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Impact of GDP, spending on R&D, number of universities and scientific journals on research publications in pharmacological sciences in Middle East

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Abstract. – OBJECTIVES: Research in pharmacological science is vital to support the health needs of human beings. Measuring the research output provides information that forms the basis of strategic decisions. This study aimed to investigate the impact of Gross Domestic Product (GDP), spending on Research and Development (R&D), number of universities and scientific journals on research documents (papers), citable documents, citations per document and H-index in pharmacological science among Middle East countries.

MATERIALS AND METHODS: All the 16 Middle East countries were included in the study. The information regarding GDP, spending on R&D, total number of universities and indexed scientific journals were collected. We recorded the total number of research documents, citable documents, citations per document and H-index in pharmacological science during the period 1996-2011. The main sources for information were World Bank, Web of Science, Journal Citation Reports (Thomson Reuters) and SCI-mago/Scopus.

RESULTS: The mean per capita GDP of all the Middle East countries is 18125.49±5386.28 US$, spending on R&D 0.63±0.28% of GDP in US$, number of universities 36.56±11.33 and mean ISI indexed journal are 8.25±3.93. The number of research documents published in pharmacological science among the Middle East countries during the period 1996-2011 is 1344.44±499.34; citable documents 1286.37±476.34; citations per document 7.62± 0.84; and H-index is 30.68±6.32. There was a positive correlation between spending on R&D and citations per documents (r = 0.56, *p* = 0.02), H-Index (r = 0.56, *p* = 0.02); number of universities and research documents (r = 0.72, *p* = 0.002), citable documents (r = 0.72, *p* = 0.001); ISI indexed journals and research documents (r = 0.88, *p* = 0.0001), citable documents (r = 0.88, *p* = 0.0001), H-Index (r = 0.67, *p* = 0.004). However, there was no correlation between the GDP per capita and research outcome in pharmacological science.

CONCLUSIONS: There is a positive association between spending on R&D, number of universities and indexed scientific journals on research outcome in pharmacological science in Middle East.

Key Words:
Pharmacological science, Pharmaceutics, Research papers, Middle east, Evaluation of science.

Introduction

Pharmacological science is a multidisciplinary field and plays a vital role in improving human health in turning advances in biomedical sciences research to supporting human well-being. It reflects the integration of diverse areas of specialization for the purpose of creating a safe and effective therapeutic arsenal to support the health needs of human and veterinary patients[1]. In measuring and evaluating the research outputs, bibliometric analysis provide information that influence decisions on strategies both at national and international levels[2]. Bibliometric indicators are widely-used to assess the research productivity, visibility and capacity of research publications in global science, and have been successfully applied to analyze the influence of research policies at various levels[3]. Bibliometric analysis provides objective evidence to describe the current scientific development and forecast possible future progress trends. Bibliometric analysis offer quantitative information to maintain qualitative analysis and grasp the relative advantage of foresight development in research[4]. These indicators are mainly based on the number of scientific research papers published and citations received[5]. Science and tech-

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nology cannot exist if researchers do not evidence or publish their experimental findings and results. Investment in research is important for progress in science and technology, as well as for social and economic development[6]. A healthy scientific research environment is a prerequisite for scientific and economic progress[7]. In order to achieve long term and sustainable economic growth, the amount of research and development is greatly important.

Middle East countries are highly loaded with immense natural resources including oil, gas, copper, gold and other valuable minerals which resulted in high economic benefits in the region. These countries are facing various health and disease related challenges and need further research progress in pharmacological science. In Middle East, universities and research institutes are involved in conducting the research in pharmacological science, but, no study has yet been published from this part of the world to highlight the impact of bibliometric indicators and their association with promising factors which have high influence in research outcomes such as GDP, spending on R&D, number of universities and Indexed journals. Keeping all these facts in mind, this study aimed to assess the impact of Gross Domestic Product (GDP), spending on Research and Development (R&D), number of universities and indexed journals on bibliometric indicators including total number of research documents, citable documents, citations per document and H-index in in pharmacological science including pharmacology, toxicology, drug discovery and pharmaceutical science in Middle East countries.

