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Bibliometric Analysis of Research Productivity of Health Care Professionals in Saudi Arabia: An Exploratory Study

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Abstract

Objectives: The aim of this study is to analyze research productivity through literature mapping of Health care Professionals (HCPs) belonging to Imam Abdulrahman Bin Faisal university (IAU), Kingdom of Saudi Arabia (KSA). To facilitate that, publications made by the HCPs in those journals indexed in the PubMed indexed medical database have been chosen for this study. The selected study period was between 2014 and 2018. This study also explores the literature growth, mapping of the health care literature and health care professional's collaboration patterns in KSA.

Methods: The chosen data were downloaded from PubMed Database through Endnote software. Publications are filtered to countries based on the affiliation. The following search terms have been used to yield the records from database on 10th April 2019, "(((((saudi[Affiliation] OR saudiarabia[Affiliation]) OR KSA[Affiliation]) OR K.S.A[Affiliation]) OR K.S.A.[Affiliation]) OR kingdom of saudi arabia[Affiliation]) AND ("2014/01/01"[PDAT] : "2018/12/31"[PDAT])))))".

Result: It revealed that 33872 papers have been published with specific on health care literature during the study period. Among the published papers, 26.52% (N=8983) of them belonging to the year 2018 whereas 75% of the articles were published in a rest of the years. The journal "PLoS One" was the most productive Journal, with 680 of publication were produced during

2014-18, followed by Saudi Med J (N=619), Sci Rep (N=612), Saudi J Biol Sci (N=412). In terms of collaboration, 59.05% (N=20001) of the articles were published with more than five authors, demonstrating a high range of collaboration among the Saudi Arabian health professionals.

Conclusion: This study concludes that there is a progressive growth in the number of publications as well as research collaborations among Saudi healthcare professionals.

Keywords: Health Care, Research Productivity, Saudi Arabia, Bibliometric Analysis, Scholarly Communication.

Introduction

Saudi Arabia is the largest country in the Arabian Peninsula and situated inside the southwest nook of Asia. The dominion of Saudi Arabia has made top notch advances inside the health services. Saudi Arabia's educational system consist of large number of faculties, schools, technical colleges and universities. The success of a higher education institution (HEI) is measured based on the number of students it attracts, number of graduates securing well paid jobs and the revenue generated from research and consultancy services (Naidoo and Jamieson 2005). As such, Saudi Arabia has been taking active steps to promote research and development through National Science, Technology and Innovation Programs, The National Science Technology and Innovation Plan (NSTIP) and Centers of Research Excellence and Science Parks (Smith, Larry, Abouammoh, Abdulrahman, 2013). Health-related research productiveness have also been improved through Ministry of Health (MoH) and Ministry of Education (MoE), which is evidenced through a dramatic increase in wide variety of undergraduate and postgraduate medical educational institutions. In recent decades, there has been an increase in the number of universities in KSA, pointing to the increasing attention the country is giving towards sustainable national development and enhanced human capital across the Kingdom. At present, there are 34 universities (25 public and 9 private) spread across the various regions of the KSA (Ministry of Education, 2014). Even though all the HEIs in Saudi Arabia are run by the Ministry of Education, some differences in the infrastructural facilities (i.e. laboratory, library and teaching hospital) and intellectual capital (i.e. availability of faculty and skilled manpower for research guidance) are obvious with respect to the conduct of scientific research (Al Kuwaiti, Subbarayallu AV, 2015). Moreover, Saudi Arabia is sharing major portions of world scientific research productivity in the last ten years and keep progressing well on scientific research output in all levels, hence analyzing its research productivity will give a deeper view and progress status and it will be valued to scientific community.

