ORIGINAL PAPERS

IMPACT OF GDP, SPENDING ON R&D, THE NUMBER OF UNIVERSITIES AND SCIENTIFIC JOURNALS ON RESEARCH PUBLICATIONS IN ENVIRONMENTAL SCIENCES IN THE MIDDLE EAST

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Abstract

Objectives: This study aimed to assess the impact of the Gross Domestic Product (GDP), spending on Research and Development (R&D), the number of universities and scientific journals on the published research documents, citable documents, citations per document and H-index in environmental sciences in the Middle East countries. **Materials and Methods:** All the 16 Middle East countries were included in the study. Information regarding the GDP, spending on R&D, the total number of universities and indexed journals was collected. Total number of research documents (papers), citable documents, citations per document and H-index in environmental sciences during the period 1996–2011 was recorded. The study used the World Bank, SCI-mago/Scopus, Web of Science, Journal Citation Reports (Thomson Reuters) as the main sources of information. **Results:** The mean GDP per capita of all the Middle East countries amounted to 18 125.49±5386.28 US$, spending on R&D was 0.63±0.28 US$, the number of universities equaled 36.56±11.33 and mean ISI indexed journals amounted to 8.25±3.93. The mean number of research documents published in environmental sciences in the Middle East countries during the period 1996–2011 was 2202.12±883.98; citable documents: 2156.87±865.09; citations per document: 8.74±0.73; and the H-index: 35.37±6.17. There was a positive correlation between the money spent on R&D and citations per documents ($r = 0.6$, $p = 0.01$), H-Index ($r = 0.6$, $p = 0.01$); the number of universities and a total of research documents ($r = 0.65$, $p = 0.006$), citable documents ($r = 0.65$, $p = 0.006$), H-Index ($r = 0.50$, $p = 0.04$), as well as ISI indexed journals and total research documents ($r = 0.94$, $p = 0.0001$), citable documents ($r = 0.94$, $p = 0.0001$), H-Index ($r = 0.73$, $p = 0.001$). **Conclusions:** The Middle East countries which spend more on R&D and which have a large number of universities and ISI indexed journals are likely to produce more significant volume of research papers in the field of environmental science.

Key words:
Bibliometric indicators, Financing science, Expenditures on science, Research publications, Middle East

INTRODUCTION

Environmental science is a multidisciplinary field and plays a critical role in preservation of natural resources and supporting human well-being. The Middle East countries are highly loaded with immense natural resources including oil, gas, copper, gold and other valuable minerals which results in high economic benefits for the region. Current economic and political situation of the Middle East countries has received great attention; however, these countries tend to overlook environmental issues such as pollution, population growth, marshland drainage, deforestation, desertification along with environmental damage [1].

In the Middle East, universities and research institutes have been involved in conducting research in the field of environmental sciences. However, none of the studies from this part of the globe has been published yet in order to highlight the impact of bibliometric indicators and their association with promising factors, such as GDP, investing in R&D, the number of universities and Indexed journals, which have great influence on research outcomes. Bibliometric indicators are frequently used to measure scientific productivity, visibility and capacity of research publications in global science. These indicators are based mainly on the number of scientific research papers published and citations received [2]. Science and technology cannot exist if researchers do not evidence or publish their experimental findings and results. Investing in research is important not only in terms of progress of science and technology, but also in terms of social and economic development [3]. Scientific publications are a key indicator of a country's development, and a healthy scientific research environment is a prerequisite for scientific and economic progress. Amount of R&D is of great importance with regard to a long term and sustainable economic growth. Keeping all these facts in mind, this study aimed to assess the impact of the Gross Domestic Product (GDP), spending on Research and Development (R&D), the number of universities and indexed journals on bibliometric indicators including a total number of research documents, citable documents, citations per document and H-index in environmental sciences in the Middle East countries.

MATERIALS AND METHODS

This cross sectional, observational study was conducted in the Department of Physiology, College of Medicine, King Saud University, Riyadh, Saudi Arabia.

The study included all the 16 Middle East countries, during the period from 1996 to 2011. Information concerning bibliometric indicators including the total number of research papers (documents), citable documents, citations per document and H-index in environmental sciences in the Middle East countries was recorded. Information concerning the GDP of all the Middle East countries for the last five years, from 2007 to2011, and spending on R&D was collected from the World Bank sources [4], and the data on the number of universities was collected from the World Association of Universities [5].