Materials and Methods

In this report we included all the 16 Middle East countries, and collected the information regarding bibliometric indicators including total number of research papers (documents), citable documents (global citations received), citations per document and Hirsch index (H-index) in pharmacological science including pharmacology, toxicology, drug discovery and pharmaceutical science during the period 1996-2011 in Middle East countries. The information regarding all the Middle East countries, their mean GDP for last five years, spending on R&D, were collected from the World Bank sources[8], and the data about number of universities were collected from the World Association of Universities[9]. The information regarding scientific journals, which are indexed in Institute of Scientific Information (ISI) were recorded from the Web of Science, Institute of Scientific Information (ISI) Journal Citation Reports (Thomson Reuters)[10]. Bibliometric indicators in pharmacology, toxicology, drug discovery and pharmaceutical sciences during the period 1996-2011 were recorded from the SCImago/Scopus[11]. For ISI indexed journals in Web of Science, territory was selected, country name was entered and the names of journals of each country of the Middle East were retrieved. For the recording of bibliometric indicators, in SCImago/Scopus, region and country were selected, then subject field "Pharmacology, Toxicology and Pharmaceutics" was selected, and detailed information regarding the bibliometric indicators including total number of research papers (documents), citable documents, citations per document and H-index in is pharamacological sciences including pharmacology, toxicology, drug discovery and pharmaceutical sciences during the period 1996-2011 among Middle East countries were recorded.

Statistical Analysis

The data were entered into the computer; Statistical Package for the Social Sciences (SPSS Inc., Chiacago, IL, USA) software version 18 was used. Data were expressed as Mean ± Standard Error of Mean (SEM). The Pearson correlation coefficient was calculated to find the strength of relation between different variables. p-value < 0.05 was considered significant.

Results

All the sixteen Middle East countries were included in the study. The mean per capita GDP of all the Middle East countries is 18125±5386.28 US$, spending on R&D 0.63±0.28 % of the total GDP US$, number of universities 36.56±11.33 and mean ISI indexed journals are 8.25±3.93 (Table I).

The mean of research documents published in pharmacological sciences including pharmacology, toxicology, drug discovery and pharmaceutical sciences among the Middle East countries during the period 1996-2011 is 1344.44±499.34; citable documents 1286.37±476.34; citations per document 7.62±0.84; and the H-index is 30.68±6.32 (Table II).

Table I. Middle East countries with their per capita GDP, spending on R&D, number of Universities and Indexed journals.

Countries	Per Capita GDP (US$)	Spending on R&D (% GDP)	Universities	Journals	Pharmacological Journals
Bahrain	18867.55	0.2	11	2	0
Egypt	2324.93	0.24	40	2	0
Iran	4402.87	0.728	186	39	1
Iraq	2582.35	0.100	35	0	0
Israel	27340.55	4.544	21	13	0
Jordan	3976.35	0.421	29	1	0
Kuwait	50566.56	0.091	6	3	0
Lebanon	8146.10	0.300	24	0	0
Oman	20524.01	0.190	11	0	0
Palestine	1194.33	0.100	15	0	0
Qatar	75175.82	2.000	2	0	0
Saudi Arabia	16861.75	0.058	61	6	1
Syrian Arab Republic	2590.35	0.200	15	0	0
Turkey	9729.07	0.719	86	54	1
United Arab Emirates	44544.27	0.150	31	12	0
Yemen	1181.09	0.110	12	0	0
Mean	18125.49	0.63	36.56	8.25	0.18
SEM	5386.28	0.28	11.33	3.93	0.10

Data expressed as Mean ± SEM, Journals are ISI indexed.

There was a positive correlation between spending on R&D and citations per documents (r = 0.56, p = 0.02), H-Index (r = 0.56, p = 0.02); number of universities and total number of research documents (r = 0.72, p = 0.002), citable documents (r = 0.72, p = 0.001); ISI indexed journals and total number of research documents (r = 0.88, p = 0.0001), citable documents (r = 0.88, p = 0.0001), H-Index (r = 0.67, p = 0.004). However, there was no association between GDP per capita and total number of research documents, citable documents, citations per document and H-index in pharmacological sciences among Middle East countries (Table III).

Table II. Middle East countries with number of published documents, citable documents, citation per documents and H-Index in Pharmacological Sciences.

