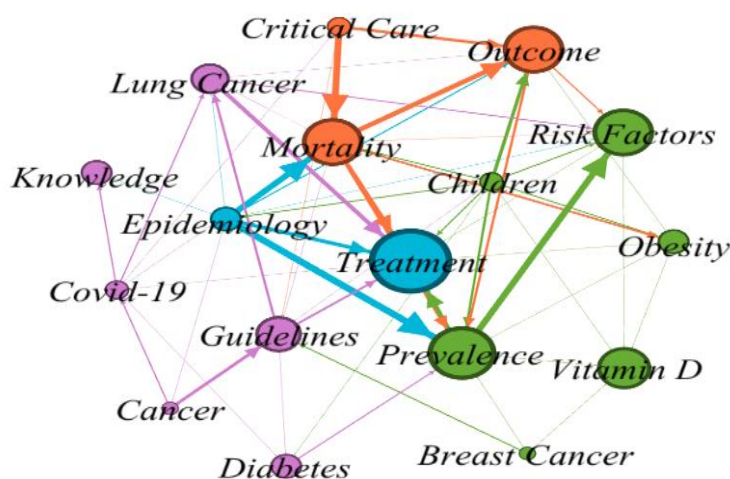


Figure 6. Keywords co-occurrences with minimum co-occurrences of 30 times 17 meet the threshold.

Research Collaboration by Countries

The authors of MNG-HA have collaborated with the authors of 173 countries and in the bibliographic coupling of 14 countries were identified with at least 100 research collaborations or co-authored publications each other. Overall, the maximum collaboration ($n=855$; 17.96%) was done among the authors from the United States, followed by Canada ($n=452$; 9.49%) and the United Kingdom ($n=406$; 8.53%). Although there were only 107 publications with the Italian authors, these publications were found most influential, as they gained 50.66 citations per document followed by 154 publications with Germany receiving 5546 citations with an average of 36 citations per publication. The publications with the United States, Canada, and the United Kingdom received 22.20, 28.17, and 29.96 citations per document, respectively. The two clear clusters of countries were found in the bibliographic coupling, one cluster has seven countries, named United States, United Kingdom, Italy, France, Germany, Canada and Australia, while the other cluster consisted of United Arab Emirates, India, Pakistan, Egypt, Jordan, Lebanon and Saudi Arabia.

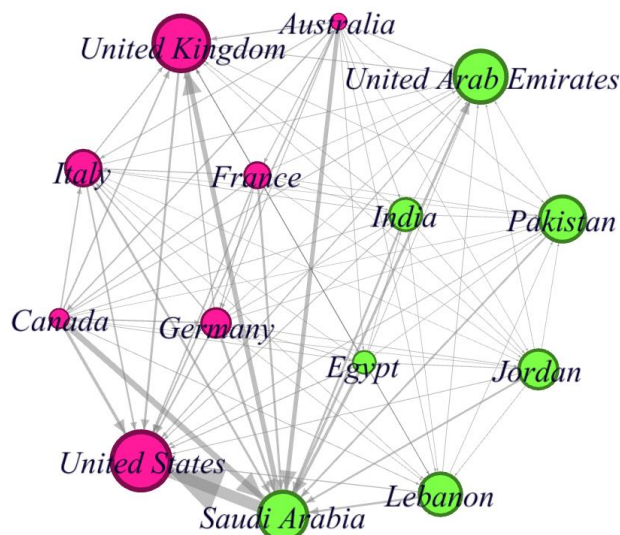


Figure 7. Bibliographic coupling of countries that published minimum 100 documents out of 173 countries 14 meet the threshold.

Three Factor Analysis (keyword, country and journal)

The three fields analysis graph presents the correlation among the top10 keywords, countries, and journals on the authors' scholarly publications affiliated with the different MNG-HA units since 2002. The size and connotation of each block with the other sets of blocks determine the share and correlation of different fields. The top-five keywords (mortality, prevalence, epidemiology, covid-19, and critical care) have a strong association with the top four countries (Pakistan, United States, Saudi Arabia, and Canada).

Authors affiliated with Saudi Arabia have a strong association with top-10 journals. The last row represents the top-10 journals in correlation chart and PLOS One is stand on the top, the contribution United State affiliated authors have been more than Saudi authors while there has been a significant

contribution by the collaborative researchers of top-10 countries with the authors of MNG-HS in this journal. In the brown box, representing the Saudi Medical Journal, the share of United States' authors has indicated very nominal contribution, but the Saudi (MNG-HA) authors contributed ominously.

