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Analysis of Pharmacy Related Publications, H-indices, and Patents of 102 Countries

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ABSTRACT

Background: The number of research publications, patents, and H-index values of each country in pharmacy related fields, could be used as scientometric indicators of pharmacy research and education. ***Methods:*** For this purpose we studied above mentioned factors for 102 counties consisting of; twenty finance ministers and central bank governors, European Union member countries, first twenty countries of the world in Human Development indices, Middle East countries, and members of Organization of the Islamic Conference. Scopus® was used to extract the bibliometric data. The correlation of some factors such as economical, educational, and research and development (R&D) indicators of the countries on the studied parameters were investigated. ***Results:*** The results of analyses showed that studied indicators are correlated with the number of publications, H-indices, and patents. This might suggest the possibility of the further researches in the field of mathematical representation in scientometrics. ***Conclusion:*** Research and development in pharmacy areas are affected by expenditure and the more the expenditure, the more the outcome of research and development.

Introduction

Pharmacy related fields are one of the most important subjects in medical sciences research and development. The outputs of research and education in pharmacy might have mutual effects on the health policies and economies of the countries. There are numerous active research and development cores in universities and companies around the world. However, outputs of these centers are not equal in quantity, quality, and distribution. So, there might be some factors which are affecting these differences.

To find out about them, the scientometric and bibliometric methodologies seems to provide a rational outline. Scientometric approach was implemented for studying trends in the development of pharmacy.[1] Bordons and Barrigón have studied contribution of Spanish pharmacologists to the pharmacy, pharmacology and subfields other than these fields in two successive papers.[2,3] Collaboration of pharmacist and pharmacologist with Spanish and other countries institutions has been studied by Méndez and Gómez.[4] Spanish biomedical sciences trends from 1986 till 1989 was studied by Gómez and colleagues. They showed that clinical papers were mostly published in Spanish journals which were not indexed in international data bases. Also most of the basic research outputs were published in European journals with similar quality that other European's publications were published.[5] Co-classification analysis of the International Pharmaceutical Abstract Database was performed by Spasser.[6] Impact of merging and acquisition on research productivity of pharmaceutical industries was performed[7] and cooperation in publication in biopharmaceutical firms was studied.[8] Comparative analysis between impact factor and H-index for pharmacology and psychiatry journals was done by Bador and Lafouge.[9] Benamer and Bakoush have also studied total publications of Arab nations in comparison with other Middle Eastern countries.[10]

Another item which could be considered as an outcome of pharmacy research and development in direct relation with articles is the number of patents. However, it has some limitations as an indicator of research and education which has been discussed in detail by Archambault.[11] Innovation is a vital factor for the pharmaceutical companies. Patents statistics show the relationship between science and technology. The

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origin and features of information referenced in pharmaceutical patents was studied.[12] Chen and Chang studied the patent citation of the American pharmaceutical companies using artificial neural network.[13]

Based on the mentioned works and to the best of our knowledge, there is no study considering scientometrical aspects of pharmacy related fields for countries around the world. So, in the present study we used a scientometrical approach to compare pharmacy related publications of 102 countries around the world consisting of: twenty finance ministers and central bank governors, European Union member countries, first twenty countries of the world in Human Development indices, Middle East countries, and members of Organization of the Islamic Conference. Also, the correlations of different economical, educational, research and development factors with the extracted bibliometric data have also been checked.

Data Acquisition

Scopus was used for data collecting as the largest abstract and citation database of peer-reviewed literature. It offers over 29 million abstract and 18 million patent records.[14] Also Scopus is a useful tool for providing data on both articles and patents published and registered by a country which makes their evaluation and analyses more accurate.

Data from Scopus for 102 countries was collected as following method. Countries in the study are: Twenty finance ministers and central bank governors (G20), European Union member countries (EU27), first twenty countries of the world in Human Development indices (HD), Middle East countries (ME), and members of Organization of the Islamic Conference (OIC). We performed affiliation search for each country. One possible problem in bibliography is missing some data due to the different names for a number of countries.[15,16] For preventing this problem we have searched different possible names of these countries. For example, about United States, "u.s." or "us" or "u.s.a." or "usa" or "United States of America" or "America" were used besides "United States". Then the data is limited to pharmacy related area by adding "(LIMIT-TO(SUBJAREA, "PHAR"))" in advanced search of the Scopus. The resulted data is saved for each country, as well. Following this step we also put year limit, by adding "PUBYEAR AFT 1999". The results are also saved for each country. All the data were collected and saved from 2011.02.11 till 2011.02.16.