Information regarding scientific journals, which are indexed in the Institute of Scientific Information (ISI), and Bibliometric indicators in Environmental Sciences during the period 1996–2011 was recorded from the Web of Science, the Science Citation Index Expanded [SCI Expanded], the Institute of Scientific Information (ISI) Journal Citation Reports (Thomson Reuters) [6] and SCI-mago/Scopus [7]. In the case of ISI indexed journals, the Web of Science was used. Territory of the country was selected, country's name was entered and the names of journals of each country of the Middle East were retrieved. In order to record bibliometric indicators, the Web of Science and SCI-mago/Scopus were applied. Territory of the country was selected, then the subject field "Environmental Sciences" was selected, and so detailed information concerning bibliometric indicators including the total number of research papers (documents), citable documents, citations per document and H-index in environmental sciences in the Middle East countries was obtained.

Statistical analysis

The data was entered into the computer by the use of the Statistical Package for the Social Sciences (SPSS) software, version 18. Data was expressed as mean ± standard error of mean (SEM). The Pearson correlation coefficient was calculated in order to find the strength of the relationship between the different variables. P-value lower than 0.05 (p < 0.05) was considered significant.

RESULTS

The number of the Middle East countries included in this study was 16. The mean GDP per capita of all the Middle East countries amounted to 18 125±5386.28 US$,

spending on R&D equaled 0.63±0.28 US$, the number of universities was 36.56±11.33, whereas mean ISI indexed journals amounted to 8.25±3.93 (Table 1). The total research documents published in environmental sciences in the Middle East countries during the period from 1996 to 2011 were 2202.12±883.98; citable documents: 2156.87±865.09; citations per document: 8.74±0.73; and H-index: 35.37±6.17 (Table 2).

There was a positive correlation between the money spent on R&D, publications per capita and citations per documents (r = 0.6, p = 0.01), H-Index (r = 0.6, p = 0.01); the number of universities and a total of research documents (r = 0.65, p = 0.006), citable documents (r = 0.65, p = 0.01), H-Index (r = 0.50, p = 0.04), ISI indexed journals and total research

Table 1. The Middle East countries – their Gross Domestic Product (GDP) per capita, spending on Research and Development (R&D), universities and indexed journals

Country	GDP Per Capita (US$)	Spending on R&D (% of GDP)	Universities (n)	Journals (n)
Bahrain	18 867.55	0.200	11	2
Egypt	2 324.93	0.240	40	2
Iran	4 402.87	0.728	186	39
Iraq	2 582.35	0.100	35	0
Israel	27 340.55	4.544	21	13
Jordan	3 976.35	0.421	29	1
Kuwait	50 566.56	0.091	6	3
Lebanon	8 146.10	0.300	24	0
Oman	20 524.01	0.190	11	0
Palestine	1 194.33	0.100	15	0
Qatar	75 175.82	2.000	2	0
Saudi Arabia	16 861.75	0.058	61	6
Syrian Arab Republic	2 590.35	0.200	15	0
Turkey	9 729.07	0.719	86	54
United Arab Emirates	44 544.27	0.150	31	12
Yemen	1 181.09	0.110	12	0
M	18 125.497	0.634	36.562	8.25
SEM	5 386.284	0.286	11.336	3.93

Data expressed as M (mean) ± SEM (standard error of mean).
Journals are ISI indexed.

Table 2. The Middle East countries – the published documents, citable documents, citation per documents and H-Index in environmental sciences

Country	Published documents (n)	Citable documents (n)	Citations documents (n)	H-Index
Bahrain	147	143	4.84	16
Egypt	3 284	3 240	9.08	51
Iran	6 899	6 765	12.58	62
Iraq	169	164	5.01	11
Israel	5 532	5 367	16.34	92
Jordan	1 118	1 110	8.92	38
Kuwait	776	769	6.81	27
Lebanon	491	480	8.19	26
Oman	420	415	9.79	29
Palestine	232	230	7.52	20
Qatar	134	133	5.51	14
Saudi Arabia	1 869	1 828	6.82	33
Syrian Arab Republic	285	282	10.66	19
Turkey	13 022	12 753	9.40	84
United Arab Emirates	776	754	7.99	30
Yemen	80	77	10.49	14
M	2 202.125	2 156.875	8.746	35.375
SEM	883.980	865.092	0.736	6.175

Abbreviations as in Table 1.

documents ($r = 0.94$, $p = 0.0001$), citable documents ($r = 0.94$, $p = 0.0001$), H-Index ($r = 0.73$, $p = 0.001$). However, there was no association between GDP per capita and a total number of research documents, citable documents, citations per document and H-index in environmental sciences among the Middle East countries (Table 3).