Research Productivity: Publications by Saudi Academics

Improving research productivity of academics in higher education is one of the objectives in the National Development Plans that aim at achieving social and economic aspirations for KSA (Abad Alzuman, 2015). The publication output of Saudi academics has increased rapidly in recent years as the government has invested more heavily in research and development. Saudi universities consider the

publishing productivity of its academics as an index of departmental and institutional prestige and is strongly associated with individual, organizational and environmental factors (Sax LJ., et al., 2002). Understanding the factors influencing the research productivity of HCPs are considered to be important for the leaders of academic institutions and its associated academic medical centers. Publications are the major output of scientific research, and they are the most commonly used vehicles through which new scientific discoveries are conveyed to the rest of the world (Tien, FF., 2007) Publication counts, articles printed in well-known academic journals and research grants are among the common measures of faculty research performance. Other authors used multiple measures to investigate faculty research productivity to be more objective (Lowcay B., 2004). However, there is no consensus among authors on what constitutes objective criteria that could be used to estimate research productivity since each criterion has its own merits and deficiencies (Arriola-Quiroz I, 2010 and Zhuo M., 2008). In addition, it is noteworthy to mention that research productivity is one of the major criterions to get into the world ranking table. HEIs begin to use global rankings as a promotion tool to showcase their education, research or business excellence, students tend to visit the ranking websites in order to choose appropriate universities to apply to (Dill and Soo 2005). Recently, launched Saudi Arabia Vision 2030, which aims to see no less than five Saudi universities make it to the league of topmost universities in international rankings (Alshuwaikhat et al. 2016). Thus, in order to aid Saudi universities, especially health science programs to improve its research productivity, it is paramount to analyze the publication pattern of healthcare professionals and how they are performing well in this regard. Accordingly, this study focusses on scientometric analysis of five years' healthcare research publication data of authors belonging to Saudi Arabia so as to identify Top 20 journals and rank them according to the following six parameters: (i) publications count per year; (ii) journal productivity expressed in terms of number of publications made by Saudi HCP each year; (iii) authorship pattern held by Saudi HCP whether single or multi-author expressed per year; (iv) degree of Collaborations made by HCP based on the formula stipulated by Subramanyam (1982); (v) subject-wise journal distribution showing the number of publication made by HCP in the last five years period; (vi) journal-wise publications showing authorship pattern indicating whether single or multi-authors.

Methodology

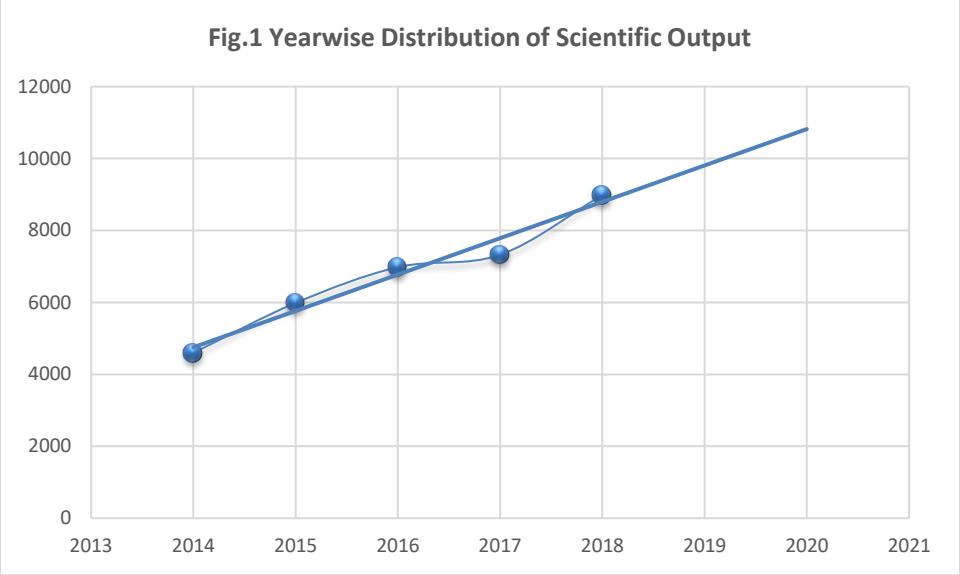
The chosen data were downloaded from PubMed Database through Endnote software. PubMed database (http://www.pubmed.gov) is published online from National Library of Medicine. The following search terms have been used to retrieve the records from database "(((((saudi[Affiliation] OR saudiarabia[Affiliation]) OR KSA[Affiliation]) OR K.S.A[Affiliation]) OR K.S.A.[Affiliation]) OR kingdom of saudi arabia[Affiliation]) AND ("2014/01/01"[PDAT] : "2018/12/31"[PDAT])))). The term 'Healthcare Professionals" refer to those healthcare employees employed at Saudi universities, teaching hospitals, ministry of health hospitals, private hospitals and other colleges & institutes for health located in Saudi Arabia.