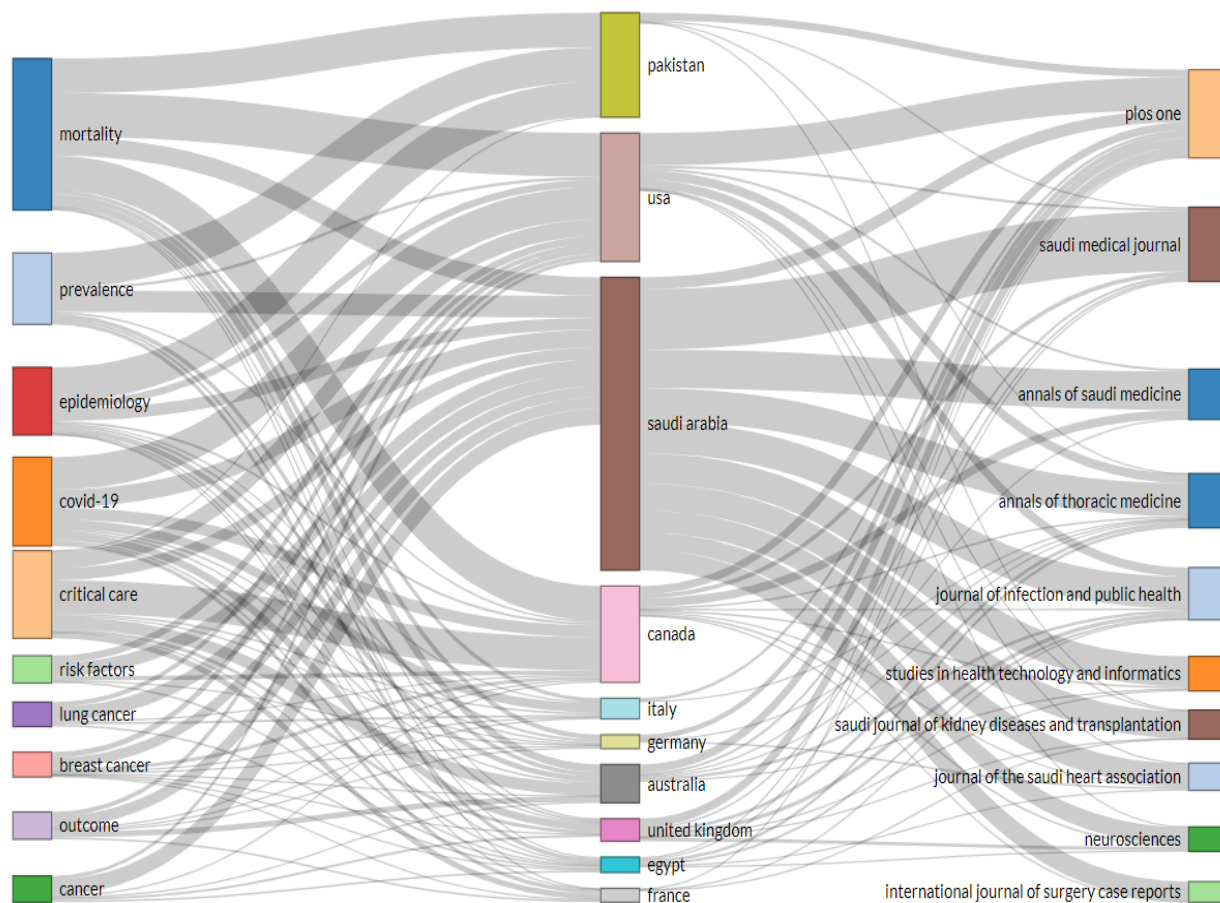


Figure 7. Three factor correlation chart

DISCUSSION

From grass-root to the higher level, educating the nation is a significant factor for the sustainable and long-term development of a country. The number of schools, colleges, universities, technical institutions, and research centers has increased remarkably during the last two decades in Saudi Arabia. The country feels proud to have the largest-ever education industry, giving free education to all citizens and generous foreign scholarship provision. These initiatives further support to develop innovative research culture in all areas of knowledge and untiring progress in science & technology (Meo, 2015). The visionary leadership of the country is equally aware about the importance of healthcare delivery system, medical education and research that contributes to improving the living standards of the citizens and overall quality of life which is inevitable for sustainable development (Meo, Hasan & Usmani, 2013).

