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Recent trends in Middle Eastern scientific production

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Abstract We compared the scientific output of 16 countries from the Middle East during the period 1996–2014 to 27 countries from West Europe and to the average world production, analyzing data year by year, in order to find trends. Overall, our data shows that during the period 1996–2014 Israel was the leading nation in the Middle East in terms of the total number of citations and of total citations per document, while Turkey and Iran were in the lead in terms of scientific documents produced and, together with Egypt and Saudi Arabia, were among the emerging countries in the Middle East in terms of scientific production. Israel has been slowing losing its relative (to the world) weight in terms of scientific production over the last years, following a trend that mirrors Western Europe countries, due to a rapid increase in scientific production and rising impact of new emerging countries. Also, while four emerging countries (Iran, Turkey, Saudi Arabia and Egypt) have been rapidly rising, the bottom countries were still under-performing when compared to the world average. Our findings show that the Middle Eastern counties greatly differed in terms of scientific production over time, that no common trend could be found among them, and that there was a profound imbalance in terms of scientific performance, highlighting a big divide between the top 5 and the other countries of the Middle East.

Keywords Middle East · Western Europe · Scientific production

Introduction

The scientific production landscape in the Middle East has been rapidly transforming over the last decades while this area has been in the international spotlight for regional conflicts. Recently new countries from the Middle East gained a significant share in terms of scientific contribution to the World, as they joined the world leading nations in number of

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scientific documents produced and cited. A few studies have highlighted the rapid growth of scientific production in certain fields in some of these countries, but they haven't provided an overall analysis of the growth of the Middle East over time, and of its relative prominence when compared to the total production of scientific documents in the World. Given the importance of scientific research for the development of countries, we hope that this study will help policy makers to improve the research and scientific production in the countries of the Middle East that fall well below the world average, and to create new alliances with the leading and the emerging countries.

Literature review

Several studies analysed the scientific production of specific regions of the world using quantitative and qualitative methods. For example, Zavadskas et al. (2011) analysed the scientific production (in terms of documents published and citation received) of 3 Baltic States. Other studies analysed the scientific production of specific regions in certain fields. For example, Gracio et al. (2013) analysed the annual Brazilian scientific production, comparing it to other countries in the area, in the field of dentistry; Chinchilla-Rodríguez et al. (2015) analysed the Latin American scientific output in Public Health; Eghbal et al. (2012) analysed the endodontic research productivity of Iran, compared to 29 other regional countries up to the year 2012; Sa'ed et al. (2014) analysed data from the Scopus database and found a growth in research productivity in the tobacco field between 2003 and 2012 in 13 Middle Eastern Arab counties.

Sarwar and Hassan (2015) analysed the scientific productivity of Islamic countries over the period 2000–2011, finding that Turkey and Iran were respectively the first and second top counties. The study investigated the output of countries located beyond the Middle East, for example Indonesia and Malaysia. They also found that during 2000–2011 all the selected subject areas show an increase in annual output of publications by more than 10 %, and that overall the impact of the scientific research in the Islamic World was above the average research output of the world in every subject area; that although the nations of the Islamic world were making significant progress, they were still underperforming when compared to other developed nations.

Gul et al. (2015) explored the scientific production of the Middle East, by collecting data over 33 years (from 1981 to 2013) from 15 Middle East countries using the Web of Science database. The study analysed the number of documents, the citation count, the average citations per documents and the impact of works, concluding that, on all counts, Israel occupied the first position.

While reviewing previous studies that covered the research productivity of the Middle East it emerged the need to carry out a year by year analysis, over a prolonged period of time, in order to collect data which can be analysed using statistical methods, and to find trends. Our research question was: is there a trend that links together the Middle Eastern counties in terms of scientific production?

Methods used

We used the The SCImago Journal & Country Rank database to extract our data. The metrics of SCImago are calculated using the Scopus raw data provided by Elsevier (Colledge et al. 2010). We also used the Thomson Reuters Web of Science, Essential Science Indicators database, which allowed us to measure the scientific output performance

of individual states over a period of time. The use of two databases allowed us to compare data. The SCImago database also allowed us to measure the performances of single countries year by year, providing data over time which we used for statistical analysis.