Countries	Published documents	Citable documents	Citations/ documents	H-Index
Bahrain	22	18	3.73	5
Egypt	3199	3162	5.38	56
Iran	4638	4458	5.91	49
Iraq	103	103	4.61	10
Israel	3434	3185	16.73	87
Jordan	573	559	7.79	30
Kuwait	330	316	9.61	26
Lebanon	216	204	11.94	27
Oman	110	99	6.86	13
Palestine	85	83	6.89	14
Qatar	68	64	3.62	9
Saudi Arabia	1764	1717	6.44	41
Syrian Arab Republic	60	59	5.33	8
Turkey	6435	6109	9.28	78
United Arab Emirates	423	398	7.96	27
Yemen	51	48	9.90	11
Mean	1344.44	1286.37	7.62	30.68
SEM	499.34	476.34	0.84	6.32

Data expressed as Mean ± SEM.

Table III. Correlation coefficient between GDP per Capita, spending on R&D, number of universities, indexed journals and total number of research documents, citable documents, citations per document, H-index in Pharmacological Sciences among Middle East countries during the period 1996-2011.

Countries	Published documents	Citable documents	Citations/ documents	H-Index
GDP per capita US$	r = -0.198 *p* = 0.462	r = -0.203 *p* = 0.450	r = -0.017 *p* = 0.950	r = -0.092 *p* = 0.734
Spending on R&D	r = 0.332 *p* = 0.209	r = 0.320 *p* = 0.228	r = 0.567* *p* = 0.022	r = 0.563* *p* = 0.023
Universities	r = 0.723** *p* = 0.002	r = 0.728** *p* = 0.001	r = -0.087 *p* = 0.749	r = 0.464 *p* = 0.070
Indexed journals	r = 0.889** *p* = 0.0001	r = 0.886** *p* = 0.0001	r = 0.166 *p* = 0.539	r = 0.671** *p* = 0.004

r = Pearson Correlation Coefficient; *p* = *p*-value.

Discussion

Bibliometric indicators are well established gauges used to analyze the productivity and visibility of research publications and describe the assessment of research performance in various disciplines. In this study, we assessed the impact of per capita GDP, spending on R&D, number of universities and ISI Indexed journals on research papers (documents), citable documents, citations per document and H-index in pharmacological sciences during the period 1996-2011 in Middle East countries. We found a positive correlation between the spending on R&D, number of universities, indexed journals and total number of research documents, citable documents, citations per document and H-Index in pharmacological sciences. However, there was no association between GDP per capita and research output in pharmacological sciences in Middle East (Table III, Figure 1).