A number of possible influencing factors on pharmacy related fields research and development include: Gross Domestics Product (GDP), GDP per capita (GDPpc), Gross National Income (GNI), GNI per capita (GNIpc), total population, expenditure per tertiary level student (XTLS), tertiary level school enrollment (TLSE), total health expenditure (THX), labor force with tertiary education (LFTE), research and development expenditure (RDX), researchers in R&D, per million people (RRD), technicians in R&D, per million people (TRD). We have used mean values for studied indices for the following reasons:

1- There are missing data for some years
2- There are outlier data for some years.

Tertiary education levels for the year 2010 were extracted from Human Development Report 2010.[17]

Statistical correlation between pharmacy related publications, pharmacy related patents, pharmacy related H-index, and studied factors have been determined using Spearman correlation test.

Results and Discussion

Bibliometric data of the studied countries are presented in Table 1. Figure 1 shows the top five countries ranking in each studied group for pharmacy related publications without time limit. As it is seen, developed countries hold the first 5 places among all of the studied countries. There is no significant difference among data of HD, G20, and EU groups. The ME countries are placed after developed countries and the last ones is from OIC. Figure 2 presents ranking based on H-index. The rankings of the studied groups are similar to those of number of publications. This could be an indicator of equivalences in quantity and quality of published articles by the studied groups of countries. Figure 3 exhibits top 5 countries ranking based on number of patents in pharmacy related fields. For all of the studied nations, HD, and G20 countries, the ranking is similar to previous indices. However, there are some differences between ranking of the countries in groups EU, ME, and OIC based on number of patents in compare with number of publications and H-index in pharmacy related fields. Also, the differences among number of patents in pharmacy related fields by ME and OIC countries are salient in compare with other studied groups.

Table S1 presents complete data related with studied 102 countries. Tables S2-S4 show the top ten results for source title, authors, and affiliations for pharmacy related publications during 1999-2010. About 20 percent of published articles in pharmacy related area from 1999 till 2010 are published in the first ten source titles reported in the Table S2. The mean impact factor of the first ten sources for ME, OIC, G20, HD and EU27 are 2.18, 2.08, 3.31, 3.34 and 2.91, respectively. The order of mean impact factor in these publications is HD>G20>EU27>ME>OIC. The difference between impact factors of first ten sources of the studied groups is not noteworthy. This might suggest that the quality of the published pharmacy related articles of the studied countries have no significant differences, but it does not seem to be rational. As Gorraiz and Schloegl reported, the number of articles published in the field of pharmacy and pharmaceutical journals with impact factors around 2 is much higher among top 100 journals.[18]

Table 1. Total number of pharmacy related publications, H-index, and patents for the studied 102 countries (Searched from Scopus).