We selected in the The SCImago Journal & Country Rank database the available data for the Middle Eastern countries, for the countries in the World, and for the Western European countries, from the year 1996 to the year 2014. In January 2016 we downloaded and stored that data in Excel files. The spreadsheets contained data on the number of citable documents published and on citations to such documents. There were 16 Countries included in the Middle Eastern region: Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates and Yemen. There were 27 countries included in the Western European nations: Andorra, Austria, Belgium, Cyprus, Denmark, Faroe Islands, Finland, France, Germany, Greece, Greenland, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Spain, Svalbard and Jan Mayen, Sweden, Switzerland and United Kingdom.

Our data shows a steady increase in the world production of scientific documents (see Fig. 1).

Previous studies also show a general increase in the number of productions and citations per paper in all the countries and in several fields of science. For example, Ucar et al. (2014) analysing the engineering scientific production, suggested that the acceleration in citation rate that is taking place and that has been noticed consistently over the last few years might be the result, among other reasons, of the increase in document accessibility, due to the expansion of the Internet.

Our analysis shows that in the Middle Eastern region there was a general increase in the production of scientific articles and of citations from the year 1996 to 2014 (see Fig. 2), consistent with the general world trend.

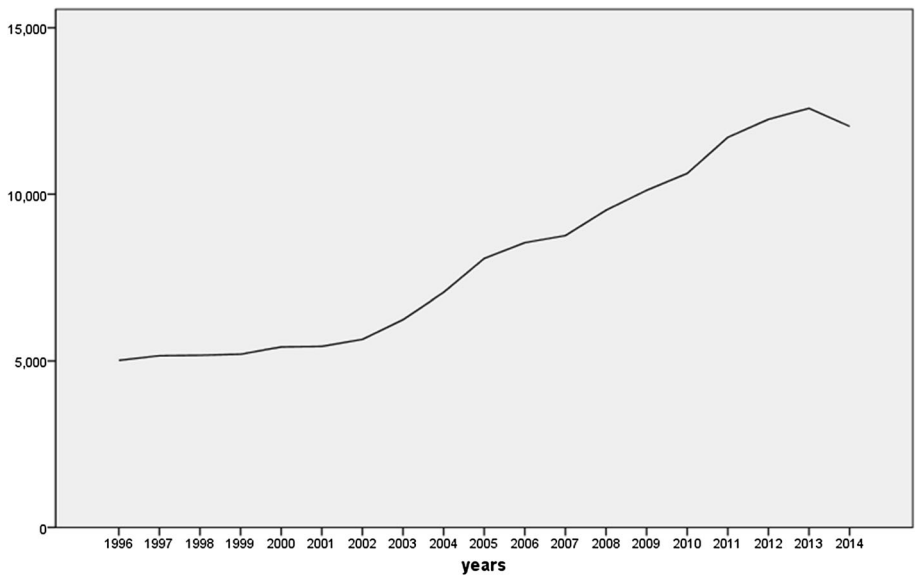

Fig. 1 Number of citable articles published in the World between 1996 and 2014

In order to calculate the relative increase in citations and publications of the countries of the Middle East, when compared to the rest of the world, we factored the number of citable documents and of citations (Number of citations of all dates received by the documents published during the source year,—i.e. citations in years X, X + 1, X + 2, X + 3… to documents published during year X) for each year, from each of the Middle Eastern nations, by the average number of citable documents published and of citations received by such publications, each year, in the entire world. This provided us with indicators of performance of single nations: if such values were below 1, the nations were below average, as they scored below the average performance of the group of nations of the entire world; if the values were above 1, the nations were above average. We used these indicators to assess the relative (to the world) performance of each nation in terms of scientific productivity (citable documents) and of quality (citations received) over time. This data provided an index of the relative growth of Middle Eastern countries to the rest of the World. Our results are illustrated in Figs. 3 and 4.