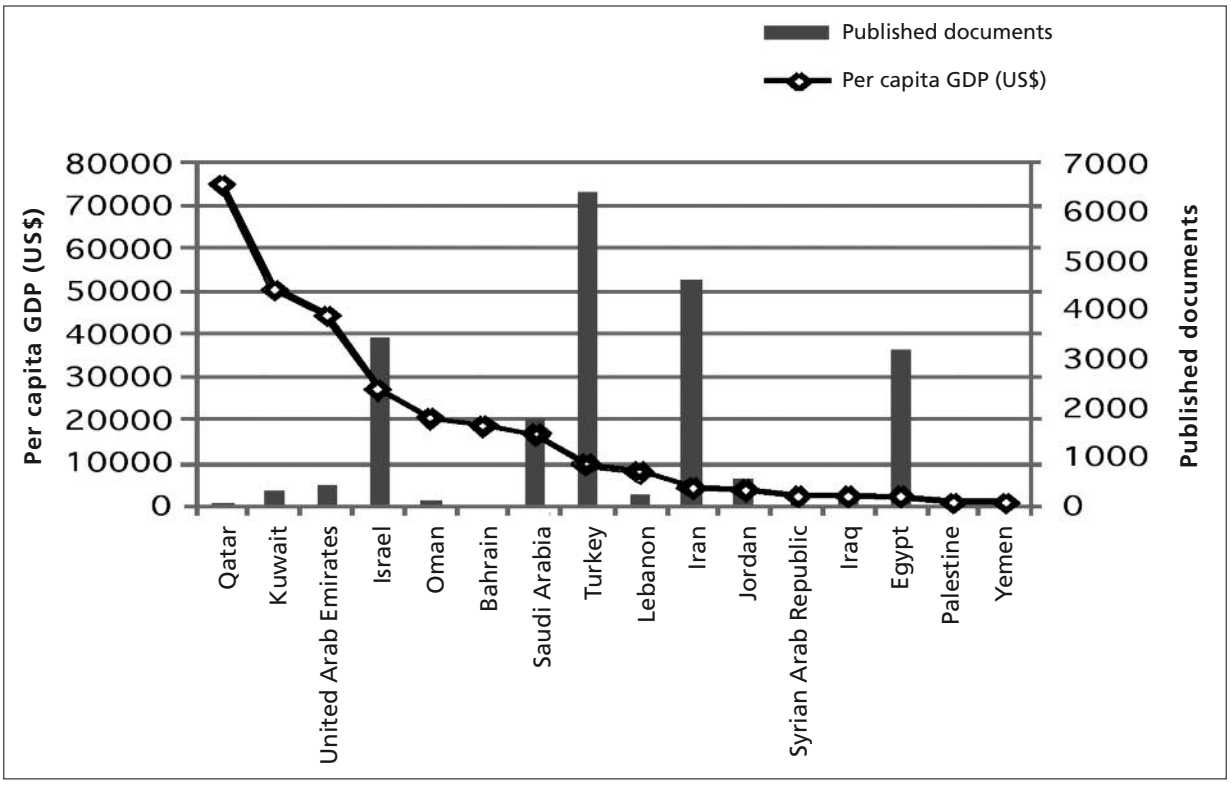

Figure 1. Association between per capita GDP and total number of Research Publications (Documents) in Pharmacological Sciences in Middle East during the period 1996-2011.

GDP is the fiscal progress measured in terms of an increase in the magnitude of country's economy. It is core indicator used to gauge the strength of a country's economy over a definite time period. In the present study, we did not find correlation between per capita GDP and total number of research documents, citable documents, citations per document and H-Index in pharmacological science. The Middle East countries with high per capita GDP are Qatar (75175.82), Kuwait (50566.56) and United Arab Emirates (44544.27) and the countries with the low GDP are Yemen (1181.09), Palestine (1194.33) and Egypt (2324.93) (Table I). We found that the countries such as Qatar, Kuwait and United Arab Emirates have higher GDP but the outcome in the form of research publications is less in contrast to their GDP (Figure 2). The results indicate that, there is no difference in the overall research outcomes in pharmacological science between the countries with high GDP compared to countries with a low GDP. The results of the present study show that, the research outcome does not depend on GDP, but it actually depends on how much percentage of total GDP is being spent on R&D.

In previous studies, it has been reported that the annual spending on R&D in most of the wealthy Middle East countries was 0.2% of their GDP compared to the world average of 1.4%[12-13]. In another report published by the World Bank it has been indicated that average annual spending on R&D by most of the Middle East states, especially the member states of Organization of Islamic Countries, was 0.34% of their GDP; much lower than the global average over the same period as 2.3%[13]. However, in recent years, Middle East countries particularly Qatar, Kuwait, United Arab Emirates, Iran, Turkey and Saudi Arabia started spending more on R&D and the mean average of spending on R&D in these countries is about 0.63% (Table I). In this study, we found a positive correlation between spending on R&D and citations per documents ($r = 0.56$, $p = 0.022$) and H-index ($r = 0.56$, $p = 0.023$) in pharmacological sciences (Table III, Figure 3).

Helpenny et al[14] conducted a study to examine the publications and link between the percentage of GDP spent on R&D. They found that spending on R&D was positively correlated with the number of publications ($r = 0.603$, $p < 0.001$). Similarly, in the present study, we found a positive correlation between spending on R&D and citations per documents and H-index in pharmacological sciences. In addition, we also found a trend of positive correlations between spending on R&D and total number of research documents, citable documents in pharmacological sciences (Table III, Figure 3), but this trend did not achieve the level of significance. Our study findings for R&D and research documents in pharmacological science are in partial agreement with the results of Helpenny et al[14].