Saudi Arabia plays a leading role in research growth in the Gulf Cooperation Council (GCC) countries and even in the Arab World. Meo et al. (2016) assessed the research productivity of GCC countries in sciences and social sciences from 1996-2013 and found that out of the total 1,33638 publications, more than half of the research (n=74,210; 55.53%) was contributed by Saudi Arabia in the region. Haq et al., (2019) assessed the publication growth of dentistry in the Arab World from 1998 to 2017. All 22 Arab countries produced 6,416 documents in dentistry and Saudi Arabia protected on prominent position with 2,427 (37.83%) documents. El Rassi evaluated the medical research growth of the Arab world from 2007 to 2016. Saudi Arabia contributed more than one-fourth (28%) of the total medical research in the Arab World.

MNG-HA has a hi-tech dynamic healthcare delivery system. All its associated units have been actively involved in a state-of-the-art clinical care and innovative research, imparting quality health education and community services. The current study aims to bibliometrically evaluate the scholarly literature produced by the researchers affiliated with different MNG-HA units from 2002 onward. Salmerón-Manzano & Manzano-Agugliaro (2020) opined that being up to date about the scholarly and scientific growth of publications requires bibliometric studies through which the characteristics, trends, and interest of publications revealed. The bibliometric study is advantageous in obtaining meaningful data and information about the statistics of the scholarly research activities in a distinct discipline that supports the researchers to recognize innovative structures among research (De Battisti & Salini, 2013).

In this study, a total of 4,759 documents met the inclusion criteria, extracted from the Scopus database. The Scopus database has the most significant citations, and bibliographical coverage of global literature. Microsoft Excel, VOS viewers, Biblioshiny, and Gephi software have been used to present the data. The remarkable and promising growth of scholarly publications reflects the national as well as an institutional vision to enhance the quality and quantity of research. There were 35 publications in 2004, and this number reached 899 in 2020 with an average annual growth rate (AAGR) of 115.88. Every unit of MNG-HA contributed significantly. The authors affiliated with KSAU-HS produced the highest number of publications, followed by KAMC. The publications of KAMC gained the maximum citation impact (15.81) compared to other MNG-HA units. The previous study results on the analysis of healthcare research produced by the institutions located in Riyadh city also revealed similar findings that the research publications of KAMC gained 14.89 citations per publication (Zahur et al., 2018).

The distribution of citations by years showed that the highest number of citations were received from 2013 to 2016. The other studies also endorsed that the older publications received more citations as compared to the latest. A study on research growth of the Arab World from 1980 to 2020 revealed that the highest numbers of citations were gained during the years 2001, 2005 and 2016-2020 (Ahmad, Rehman & Ashiq, 2020). Another bibliometric study on the research output of road traffic injuries by GCC region from 1981 to 2019 stated that the maximum citations were received by the publications of 2015, 2010 and 2008 (Butt, et al., 2020). Haq et al., (2020) evaluated the health science research of Saudi Arabia from 2008 to 2017. A total of 35,291 items were identified in the Scopus database and the AAGR was recorded 17.7%. The AAGR of the publications of MNG-HA has been much higher as compared to this study. Haq et al., the study included all types of health sciences documents, whereas the present city is limited to scholarly literature only.

Among the influential authors, Yaseen M. Arabi emerged as the most productive and influential author with 273 publications and he also gained the highest h-index scale. According to the retrieved dataset, only top-four authors produced more than one hundred publications each. The numbers of publications are limited to the Scopus indexed only although the Scopus database allots one unique ID to each

author but sometime due to the variation in the spelling of names or in affiliated address, the Scopus split the publications into more than one ID. The majority of research has been conducted by multi-authors and only 5% of the publications were the result of a single author but interestingly, these publications received the third-highest citation impact. The KAIMRC's publications have the highest average number of authors per paper compared to other MNG-HA units.

A researcher of Stanford University, Ioannidis, with his two co-authors, prepared the list of topmost two percent researchers of the world ($n=1,59,684$) in all the branches of knowledge. The study covered the life-long research growth and citation impact of researchers indexed in the Scopus database in distinct subjects. Three hundred and twenty-one ($n=321$) researchers of Saudi Arabia have figured in this list, included the three researchers (Yaseen M. Arabi, Abderrezak Bouchama, & Yousef Al Eissa) from MHG-HA. (Ioannidis, Boyack & Baas, 2020).