Our data shows that the Middle Eastern nations started with relatively modest results in the year 1996 (with the exclusion of Israel and Turkey, which were above the average) in terms of scientific production, and that over time Iran, Turkey, Saudi Arabia and Egypt increased rapidly their scores, all surpassing the world average by the year 2012 (all scoring above 1.0). These findings are consistent with other studies (Sarwar and Hassan 2015; Gul et al. 2015).

Overall, the Middle East increased steadily its relative scientific production, although it was still below the World average. On the contrary, other Western nations, like the European Western nations, slowly lost part of their relative scientific production share, but remained all the time above the World average (see Fig. 4).

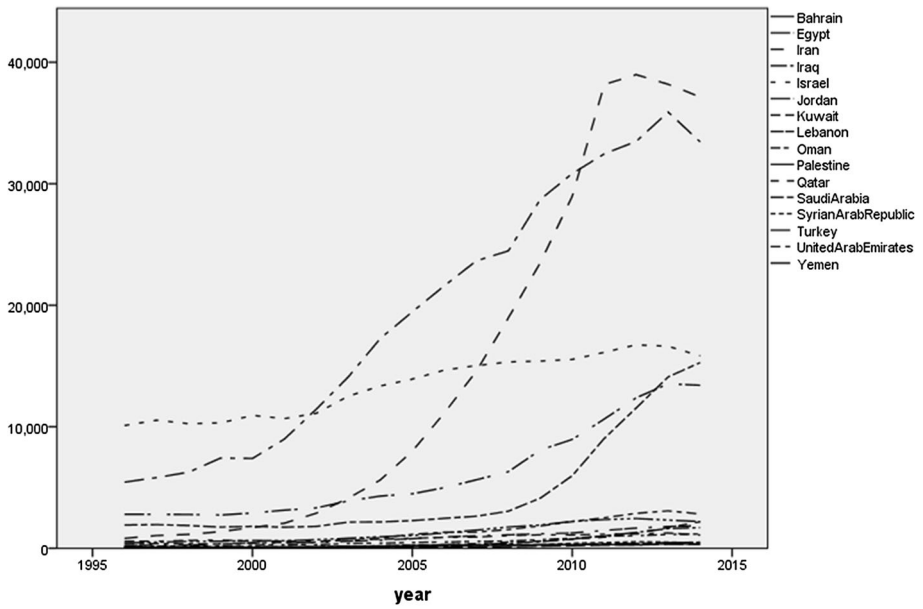

Fig. 2 Number of citable articles published by countries of the Middle East between 1996 and 2014

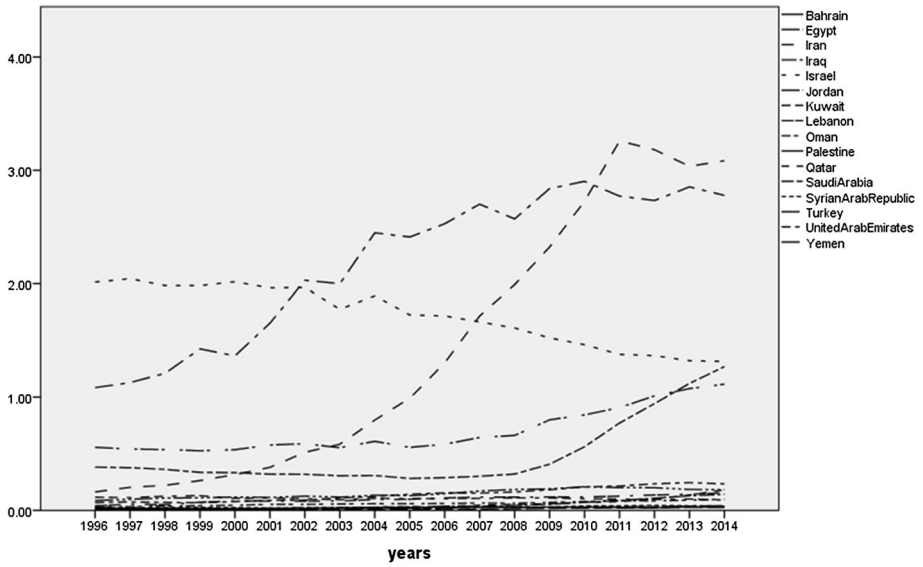

Fig. 3 Relative number of citable documents published by the countries of the Middle East between 1996 and 2014