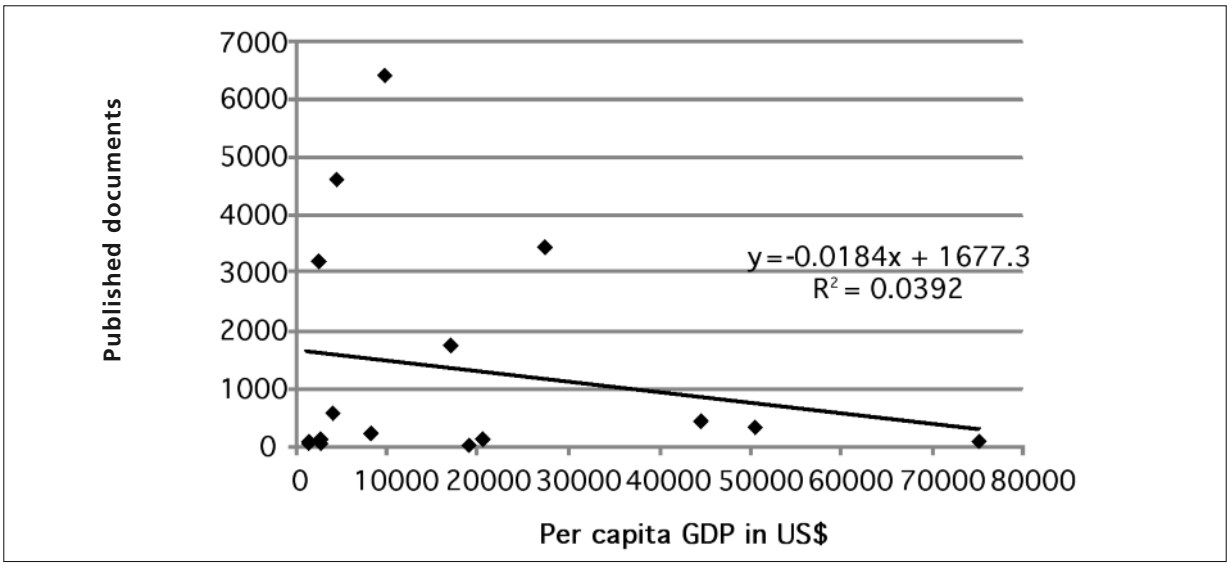

Figure 2. Correlation coefficient between per capita GDP and total number of Research Publications in Pharmacological Sciences in Middle East during the period 1996-2011.