Table 3. Correlation coefficient between GDP per capita, spending on R&D, the number of universities, indexed journals and the total number of documents, citable documents, citations per document, H-index in environmental sciences among the Middle East countries during the period from 1996 to 2011

Parameter	Published documents	Citable documents	Citation per documents	H-Index
GDP per capita US$	r = –0.163 p = 0.547	r = –0.164 p = 0.545	r = –0.248 p = 0.355	r = –0.106 p = 0.696
Spending on R&D	r = 0.318 p = 0.230	r = 0.315 p = 0.235	r = 0.599* p = 0.014	r = 0.599* p = 0.014
Universities	r = 0.653** p = 0.006	r = 0.654** p = 0.006	r = 0.321 p = 0.225	r = 0.507* p = 0.045
Indexed journals	r = 0.940** p = 0.0001	r = 0.940** p = 0.0001	r = 0.359 p = 0.172	r = 0.736** p = 0.001

r – Pearson correlation coefficient.
* Significant; ** Highly significant.
Other abbreviations as in Table 1.

DISCUSSION

Bibliometric indicators are well established gauges used to analyze the productivity and visibility of research publications and to assess research performance in various disciplines. In this study, we assessed the impact of GDP per capita, spending on R&D, the number of universities and ISI indexed journals on research papers (documents), citable documents, citations per document and H-index in environmental sciences during the period from 1996 to 2011 in the Middle East. We have found a positive correlation between the money spent on R&D and publications per capita, the number of universities, indexed journals and total research documents, citable documents, citations per document and H-Index in environmental sciences. However, there was no correlation between GDP per capita and research output in environmental sciences in the Middle East (Table 3).

GDP is the economic growth measured in terms of an increase in the size of a country's economy. It is a main indicator used to gauge the strength of a country's economy over a specific period of time. We have not found any correlations between GDP per capita and the total number of research documents, citable documents, citations per document and H-Index in Environmental Science. The Middle East countries with a high GDP per capita are: Qatar (75 175.82), Kuwait (50 566.56) and United Arab Emirates (44 544.27), and the countries with a low GDP include: Yemen (1181.09), Palestine (1194.33) and Egypt (2324.93) (Table 1).

In this study, we have found that the countries with a higher GDP such as Qatar, Kuwait and United Arab Emirates have a lower publication output than several countries with a much lower GDP (Figure 1). It means that, the publication outcome in environmental research does not depend on GDP, but rather on how much percentage of the total GDP is 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
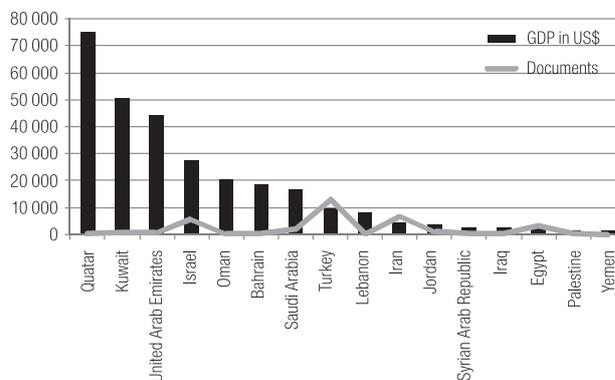

Fig. 1. Association between the Gross Domestic Product (GDP) and research publications (documents) in environmental sciences in the Middle East during the period 1996–2011

countries was 0.2% of their GDP compared to the world's average of 1.4% [8,9]. In another report, published by the World Bank, it has been demonstrated that the average annual spending on R&D in the majority of the Middle East states, especially the Organization of Islamic Countries, was 0.34% of their GDP – much lower than the global average over the same period, which was 2.3% [9]. However, in recent years, the Middle East countries such as Israel, Qatar, Iran, Turkey, Saudi Arabia and UAE are spending more on R&D and the mean average spending on R&D in these countries is about 0.63% of their GDP (Table 1). In this study, we have found a positive correlation between the money spent on R&D as a percentage of GDP and publication per capita in environmental sciences (Figure 2). However, there was no correlation between GDP per capita and research output in environmental sciences in the Middle East (Figure 3).