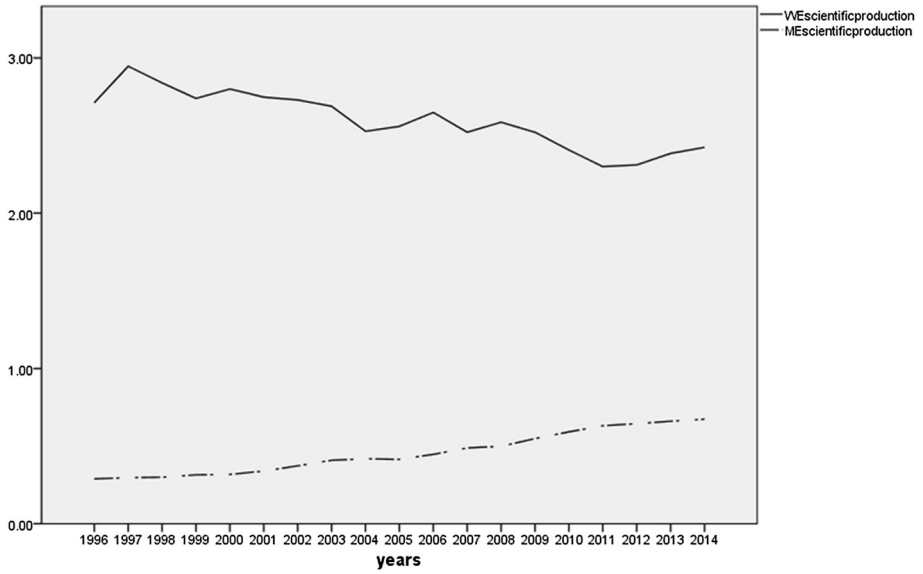

Fig. 4 Relative number of citable documents published in Middle Eastern nations and Western Europe nations between 1996 and 2014

These results depend on economic and political events which affected each country. For example, the rapid climb in international ranking of Saudi Arabia could be linked to the aggressive policies of Saudi institutions of acquiring affiliations by targeting highly cited

researchers overseas (Bhattacharjee 2011), as well as the sharp rise in student numbers in recent years (Abouchedid and Abdelnour 2015). In the field of computer science, quantitative studies confirmed there was over the last few years (up to 2013) a positive linear increase of production of scientific articles in Saudi Arabia, as a result of significant investments in higher education (Alali and Nikoladis 2015).

Our data show that Iran has made the most significant leap in terms of scientific production, becoming in recent years the top Middle Eastern nation in terms of scientific production. This result is linked to several factors, like the increase in the number of Iranian scientific journals: for example, in the medical field, Iranian (English) journals increased from 8 in 1979 to 146 in 2009, and more and more articles from these journals have being indexed in international bibliographic databases (Eghbal et al. 2012). The enhancement of scientific performance of Turkey is the result of a sixfold increase in R&D expenditure by the Turkish government in the last decade (Sarwar and Hassan 2015). Also, studies show that in the time frame investigated Turkey and Iran together had 10 out of 20 of the top Middle Eastern universities (Gul et al. 2015).

Our data also shows that Israel was the only nation to steadily decrease its relative scores in terms of scientific articles produced and citations received across the years 1996–2014, though its performance consistently remained above the world average. Also, starting from the year 2012, Iran surpassed Israel in terms of citations received by Iranian scientific documents (117,589 vs 116,013). However, the overall citations received per Israeli scientific documents were higher than those of Iran (6.26 for Israel vs 2.93 of Iran) and of any other Middle Eastern countries (Saudi Arabia was ranked second with 4.97 citations received per document) in the period 1996–2014 (see Table 1).

We also used Thomson Reuters Web of Science, Essential Science Indicators, which allowed us to extract data regarding publications, total number of citations and citations per paper received by documents in the approximately 11,855 journals, and indexed in the WoS database, during the years 2005–2015. We selected 15 out of the 16 nations included in the Middle Eastern region by Elsevier's SCImago Journal & Country Rank database. The Countries included in the Middle Eastern region were 15: Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates and Yemen. Palestine was not included in our analysis because WoS didn't provide data for this Country. The values that we found were consistent with the results from the Elsevier's SCImago Journal & Country Rank database (see Table 2).