Country	Group	Publication	H-index	Patent	Country	Group	Publication	H-index	Patent
Afghanistan	OIC	10	2	0	Lebanon	ME, OIC	690	38	66
Albania	OIC	27	6	0	Libya	OIC	185	13	0
Algeria	OIC	321	18	0	Liechtenstein	HD	5	2	170
Argentina	G20	6646	63	19	Lithuania	G20, EU	376	27	1
Australia	HD, G20	29915	130	753	Luxembourg	G20, EU	217	33	167
Austria	G20, EU	10260	92	512	Malaysia	OIC	2056	40	10
Azerbaijan	OIC	100	8	0	Maldives	OIC	0	0	0
Bahrain	ME, OIC	63	9	0	Mali	OIC	82	17	6
Bangladesh	OIC	686	26	0	Malta	G20, EU	88	10	2
Belgium	HD, G20, EU	18660	121	662	Mauritania	OIC	6	4	0
Benin	OIC	384	19	0	Mexico	G20	8130	73	81
Brazil	G20	17993	87	97	Morocco	OIC	726	36	11
Brunei	OIC	13	6	0	Mozambique	OIC	33	7	0
Bulgaria	G20, EU	3947	43	12	Netherlands	HD, G20, EU	32997	154	946
Burkina Faso	OIC	84	11	0	New Zealand	HD	7328	119	99
Cameroon	OIC	680	24	1	Niger	OIC	72	12	0
Canada	HD, G20	54005	190	1948	Nigeria	OIC	3666	38	5
Chad	OIC	5	4	42	Norway	HD	6024	83	149
China	G20	60045	93	1092	Oman	ME, OIC	132	16	0
Comoros	OIC	1	1	0	Pakistan	OIC	2296	37	2
Cote d'Ivoire	OIC	176	23	2	Palestine	ME, OIC	115	12	22
Cyprus	G20, EU	103	15	7	Poland	G20, EU	19516	86	46
Czech	G20, EU	4886	63	40	Portugal	G20, EU	4218	65	10
Denmark	HD, G20, EU	11668	124	834	Qatar	ME, OIC	88	11	0
Djibouti	OIC	4	3	0	Romania	G20, EU	1908	33	12
Egypt	ME, OIC	6789	54	17	Russia	G20	24579	70	161
Estonia	G20, EU	572	32	11	Saudi Arabia	ME, OIC, G20	3070	46	1
Finland	HD, G20, EU	11005	106	270	Senegal	OIC	109	14	1
France	HD, G20, EU	69362	190	606	Sierra Leone	OIC	31	5	0
Gabon	OIC	62	13	0	Slovakia	G20, EU	2281	40	1
Gambia	OIC	32	8	0	Slovenia	G20, EU	1914	44	101
Germany	HD, G20, EU	120929	206	4245	Somalia	OIC	14	7	0
Greece	G20, EU	6409	65	8	South Africa	G20	4817	61	64
Guinea	OIC	152	17	1	South Korea	HD, G20	20448	87	275
Guinea-Bissau	OIC	2	2	0	Spain	HD, G20, EU	37182	123	381
Guyana	OIC	36	10	0	Sudan	OIC	408	17	0
Hungary	G20, EU	9745	77	135	Suriname	OIC	22	9	0
Iceland	HD	388	42	69	Sweden	HD, G20, EU	25025	159	1322
India	G20	55044	108	836	Switzerland	HD	21955	156	393
Indonesia	OIC, G20	657	31	10	Syria	ME, OIC	58	8	1
Iran	ME, OIC	5612	55	5	Tajikistan	OIC	20	3	0
Iraq	ME, OIC	308	19	0	Togo	OIC	82	11	7
Ireland	HD, G20, EU	4962	80	3272	Tunisia	OIC	701	31	2
Israel	ME, HD	11164	107	1012	Turkey	ME, OIC, G20	10640	73	40
Italy	G20, EU	62281	157	329	Turkmenistan	OIC	2	1	0
Japan	HD, G20	171220	182	7048	Uganda	OIC	165	16	0
Jordan	ME, OIC	1032	36	29	United Arab Emirates	ME, OIC	552	29	1
Kazakhstan	OIC	150	10	0	United Kingdom	G20, EU	171154	269	4623
Kuwait	ME, OIC	623	30	9	United States	HD, G20	449709	390	30166
Kyrgyzstan	OIC	16	2	0	Uzbekistan	OIC	324	16	0
Latvia	G20, EU	416	26	29	Yemen	ME, OIC	80	14	0

Figure 1. The number of pharmacy related publications of top 5 countries in each studied group