Results

Table 1 shows the year-wise publication of articles made by Saudi healthcare Professionals as per the data retrieved from PubMed database. While analyzing the last five years publication data, it is observed that 26.5% of articles (N=8983) published in the year 2018 and the remaining 75% of the articles were published in a span of 4 years. While 2017 has the second highest number of articles (7325, 21.63%), the least number of 4597 (13.57%) articles were published in 2014. On an average, 6774 articles were published per year. The first three years contributed 51.85% (17564) of the research output while the next 2 years contributed the remaining 48.15% of the research output. From the fig 1, we can witness an uptrend in the research performance of IAU healthcare professionals with regard to number of publications as retrieved from PubMed database.

Table 1: Year wise Publications Distribution

Year	Count	Percent
2014	4597	13.57
2015	5986	17.67
2016	6981	20.61
2017	7325	21.63
2018	8983	26.52
Grand Total	**33872**	100.00



Further exploration was carried out regarding the number of articles published by Saudi healthcare professionals in PubMed in the last five calendar years and it is depicted in the table 2. Based on the number of publications made by Saudi healthcare Professionals in PubMed indexed journals, the authors screened a list of top fifty journals and ranked them chronologically in ascending order based on the cumulative number of publications made in the last five calendar years. From the list of fifty, the top twenty journals are chosen and presented in the table 3.

Table 2: Year wise Journal Productivity

SL. No.	Journal Title	2014	2015	2016	2017	2018	Total
1	PLoS One	151	153	146	105	125	680
2	***Saudi Med J***	134	146	112	108	119	619
3	Sci Rep	40	82	164	189	137	612
4	***Saudi J Biol Sci***	40	74	62	105	131	412
5	Molecules	34	49	67	50	74	274
6	Spectrochim Acta A Mol Biomol Spectrosc	88	110	27	17	31	273
7	***Saudi Pharm J***	45	33	21	71	85	255
8	ACS Appl Mater Interfaces	12	43	55	79	61	250
9	J Contemp Dent Pract	17	30	47	65	64	223
10	Int J Biol Macromol	14	18	32	53	87	204
11	Biomed Res Int	42	51	26	30	46	195
12	***Ann Saudi Med***	35	40	35	41	41	192
13	Nat Commun	24	38	38	37	48	185
14	Int J Health Sci (Qassim)	26	26	22	41	51	166

SL. No.	Journal Title	2014	2015	2016	2017	2018	Total
15	Environ Sci Pollut Res Int	5	15	27	46	64	157
16	J Am Chem Soc	4	34	40	40	30	148
17	Scientific World Journal	115	20	2	1	1	139
18	***Neurosciences (Riyadh)***	17	27	23	27	39	133
19	Pak J Med Sci	21	37	24	26	25	133
20	Int J Nanomedicine	24	34	30	20	23	131
21	J Infect Public Health	13	11	31	34	42	131
22	Angew Chem Int Ed Engl	3	23	35	29	37	127
23	Adv Mater	6	17	36	34	33	126
24	Pak J Pharm Sci	11	41	25	21	24	122
25	Chemistry	3	19	35	39	25	121
26	***Saudi J Anaesth***	26	14	28	26	26	120
27	***Saudi J Kidney Dis Transpl***	25	21	23	27	24	120
28	Ann Thorac Med	34	25	20	19	21	119
29	Bioorg Chem	4	6	12	31	66	119
30	***Saudi J Ophthalmol***	28	19	22	16	34	119
31	Biomed Pharmacother	1		7	51	59	118
32	Asian Pac J Cancer Prev	28	39	21	10	19	117
33	***Saudi J Gastroenterol***	25	26	23	19	23	116
34	Sensors (Basel)	8	15	27	31	33	114
35	Int J Mol Sci	23	24	26	17	22	112
36	J Clin Diagn Res	15	34	34	28		111
37	Eur J Med Chem	19	22	18	23	28	110
38	Front Microbiol	9	16	32	26	24	107
39	***J Family Community Med***	19	19	23	23	23	107
40	J Pak Med Assoc	1	19	25	34	22	101
41	New Microbes New Infect		8	45	31	16	100
42	***Saudi Dent J***	13	18	24	19	24	98
43	Int J Surg Case Rep	6	9	15	25	42	97
44	J Coll Physicians Surg Pak	28	18	20	12	17	95
45	J Int Soc Prev Community Dent	6	24	30	16	18	94
46	J Enzyme Inhib Med Chem	3	10	44	15	17	89
47	Food Chem	7	25	27	12	17	88
48	J Colloid Interface Sci	8	17	13	21	29	88
49	Urol Ann	15	22	15	14	22	88
50	Materials (Basel)	4	11	16	21	34	86
	Others	3318	4354	5229	5450	6880	25231
	Total	4597	5986	6981	7325	8983	33872