Also, this data shows that the countries that stood out in terms of scientific production were Iran, Turkey, Israel, Saudi Arabia and Egypt (see Table 2). The difference between these top countries and bottom ones in terms of relative world production is significant. Our data from Elsevier's database allowed us to calculate the relative share of publications of Middle Eastern countries year by year. This data shows that the top 5 countries of the Middle East in terms of numbers of scientific documents published accounted for approximately 90 % of all documents published each year in the region between 1996 and 2014 (from 92.5 % in 1996 to 91.07 % in 2014), revealing that the growth of scientific production has been uneven thorough the years.

The low score that we found for the bottom contributors of the Middle East is consistent with previous studies, which highlight that such modest values in scientific production depend on the poverty of the countries, the few funds assigned to research and development, and to political and social instabilities (Gul et al. 2015). However, our study also shows that in the Middle East there are a few top emerging countries which are improving in terms of relative performance, due to the increasing collaboration with each other, the

Table 1 Rank of countries by number of citable documents, citations and citations per document 1996–2014 Elsevier

Rank	Country	Documents	Rank	Country	Citations	Rank	Country	Citations per document
1	Turkey	368,197	1	Israel	5,079,652	1	Israel	20.56
2	Iran	278,388	2	Turkey	2,938,841	2	Syrian Arab Republic	11.86
3	Israel	255,036	3	Iran	1,504,541	3	Lebanon	11.56
4	Egypt	117,104	4	Egypt	818,728	4	Yemen	9.98
5	Saudi Arabia	87,643	5	Saudi Arabia	547,167	5	Iran	9.83
6	United Arab Emirates	25,166	6	Jordan	167,105	6	Turkey	9.79
7	Jordan	24,845	7	United Arab Emirates	166,455	7	Kuwait	9.2
8	Lebanon	16,817	8	Lebanon	151,940	8	Egypt	9.19
9	Kuwait	16,230	9	Kuwait	134,541	9	United Arab Emirates	9.13
10	Oman	10,434	10	Oman	70,272	10	Palestine	9.05
11	Qatar	9708	11	Qatar	49,372	11	Saudi Arabia	8.95
12	Iraq	9097	12	Syrian Arab Republic	44,354	12	Jordan	8.74
13	Syrian Arab Republic	4916	13	Iraq	28,608	13	Oman	8.71
14	Bahrain	3856	14	Palestine	23,425	14	Qatar	7.39
15	Palestine	3729	15	Bahrain	20,118	15	Bahrain	6.12
16	Yemen	2378	16	Yemen	15,096	16	Iraq	5.95

increase in the number of academic institutions and documents being published and indexed in international databases, and the increase in R&D expenditures and in international collaboration (Eghbal et al. 2012).

Regarding the total number of citations, we found that over the 1996–2014 period, Israel tops the Middle Eastern countries. However, starting from the year 2012 Iran surpassed Israel, ranking first among the Middle Eastern counties by the overall number of citations received by its scientific documents (117,589 of Iran vs 116,013 of Israel). This trend continued during the following years (see Fig. 3). Regarding the number of citations per document, we found that Israel ranked first each year and also during the cumulative 1996–2014 time frame.

We used statistical analysis to find correlations among the results from each country over the years. Also, we added the values related to Western Europe (1996–2014) from the SCImago database, in order to carry out additional comparisons. We exported our values for analysis, using SPSS version 21. We tested Pearson bivariate correlations among the findings of our searches.