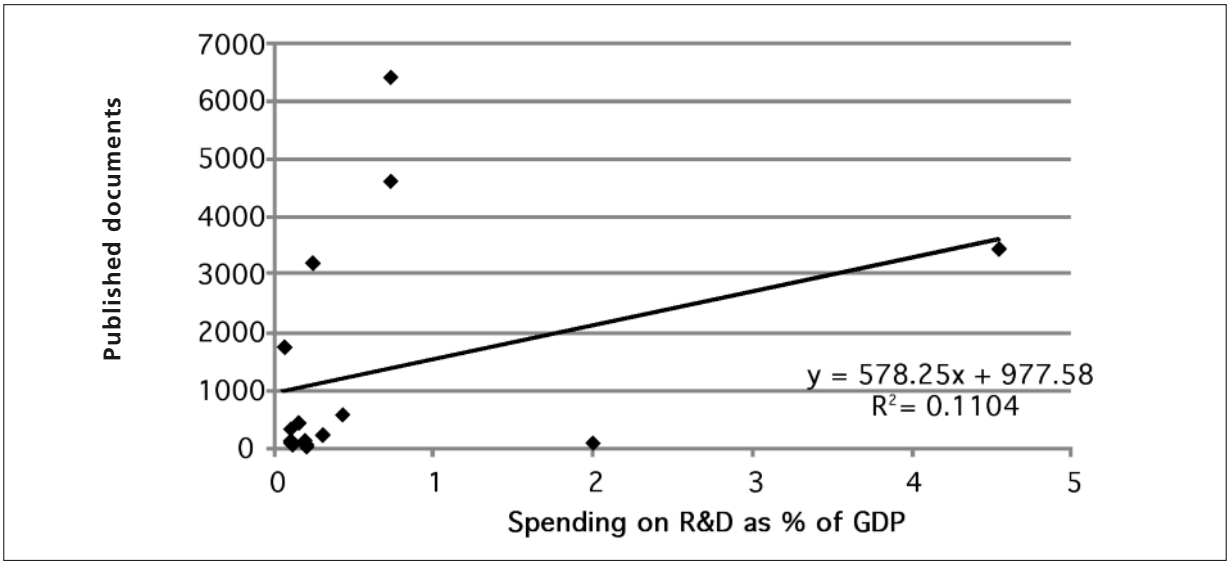

Figure 3. Correlation coefficient between spending on R&D as percentage of GDP and total number of Research Publications in Pharmacological Sciences in Middle East during the period 1996-2011.

Anwar and Abu Baker[15] have reported that most of the countries in Middle East especially the Muslim Majority countries lack researchers, scientists and technicians, and have an average of nine scientists, engineers and technicians per thousand people, compared with a world average of forty-one. Likewise, Hoodbhoy[16] reported that the top global performers all have above 5,000 researchers per million people, while the average in Muslim world countries mainly in Middle East is 500[16]. Insufficient spending on R&D is the obvious reason; hence the majority of Middle East countries have less number of researchers and scientists. A major part of the research scholars, scientists migrate from Middle East countries including Egypt, Jordon, Iraq and Yemen to other countries like USA and UK. It is an established fact that the scientific travel not only relocates the scientists but also carries with it a sort of scientific attestation[17].

In Middle East, the number of universities and research institutions is also not enough, the mean average number of universities in all the 16 countries in Middle East is 36.56±11.33 (Table I). In spite of this situation, in the present study, we found a strong positive correlation between the number of universities and total number of research documents (r = 0.72, p = 0.002) and citable documents (r = 0.72, p = 0.001) in pharmacological science (Table III, Figure 4). This is a recognized fact that the basic birth place for the research documents is a university, we believe that Middle East countries must increases the number of universities and ultimately the research outcome will further increase.

In addition to reviewing GDP, spending on R&D, number of universities, we also reviewed the ISI indexed scientific journals in Middle East countries. The mean number of ISI indexed journals in the all the Middle East countries is 8.25±3.93 (Table I). The few countries in Middle East having a good number of ISI indexed journals are Turkey[54], Iran[39], Israel[13], United Arab Emirates[12] and remaining none of the country scored a double figure. Moreover, the number of ISI Indexed journals in Pharmacological Sciences in the whole Middle East is only 3. It shows that in all the 16 Middle East countries there are 8.25 ISI indexed journals in science, and 0.18 journals in pharmacological science in each country on average.

It has been reported that the Arab States in Middle East are producing less than 0.5% of scientific research papers appearing in the 200 leading medical journals. The number of publications, original writings and translations per million people is about 0.05 in the Arab Middle East countries compared with an average of 0.15 worldwide and 0.6 in industrialized countries[18]. In the present study we found a strong positive correlation between the number of ISI indexed journals and total number of research documents (r = 0.88, p = 0.0001), citable documents (r = 0.88, p = 0.0001) and H-index (r = 0.67, p =