The PLoS One journal was the most productive Journal, with 680 of publication during years 2014-18, followed by Saudi Med J (N=619), Sci Rep (N=612), Saudi J Biol Sci (N=412). Most

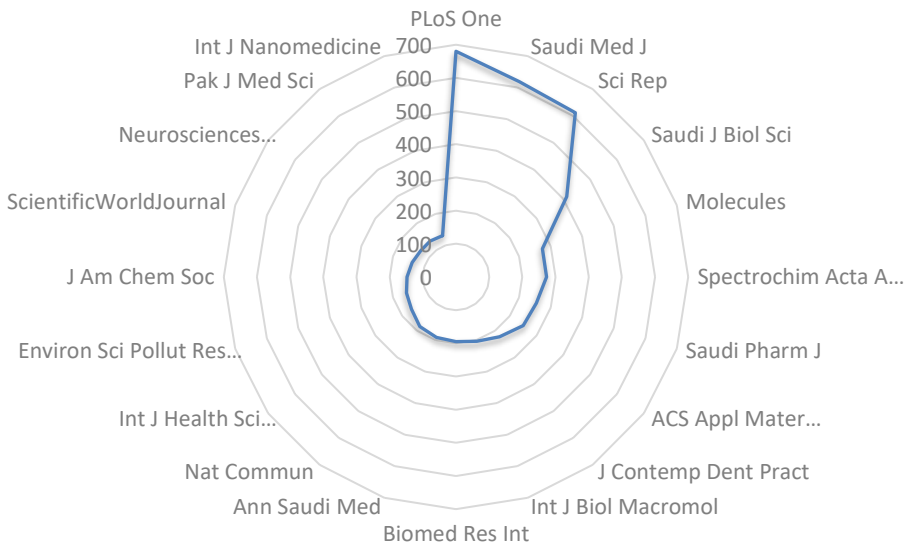
of the Saudi journal articles are increased year by year, so we can see that Saudi Arabia is well growing by medical research.

Table 3. Top 20 Journal Ranking

Journal Title (Abbr)	Total Publication (N=33872)	Percentage	Rank
PLoS One	680	2.01	1
Saudi Med J	619	1.83	2
Scientific Reports	612	1.81	3
Saudi J Biol Sci	412	1.22	4
Molecules	274	0.81	5
Spectrochim Acta A Mol Biomol Spectrosc	273	0.81	6
Saudi Pharm J	255	0.75	7
ACS Appl Mater Interfaces	250	0.74	8
J Contemp Dent Pract	223	0.66	9
Int J Biol Macromol	204	0.60	10
Biomed Res Int	195	0.58	11
Ann Saudi Med	192	0.57	12
Nat Commun	185	0.55	13
Int J Health Sci (Qassim)	166	0.49	14
Environ Sci Pollut Res Int	157	0.46	15
J Am Chem Soc	148	0.44	16
ScientificWorldJournal	139	0.41	17
Neurosciences (Riyadh)	133	0.39	18
Pak J Med Sci	133	0.39	19
Int J Nanomedicine	131	0.39	20
total	5381	15.91	--

Table 3 gives information of the top-20 most active journals publishing the research work of Health Care Professionals in Saudi Arabia. It is observed that the PLos One journal published largest number of literatures i.e. 680 (2.01%). The Saudi Med Journals is at second position with 619 (1.83 %) Publication followed by Journal of Scientific Reports with 612 (1.81%) publications.