Table 2 Rank of countries by number of citable documents, citations and citations per paper 2005–2015 WoS

Rank	Countries	WoS docs	Rank	Countries	Citations	Rank	Countries	Cites/paper
1	Turkey	227,906	1	Israel	1,850,432	1	Israel	14.47
2	Iran	180,085	2	Turkey	1,468,755	2	Lebanon	8.46
3	Israel	127,893	3	Iran	1,046,651	3	Syria	7.34
4	Egypt	61,229	4	Egypt	392,664	4	United Arab Emirates	7.05
5	Saudi Arabia	54,148	5	Saudi Arabia	324,783	5	Oman	6.59
6	United Arab Emirates	11,437	6	United Arab Emirates	80,609	6	Kuwait	6.5
7	Jordan	10,641	7	Lebanon	71,056	7	Turkey	6.44
8	Lebanon	8400	8	Jordan	67,636	8	Egypt	6.41
9	Kuwait	6805	9	Kuwait	44,262	9	Jordan	6.36
10	Qatar	5539	10	Qatar	33,742	10	Qatar	6.09
11	Oman	4570	11	Oman	30,117	11	Saudi Arabia	6
12	Iraq	4293	12	Syria	19,373	12	Iran	5.81
13	Syria	2638	13	Iraq	14,674	13	Yemen	5.66
14	Bahrain	1453	14	Bahrain	7706	14	Bahrain	5.3
15	Yemen	1303	15	Yemen	7379	15	Iraq	3.42

We found that regarding the production of documents between 1996 and 2014, Israel correlated very strongly with the Western Europe Countries (listed above) at the 0.01 level (2-tailed) (.910). Our data, and this correlation, confirm the slow and steady reduction in relative prominence of Western Europe in the world regarding the production of scientific documents (Glänzel et al. 2007); it also shows that Israel mirrored such a trend. Among the Middle Eastern Nations, Israel correlated strongly with Kuwait and Bahrain. We found strong negative correlations the 0.01 level (2-tailed) between Israel and the other countries of the Middle East.

We also found very strong positive correlations (above .7 at the 0.01 level) between Iran and the following Middle Eastern Nations: Bahrain, Egypt, Iran, Israel, Saudi Arabia and Syrian Arab Republic.

Regarding the number of citations per article, our statistical analysis showed a very strong positive correlation (above .9 at the 0.01 level) between the Western Europe Countries and the following Middle Eastern Nations: Israel, Egypt, Iran, Iraq, Jordan, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, and Syrian Arab Republic. Oman, Lebanon, Kuwait and Turkey were all above .8 (at the 0.01 level). Overall our data shows a correlation both in publication and citation patterns between Israel and the Western Nations, and a correlation between the Middle Eastern and Western Nation regarding the number of citations per document. In particular, our analysis covered a period in which various academics in Europe, USA and Australia repeatedly called for a boycott of Israeli academic institutions. Despite the call of refraining from collaboration with Israeli academic institutions by several members of the international scientific community, our results seem to suggest that the Academic boycott of Israel did not gain momentum against Israel, not even after the 2006 war (Rose and Rose 2008). This might be due to the fact that the

boycotts hardly ever targeted individual Israeli scholars engaged in collaboration on research and publication with scholars from other nations. Also, the entrance of Israel into the European Union Research Framework Programme consolidated Israel as a European partner and a world leading nation in terms of scientific production. Our data shows that the relative impact of Western Europe and of Israel seemed to diminish over the years, due to the rising impact of other emerging counties (Zimmerman et al. 2009). Our data highlights in particular that there are four emerging countries in the Middle East: Iran, Turkey, Saudi Arabia and Egypt.

Conclusions

Overall, our data shows that during the period 1996–2014 Israel was the leading nation in the Middle East in terms of the total number of citations and of total citations per document, while Turkey and Iran were in the lead in terms of scientific documents produced, and together with Egypt and Saudi Arabia, were among the emerging countries in the Middle East in terms of scientific production.

We also concluded that the Middle Eastern countries greatly differ in terms of scientific production over time and that no common trend can be found among them. The relative weight of Israel scientific production is lessening in a way consistent with a trend that we found for Western Europe countries over the years, and which seemed significantly different from that of most its neighbouring countries. The international pressure on Israel in the form of academic boycott didn't seem to have a significant effect on its scientific production over the period examined. Our findings also show a profound imbalance in terms of scientific performance, highlighting a big divide between the top 5 and the other countries of the Middle East.

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