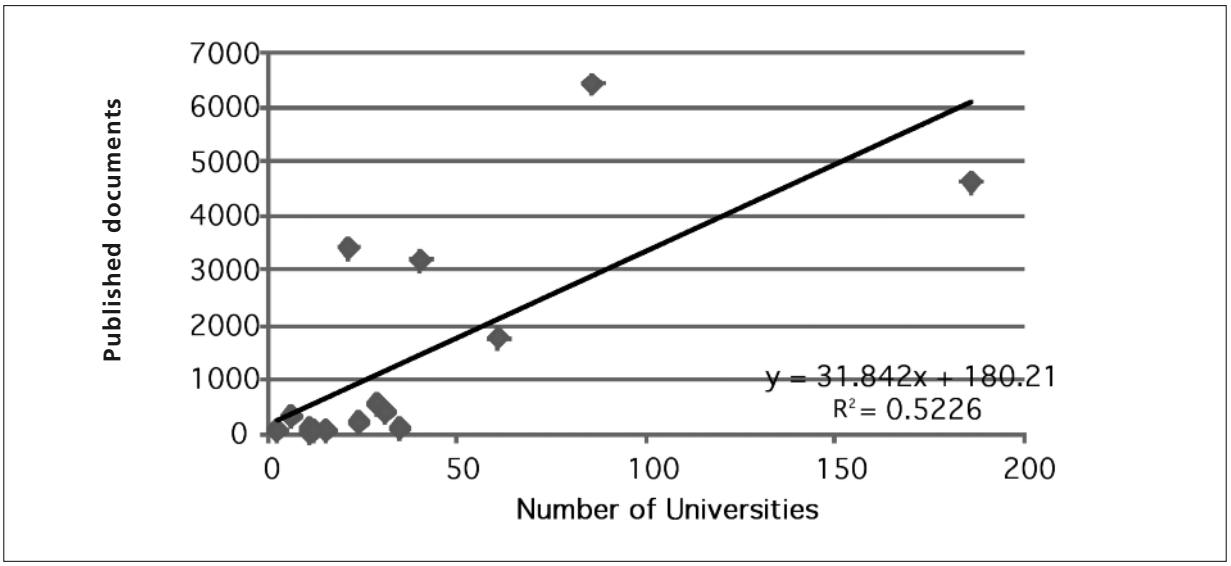

Figure 4. Correlation coefficient between the number of universities and research publications in Pharmacological Sciences in Middle East during the period 1996-2011.

0.004) (Table III, Figure 5). Moreover, we also found a positive correlation between numbers of ISI indexed journals in pharmacological science and research documents (Figure 6). It shows that Middle East must launch ISI Indexed journals in their universities and research institutes.

Study Strengths and Criticism

The main strengths of this study are: we selected all the Middle East countries and employed promising parameters to compare the research outcomes which play potential role in the development of scientific research such as GDP, spending on R&D, Number of Universities, and Indexed Journals. We gathered the information regarding all the Middle East countries, their GDP, spending on R&D, from very reliable source of the World Bank. The data about number of universities were gathered from the World Association of Universities. The information re-

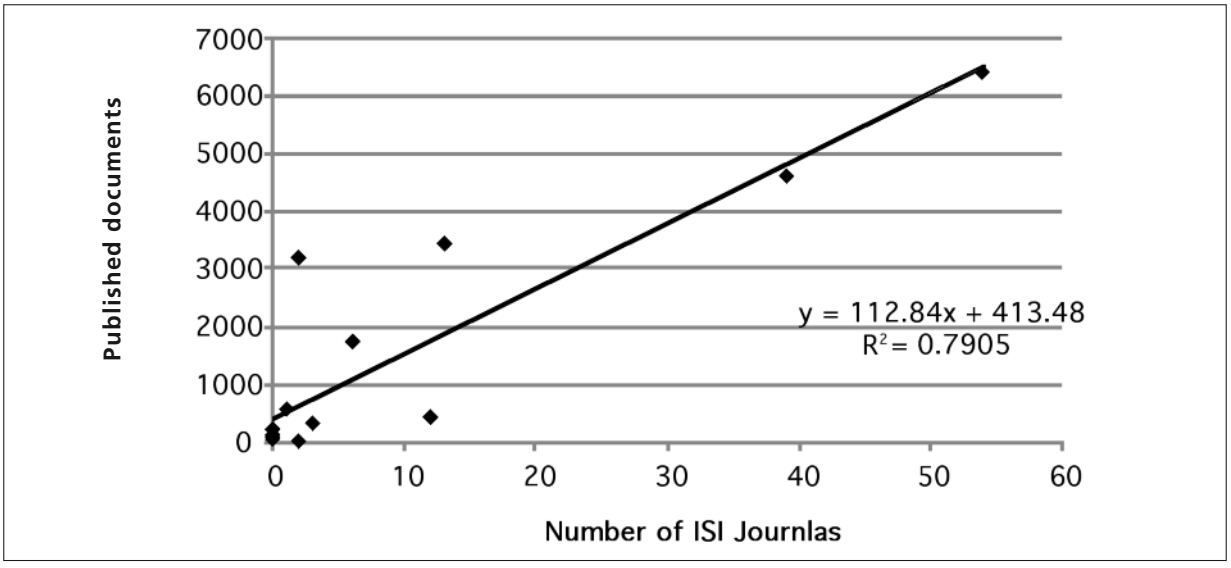

Figure 5. Correlation coefficient between ISI indexed scientific journals and research publications in Pharmacological Sciences in Middle East during the period 1996-2011.