Fig. 2 Journal Ranking



Further attempt has been made to study the authorship pattern adopted by Saudi healthcare professionals in publishing research articles and the results are depicted in table 4.

Table 4. Year-wise Distribution of Authorship Pattern

Year	Single Author	Double Author	Three Author	Four Author	5 and above	Total
2014	449	540	649	658	2301	4597
2015	433	576	718	911	3348	5986
2016	425	626	830	920	4180	6981
2017	390	616	793	992	4534	7325
2018	495	716	928	1206	5638	8983
Grand Total	2192 (6.47%)	3074 (9.08%)	3918 (11.57%)	4687 (13.84%)	20001 (59.05%)	33872 (100%)

From the results, it is observed that 59.05% of authors have collaborated in five and above authorship pattern, followed by 13.84 % (N=4687) of authors have in group of four authors, 11.57% (N=3918) of authors in three authors, 9.08% (N=3074) of authors in two authors, and only 6.47% (N=2192) of authors in single authorship pattern. It was clear that 93.53% of the authors published their articles with multi authors in the articles; hence the authorship pattern proves that the collaboration pattern is high.

Table 5. Degree of Collaborations

Year	Single Author (Ns)	Multiple Author (Nm)	Total (Nm+Ns)	Degree of Collaboration
2014	449	4148	4597	0.90
2015	433	5553	5986	0.93
2016	425	6556	6981	0.94
2017	390	6935	7325	0.95
2018	495	8488	8983	0.94

The table 5 shows the details about the degree of collaboration held by the authors in publishing their research articles since 2014. Degree of collaboration is a prominent area of research in bibliometric studies which indicate tends in single and joint authorship during the period from 2014 to 2018 (table 5). In this study, the degree of collaboration is calculated based on the formula stipulated by Subramanyam (1982) and it is described below:

C= Nm / (Nm+Ns)

C= Degree of Collaboration

Nm=Number of Multi Authored Papers

Ns=Number of Single Authored Papers

C=31680/2192+31680 = 0.93

Thus, it is observed that in the last five years, highest degree of collaboration occurred during the year of 2017. Overall the collaboration during the study period was very high with 0.93.

Table 6. Subject wise Journal Distribution showing the number of publications done by Saudi-based Health Care Professionals from the year 2014 to 2018

Sl.No	Subject of the Journal	Count	Percent
1	Medicine (General)	13094	31.51
2	Therapeutics. Pharmacology	4536	10.91
3	Surgery	3252	7.83
4	Dentistry	3143	7.56
5	Oncology	1640	3.95
6	Pediatrics	1396	3.36
7	Radiology	1193	2.87

Sl.No	Subject of the Journal	Count	Percent
8	Neurology	1162	2.80
9	Optometry	1125	2.71
10	Pathology	1118	2.69
11	Urology	1106	2.66
12	Rheumatology	910	2.19
13	Infectious disease	872	2.10
14	Cardiology	850	2.05
15	Gynecology and Obstetrics (Gynaecology)	613	1.48
16	Nursing	596	1.43
17	Epidemiology	595	1.43
18	Critical care medicine	473	1.14
19	Psychiatry	436	1.05
20	Otorhinolaryngology	422	1.02
21	Orthopaedics	410	0.99
22	Dermatology	402	0.97
23	Endocrinology	391	0.94
24	Gastroenterology	381	0.92
25	Pulmonology	379	0.91
26	Hematology	353	0.85
27	Nephrology	328	0.79
28	Sports medicine	238	0.57
29	Hepatology	73	0.18
30	Preventive medicine	72	0.17
		41559	100.00

Subject-wise analysis of journals showing the number of articles published by Saudi Healthcare Professionals in the last five years is shown in table 6. It is observed that 13094 (31.51 %) published articles are related to Medicine (General) subject followed by 4536 (10.91%) articles related to Therapeutics Pharmacology subjects. Surgical subjects occupy third position with 3252 (7.83%) published articles followed by Dentistry where the number of publications is reported to be 3143 (7.56%) articles in the last four five academic years. Similarly, the number of publications made with specific focus on Oncology and pediatrics is reported as 1640 (3.95%) and 1396 (3.36%) respectively.