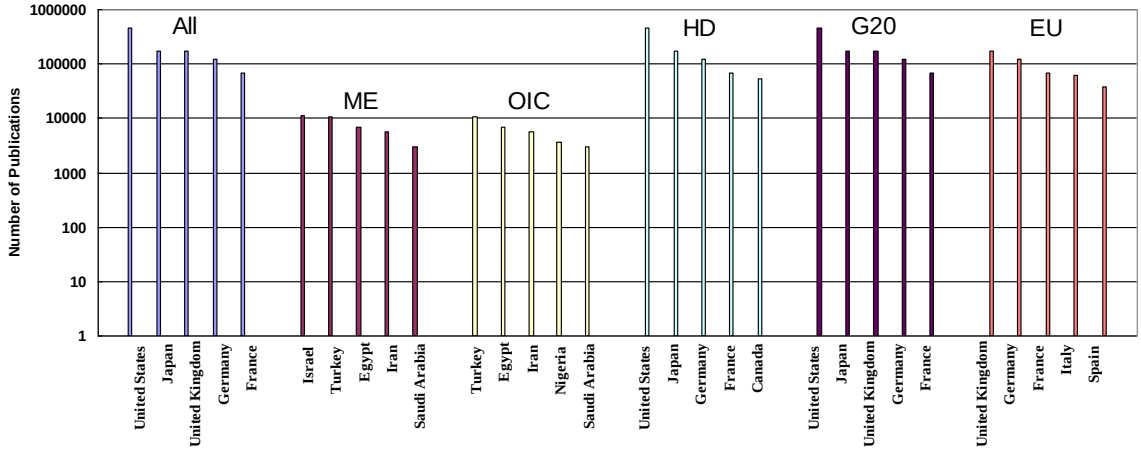


Figure 2. The H-indices of pharmacy related publications of top 5 countries in each studied group

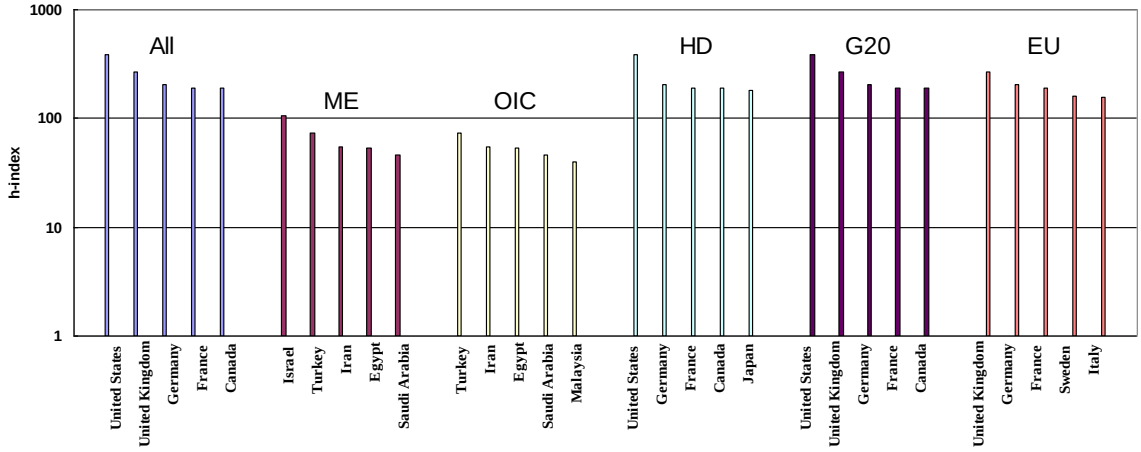
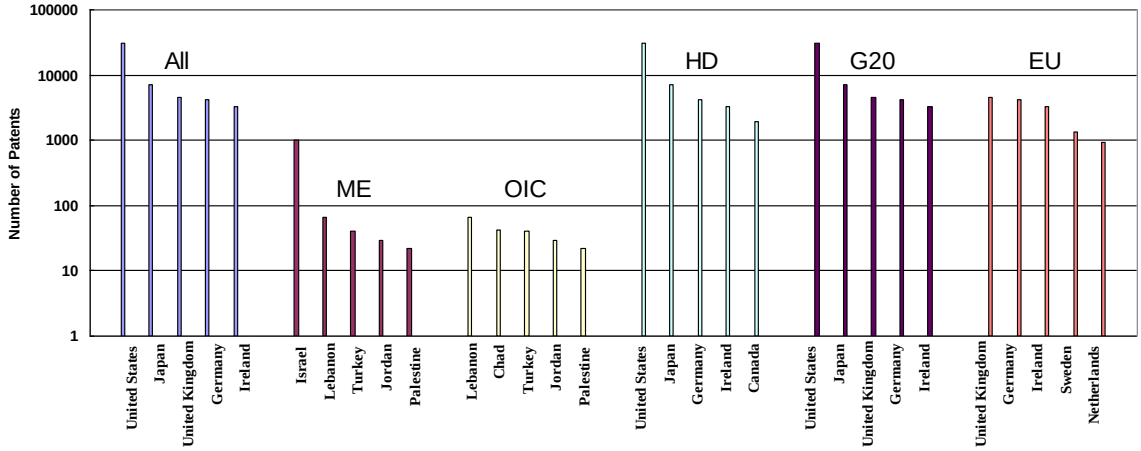