Helpenny et al. [10] conducted a study to examine geographic origins of publications and a link between 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 have found a positive correlation between spending on R&D and publications per capita in Environmental Sciences (r = 0.6, p = 0.001, Figure 2). Our study
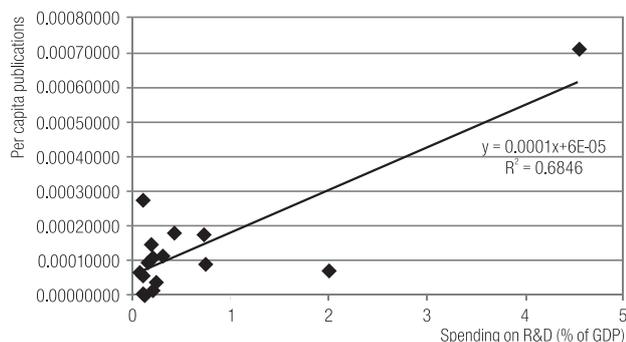
Fig. 2. Correlation coefficient between spending on R&D as a percentage of the Gross Domestic Product (GDP) and research publications per capita in environmental sciences in the Middle East during the period 1996–2011

findings are in agreement with the results of Helpenny et al. [10].

Anwar and Abu Baker [11] have reported that most of the Muslim Middle East countries lack researchers, scientists and technicians, and have an average of 9 scientists, engineers and technicians per 1000 people, compared with a world average of 41. The top global performers all have above 5000 researchers per million people, while in the Muslim world countries, mainly in the Middle East, the average is 500 [11]. The reason is spending not enough on R&D, hence the majority of the Middle East countries have a lower number of researchers and scientists.
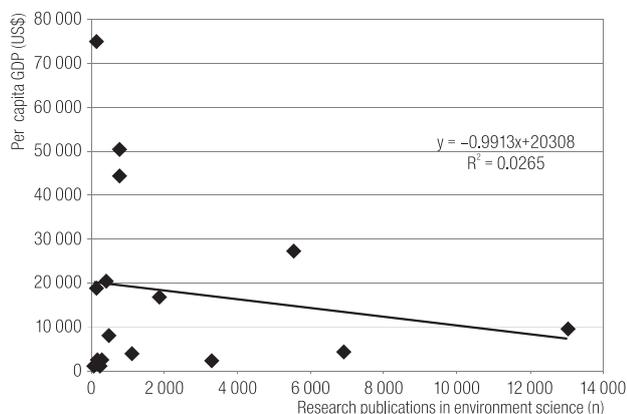

Fig. 3. Correlation coefficient between the Gross Domestic Product (GDP) per capita and the total number of research publications in environmental sciences in the Middle East during the period 1996–2011

A major part of the research scholars, scientists migrate from the Middle East countries, Egypt, Jordan, Iraq, Turkey and Yemen, to other countries such as the USA and UK. It is an established fact that scientific travel is not only about empirical observation but also about a sort of scientific attestation [12].

In the Middle East, the number of universities and research institutions is also not satisfactory; the mean average number of universities in all the 16 countries in the Middle East is 36.56±11.33. In spite of this situation, in the present study we have found a strong positive correlation between the number of universities and the total research documents ($r = 0.65$, $p = 0.006$), citable documents ($r = 0.65$, $p = 0.006$) and H-Index ($r = 0.50$, $p = 0.04$) in Environmental Sciences (Table 3, Figure 4). This is a recognized reality that the basic birth place of the research is the university. We believe that the Middle East countries should increase the number of universities, consequently further increasing the research outcomes.

In addition to reviewing GDP, spending on R&D, the number of universities, we have also reviewed the ISI indexed journals in the Middle East countries. The few countries in the Middle East which have a good number of ISI indexed journals are: Turkey (54), Iran (39), Israel (13), United Arab Emirates (12) and none of the remaining countries managed to reach a double figure. The mean average journals in all the Middle East countries is 8.25±3.93 (Table 1).
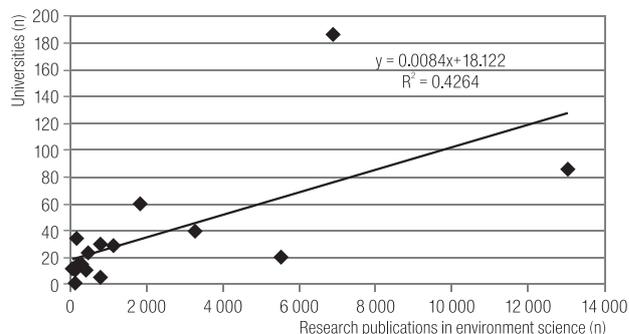