Further attempt has been made to ascertain authorship pattern in each one of the published articles by Saudi Healthcare Professionals in PubMed indexed journals in the last five academic years. The following table illustrates the number of articles published by Saudi Healthcare Professionals in the top 20 journals with specific reference to author distribution.

Table 7. Journal wise Author Distribution

Sl.No	Journal Title	Number of Authors					
		Single Author	**Two Authors**	**Three Authors**	**Four Authors**	**5 and more**	**Grand Total**
1	PLoS One	9	27	61	**113**	**470**	680
2	Saudi Med J	**121**	**110**	**76**	93	219	619
3	Sci Rep	3	25	58	56	**470**	612
4	Saudi J Biol Sci	56	45	56	56	199	412
5	Molecules	9	17	28	40	180	274
6	Spectrochim Acta A Mol Biomol Spectrosc	13	29	42	44	145	273
7	Saudi Pharm J	28	35	38	39	115	255
8	ACS Appl Mater Interfaces	0	5	11	22	212	250
9	J Contemp Dent Pract	42	27	20	31	103	223
10	Int J Biol Macromol	7	14	20	34	129	204
11	Biomed Res Int	13	18	28	33	103	195
12	Ann Saudi Med	25	19	18	29	101	192
13	Nat Commun	0	3	7	6	169	185
14	Int J Health Sci (Qassim)	61	21	19	17	48	166
15	Environ Sci Pollut Res Int	5	11	13	21	107	157
16	J Am Chem Soc	0	2	2	9	135	148
17	Scientific World Journal	24	19	29	28	39	139
18	Neurosciences (Riyadh)	18	30	19	29	37	133
19	Pak J Med Sci	26	17	12	25	53	133
20	Int J Nanomedicine	3	13	20	22	73	131
	Others	1729	2587	3341	3940	16894	28491
	Total	2192	3074	3918	4687	20001	33872

It is clear from the table 7 that 93.5% of articles are published with more than one author affiliation. Specifically, the Journal of PLoS One have highest publication count (N=680) in which 113 articles are published with four authors collaboration and 470 articles are published with more than five authors. Likewise, Saudi Medical Journal has contributed with single (n=121), two (N=110) and three authors (N=76) publications with an overall count of 619 publications.

Discussion

The past decade has seen a continued increase in Health care research productivity in Saudi Arabia as huge investments & progressive efforts has been made to improve the quality of higher education and research output during the last two decades. According to Scimagojr Journal and country rank, Saudi Arabia Stood at 50th position in the year 2005 (4.31%), now its reaches 32rd position in 2017(12.07%) (SJR Website 2018)[1]. Out of 1000 universities assessed by QS ranking during the year 2019, a total of eight Saudi universities observed with their respective rankings in 2019 QS world ranking results (QS, 2019). Specifically, QS has provided 20% weightage to research performance of faculty while finalizing the ranking status of world universities. In order to complete in these world rankings, the research productivity of Saudi universities need to be optimized. As a measure to fulfil that, the research performance of Saudi academics and professionals need to be studied so that appropriate strategies can be formulated to improve it. Hence, the present study is conducted to ascertain the research productivity of Saudi Healthcare Professionals and these findings would help policy planners to device suitable strategies to improve it.

The authors used retrospective data analysis method by retrieving publication data from PubMed database through Endnote software. Publications pertaining to five calendar years were considered i.e. 2014 to 2019. Any article type which are published in those journals indexed in PubMed database with Saudi university or industry/hospital affiliation was included.