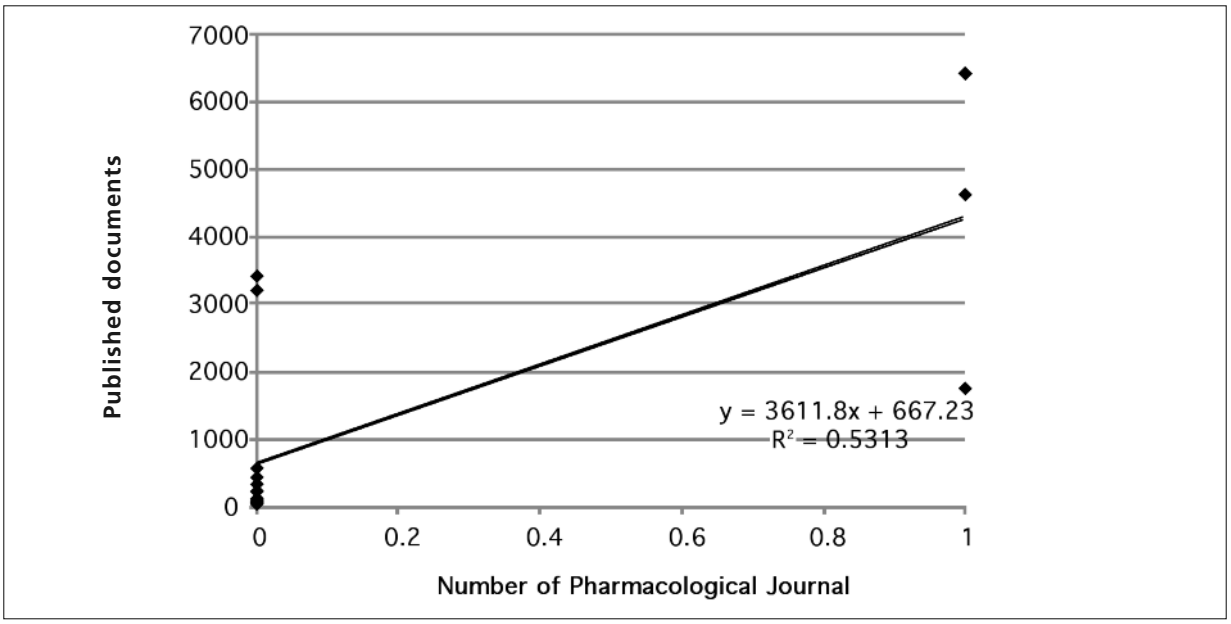

Figure 6. Correlation coefficient between ISI indexed journals in Pharmacological Sciences and research publications in Pharmacological Sciences in Middle East during the period 1996-2011.

garding the indexed scientific journals and Bibliometric indicators in pharmacological sciences was obtained from the Web of Science, Institute of Scientific Information (ISI), Journal Citation Reports (Thomson Reuters) and Scopus. These are reliable sources in scientific literature. Rarely the citation count tools may mis-cite a paper, and there is some chance of same paper appeaing twice with slightly different details in citation counts. This may inflate the number of research papers. This is, however, the only criticism to our report.

Conclusions

This is the first study which has investigated the productivity and visibility of research papers in pharmacological science in Middle East. We found that spending on R&D, number of universities and ISI indexed journals have a positive association with the number of research documents, citable documents, citations per documents and H-index in pharmacological science. However, we did not find association between the GDP and research outcomes. It shows that the countries which are spending more on R&D, have large number of universities and ISI indexed journals are producing significant volume of research papers in pharmacological science. It is suggested that, Middle East countries must increase funding on R&D, establish more universities and scientific journals, and get the journals indexed in ISI. Continuing efforts must be taken to promote research in pharmacological science. These steps will increase the research oriented education, culture and ultimately the research outcome in pharmacological science will increase and bring the further scientific, social as well as economic development in the continent.

Acknowledgements

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Conflict of Interest

The Authors declare that they have no conflict of interests.

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