Fig. 4. Correlation coefficient between the number of universities and research publications in environmental sciences in the Middle East during the period 1996–2011
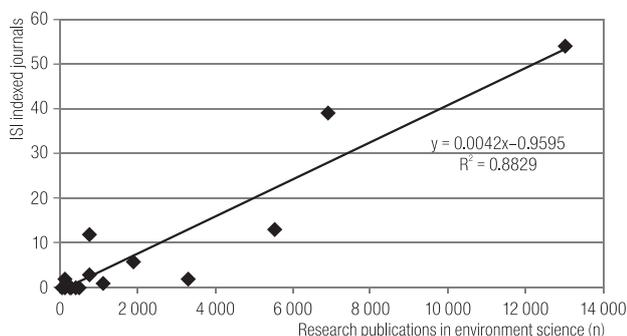
Fig. 5. Correlation coefficient between ISI indexed journals and research publications in environmental sciences in the Middle East during the period 1996–2011
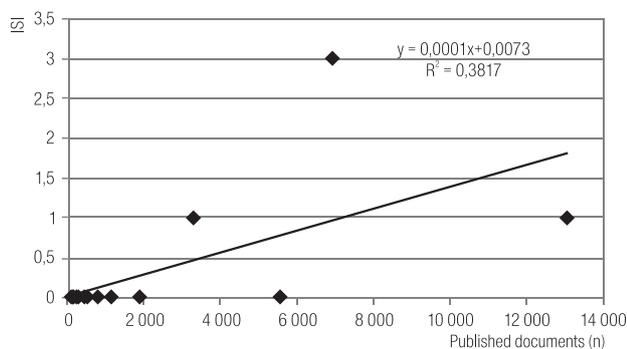

Fig. 6. Correlation coefficient between ISI indexed journals in environmental sciences and research publications in environmental sciences in the Middle East during the period 1996–2011

Moreover, the number of ISI Indexed journals in the field of Environmental Sciences in the whole Middle East is only 5. It shows that in all the 16 Middle East countries, in each country they have about 8.25 ISI indexed journals in science, and 0.3% journals in Environmental Science.

It has been reported that the Muslim states in the Middle East produce 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 the industrialized countries [13]. We have found that the mean average number of ISI indexed journals in the Middle East is 8.25. We have also found a positive correlation between the number of ISI indexed journals and total documents, citable documents and H-index (Table 3, Figure 5 and 6), which shows that the Middle East should establish ISI Indexed journals in their universities and research institutes.

Study strengths and limitations

The main strengths of this study are: all the Middle East countries which are under the umbrella of United Nations were taken into account, and promising parameters, such as: GDP, spending on R&D, the number of universities, and Indexed Journals, which play potential role in the development of science, were employed to compare research outcomes. Information regarding all the Middle East countries, their GDP, spending on R&D, was obtained from a very reliable source of the World Bank, whereas the data on the number of universities was obtained from the World Association of Universities.

Information regarding the indexed scientific journals and Bibliometric indicators in environmental sciences was obtained from the Institute of Scientific Information (ISI), Journal Citation Reports (Thomson Reuters) and SCImago/Scopus. In the case of scientific literature they are regarded as highly reliable sources. Rarely may the citation count tools mis-cite a paper, but there is some chance of the same paper appearing twice with slightly different details in citation counts. This may inflate the number of research papers. Another limitation is the fact that we were not able to obtain the amount of money spent on R&D in the field of environmental sciences exclusively. This information is generally missing as many countries mention their GDP for R&D in general and do not disclose particular amounts spent on specific fields such as environmental sciences for example. The governments and financial bodies do not publicly disclose information concerning the amounts of money spent within R&D on specific fields such as molecular, anatomical, physiological and environmental sciences. However, these are the only two limitations of the present study.

CONCLUSION

This is the first study which has analyzed the productivity and visibility of research papers in the field of environmental science in the Middle East. We have found a positive association between the money spent on R&D and publications per capita, citations per documents, the number of universities and indexed scientific journals and research outcomes in environmental sciences in the Middle East countries. However, we have not found any associations between GDP and research outcomes. It shows that the Middle East countries which spend more on R&D and which have large number of universities and ISI indexed journals are likely to produce more significant volume of research papers in environmental science. It is suggested that the Middle East countries should take continuing efforts to promote research in environmental science.

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