The research performance of Saudi HCP with regard to the number of publications per year show an uptrend since 2014 (N=4597) with over 30% increase in each succeeding year and the total number of publications reached the tally of 8983 in the year 2018. From this finding, it is witnessed that Saudi HCPs progressing well, regarding research performance and several reasons might be attributed to this increased trend. Faculty members at Saudi public universities are expected to teach, participate in research, and community service activities. Academic promotions are based on these three key components regardless of university's mission (Al-Ghamdi & Tight, 2013). In academic setup, research is an important component for faculty promotion which motivates faculty members to get involved in research and publications. To aid faculty, an exclusive deanship is existing in each Saudi University and it provide funding for faculty to conduct research. Financial rewards are also provided to those faculty who publish in Journals with high impact factor. A similar financial aid is being offered

to HCPs working in Academic Medical Centers in Saudi Arabia. Moreover, KSA government has established a National Science Technology and Innovation Programme that provides funding for those faculty involved in research at the international level (Latif, 2015).

While studying the contribution of the Journals, it is observed that eleven Saudi based journals namely Saudi Medical Journal (N=618), Saudi J Biol Sci (N=612), Saudi Pharm Journal (N=255), Ann Saudi Medicine (N=192), Neurosciences [Riyadh] (N=133), Saudi J Anaesth (N=120), Saudi J Kidney Dis Transpl (N=120), Saudi J Ophthalmol (N=119), Saudi J Gastroenterol (N=116), J Family Community Med (N=107) and Saudi Dent Journal (N=98) contributed more for showcasing the research work of Saudi scholars in the last five academic years. In addition to the above, PLoS One journal is the most preferred choice for Saudi HCP where 680 publications were made during years 2014-18. The affinity of Saudi scholars to publish in the above regional journals might be due to their nature of research study/article, topic of interest and scope of these journals published from middle east region. Another important factor is the access provided by these regional journals in which most of them offering free access to readers to download articles. Budapest Open Access Initiative (BOAI) defines open access as: "Free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles...without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself". However, an earlier study argued that free public availability and increased exposure may not be strong enough incentives for authors to choose open access over more traditional and respected subscription-based publications, unless the quality issue is also addressed (Stefanie Warlick and Vaughan, 2007). Exploring the reasons behind the authors choice to publish in these regional journals is beyond the scope of this research and further study is warranted to address this critical issue.

Another important finding of this study is the pattern of authorship where 93.53% of published articles are multi-authored, thus stressing the importance of research collaboration adopted by Saudi HCPs. It is interesting to note that when the degree of collaboration is high, there is an increase number of publications in that academic year (Table 5). In support of our findings, earlier study also stressed the importance of international research collaboration in health care and it is frequently regarded as an indicator of quality to develop and disseminate scientific knowledge to newly developing countries (Freshwater et al. 2007; Kim, 2006). Earlier studies highlighted the reason for increased collaborative research work in healthcare, which is largely due to developments in information technology and communication systems, and the internet

in particular, have facilitated the rapid and extensive exchange of information, expertise and ideas across international communities, resulting in the widespread creation and dissemination of knowledge (Bettcher and Lee, 2002; Freshwater, 2004). Zutshi et al. (2012) indicated that Collaborative research allows the development of networks with early-career researchers in other countries. Other studies also highlighted the benefits of collaboration as it is suitable to address particularly complex problems from multiple perspectives, something that may be easier for a team of individuals than for a single researcher (Laband, D. N., & Tollison, R. D, 2000).

There are several limitations to this study that need to be addressed. First, the results are derived from PubMed article database and there is a need to include other database to get a comprehensive picture of Saudi HCPs research productivity. Secondly, this study addresses the research performance of HCPs as whole and further studies should focus to bring out the research performance of each category of HCPs such as Physicians, Nurses, Pharmacists and other healthcare professionals. Lastly, future studies should explore reasons for the existing research performance of HCPs and develop suitable strategies to improve the same.

Conclusion

This study concludes that a consistent research performance is witnessed among Saudi HCPs in the last five years. An uptrend in performance is observed with regard to the number of publications as well as research collaborations among Saudi HCPs. Also, it is observed that over 93% of published articles are multi-authored publications, thus demonstrating a high degree of research collaboration adopted by Saudi HCPs. This study provides necessary information to policy-planners to strengthen the research-oriented activities so as to improve the research performance of HCPs in Saudi Arabia.

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