Figure 3. The number of pharmacy related patents of top 5 countries in each studied group



In ME, OIC, G20, HD and EU27 the first ten authors are published correspondingly 0.42 %, 0.37%, 0.07%, 0.10%, and 0.18% of the pharmacy related publications from 1999 till 2010. Analyzing top ten authors of each group and their percent of contributions in publishing articles show that research output of ME and OIC countries is more "author oriented" in compare with other nations.

The first ten affiliations published 28.9%, 23.9%, 5.38%, 6.81% and 8.86% of the all pharmacy related publications from 1999 till 2010 in ME, OIC, G20, HD and EU27, respectively. Based on the results of first ten affiliation of each group, it seems that universities are the first ten affiliations in ME and OIC while companies are significant in G20, HD and EU27. This might be representative of the fact that most of the publications in pharmacy related area are supported more by companies in developed countries. Also it might show that in these countries, the research outcome of pharmacy education is more practical in compare with OIC and ME countries where research outcome of pharmacy education is more theoretical. Tehran University of Medical Sciences of Iran is the first affiliation in ME and OIC. This result is in good agreement with our previous report.[16] However the number of universities from Turkey and Israel in OIC and ME are more than Iranian universities in pharmacy related publications. This might show that other universities in the country should try to improve their education and research status.

Table S5 exhibits more detailed information of the articles published by each country. The curves in the Table S5, display the number of pharmacy related publications and patents during 1999-2010.

The correlations between bibliometric data and studied factors are tabulated in Table 2. Spearman analysis shows that pharmacy related publications, patents, and H-indices are correlated significantly with most of the studied factors, except of XTLS and LFTE. The GDP and GNI have higher correlation coefficients in compare with other studied factors. The lower correlation coefficients of other factors might suggest they have less effect on pharmacy related research and development.

Table 2. Spearman correlation coefficients between studied bibliometric, economic, education, and research and development indices.

Indices	Publication	H-index	Patent
GDP	0.897	0.845	0.705
GNI	0.902	0.849	0.709
GDPpc	0.582	0.634	0.617
GNIpc	0.631	0.685	0.673
Population	0.590	0.506	0.312
XTLS	-0.266	-0.239*	-0.209*
TLSE	0.511	0.555	0.482
THX	0.273	0.342	0.317
LFTE	0.249*	0.260*	0.336
RDX	0.455	0.547	0.559
RRD	0.314	0.400	0.354
TRD	0.382	0.479	0.426
Tertiary education level	0.690	0.707	0.687

*These correlation coefficients are not significant by p value <0.05.

Conclusion

Almost all of the studied countries show significant increase in recent decade in publishing pharmacy related articles. We have tried to check possible economical and research and development factors affecting trends in pharmacy research and development. There are good correlations between pharmacy related publications, patents, and H-indices with GDP and GNI. The correlation between the studied bibliometric indices with GDPpc, GNIpc, population, TLSE, THX, RDX, RRD, TRD, and tertiary education of studied countries are significant, but have low correlation coefficient which might suggest lower effect. The XTLS and LFTE have not significant correlation with studied bibliometric data. This study shows that research in pharmacy related fields is highly affected by GDP and GNI.

Based on the results of the present study, we concluded that research and development in pharmacy related fields are mostly affected by expenditure of the governments and private sector on their R&D sectors (universities and companies). The more the expending, the more the outcome of research and development.

Appendices

Table S1 (as an Excel file) and Tables S2 to S5 (as Word files) are provided as supplementary information.

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