The MNG-HA authors used 1,755 sources to share their research and seven journals published from Saudi Arabia amongst the ten most influential journals. The maximum number ($n=145$) of papers were published in Saudi Medical Journal (SMJ). It is the oldest and the most prestigious medical journal of Saudi Arabia. Previous studies also validated that SMJ has been frequently used as a source title for disseminating health science research. Sweileh, et al., (2014) assessed the Osteoporosis research in the Arab World and exposed that the highest number of papers were produced by Saudi Arabia and the highest number ($n=30$; 7.04%) were published in SMJ. El Rassi et al., (2018) examined the medical research output of the Arab World from 2007 to 2016 and pointed out that the highest number of papers ($n=1,412$) were published in SMJ by the Arab World's researchers.

Shehetta and Mahmood (2016) revealed that the Saudi Arabian authors produced 88,506 papers in a span of 35 years (1980-2014) with an average of 6.42 citations per paper. These papers counted as 0.18% of the global research output and 81% percent of the research was carried out in a multi-author pattern. More than one-fourth ($n=24,937$; 28.17%) of the total research were comprised of clinical, pre-clinical and health discipline. According to the Scimago Journal and Country Rank (SJR), Saudi Arabia was at 51st position in the global ranking of research productivity in 2009 with 0.17% of worldwide share, but in 2019, the country reached 29th rank with 0.66% of the scholarly share, globally.

Singh and Parvez (2019) measured the research output of seven Indian Institutes of Management located in different cities of India, from 2008 to 2018. A total of 2,068 documents were found and Institute located in Ahmadabad produced the highest number ($n=550$). In international collaboration analysis, the United States was the topmost preference ($n=367$) followed by England, Canada and China. About one-fifth (19%) of the documents were written by single author, whereas the two-author patten found a high ratio ($n=39\%$). Indian Institute of Management Bangalore gained the highest average of 7.53 citations per document. Mushtaq, Abid & Qureshi (2012) examined the quality publications of 26 medical universities of Pakistan, indexed in Journal Citation Report of Web of Science from 2007-2010. Sixty-four percent of the publications contributed by three leading universities.

KAIMRC has been compiling the data of publications of all the MNG-HA units and presented it annually as a monograph. The MNG-HA's publication data of 2019 consisted of 1,186 papers; slightly more than two-thirds (66%) of the papers were published in impact factor journals and one-fourth (25.9%) of the papers were published in journals having an impact factor of more than two. The subject dispersion showed that 24.5% of the papers were related to Blood and Cancer, followed by Rare and Genetic Diseases (22.4%) and Infectious Diseases (15.9%). The majority of studies belonged to the category of Clinical, followed by Pre-Clinical, Medical Management, Public Health and

Education. Three articles were published in the New England Journal of Medicine, having an impact factor of 70.67 (King Abdullah International Medical Research Center, 2020).

The efforts of MNG-HA's leadership to stimulate the innovative research culture, teamwork, collaboration at the national and international level among the MNG-HA community have been very fruitful. The research productivity is not only enhancing the prestige of the organization but also improve the global ranking. The leadership has been revisiting the research policies and strategies to increase the quality and quantity of research publications and encourage collaboration as well as a partnership with the industry.

LIMITATIONS OF STUDY

This article was limited to the publications indexed in Scopus database, affiliated to KSA, from 2002 to 2020. It was beyond the scope of our study to ascertain whether the included research was carried out in MNG-HA or not. The Saudi researchers working outside KSA with no current affiliation with MNG-HA might have been omitted. Other databases like Web of Science, Google Scholar and PubMed might have different records, which were not considered in this analysis; future study may verify the present findings with the data from these sources. Future research may also focus on the comparison of MNG-HA publication with similar national and international organizations.

CONCLUSION

The human capital of MNG-HA has been striving hard to get brilliance in healthcare, research, education and community services. Methods and techniques of bibliometric study are very ideal and useful for depicting the research output of academic institutions. MNG-HA researchers are actively participating and exploring new horizons in healthcare services and facilities as is evident from current study. The growing numbers of research publications with sound citation-impact and international collaboration reflect the idealistic and practical approach of MNG-HA leadership, appropriate allocation and spending of research grants, and aspiring contribution of researchers.

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