

Comparative analysis of quantity and quality of biomedical publications in Gulf Cooperation Council countries from 2011-2013

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ABSTRACT

الأهداف: مقارنة الإنتاج البحثي بين دول مجلس التعاون الخليجي في مجال العلوم الطبية الحيوية على مدى السنوات التالية: 2011-2013.

الطريقة: تم استرجاع بيانات عن المنشورات الطبية الحيوية الناتجة من دول مجلس التعاون الخليجي بين عامي 2011 و 2013 من قاعدة البيانات (PubMed). سوّيت عدد المنشورات الصادرة من كل دولة وفقا لعدد السكاني. وقد تم جمع عامل التأثير لدى كل دولة خلال سنة واحدة، ومن ثم تقسيمه على العدد الكلي للمنشورات الصادرة في هذه السنة. وبهذا حصلنا على متوسط عامل التأثير لتلك السنة تحديداً والذي استخدم في التحليل المقارن.

النتائج: تم استرجاع إجمالي 11,000 منشورة من قاعدة البيانات (PubMed). نظرا لمعايير الاستثناء، اخترنا 9222 منشورة من أجل التحليل. لاحظنا تزايداً متتالية لعدد المنشورات خلال فترة الدراسة لكل دولة. حازت المملكة العربية السعودية على أبرز ازدياد لعدد المنشورات خلال فترة الثلاث أعوام السابقة. ولكن بعد التسوية لعدد السكان، وجدنا أن عمان، وقطر، والكويت تفوقت على المملكة العربية السعودية في الإنتاج البحثي. لقد أوضحت بيانات متوسط عامل التأثير أن إجمالي متوسط عامل التأثير لم يتغير لكل دول مجلس التعاون الخليجي، ماعدا عمان. بالرغم من بدء عمان على معدل بسيط في 2011 مقارنة بدول الخليج الأخرى، تمكنت من تحقيق تقدم هائل في السنتين التاليتين.

الخاتمة: بالرغم من الازدياد الكمي للبحوث العلمية في دول مجلس التعاون الخليجي خلال فترة الثلاث سنوات الماضية، تبقى جودة البحث بحاجة إلى تحسينها عن طريق نشرها في صحف ذات معامل تأثير عالٍ.

Objectives: To compare the research productivity of different Gulf Cooperation Council (GCC) countries in the field of biomedical sciences from 2011-2013.

Methods: This is a retrospective study conducted in the College of Medicine, Alfaisal University, Riyadh, Saudi Arabia. Data on the biomedical publications

originating from GCC countries published between January 2011 to December 2013 was searched via MEDLINE using PubMed. The total number of publications emanating from each country was normalized with the country's population. The mean impact factor (IF) of all the publications in a year was calculated for comparative analysis.

Results: A total of 11,000 publications were retrieved via MEDLINE using PubMed, out of which, 9222 were selected for analysis. A successive increase in the number of publications by every country was observed. The most striking increase in the number of publications was from Saudi Arabia. However, after normalization with population, the performance of Oman, Qatar, and Kuwait looks far better than Saudi Arabia in terms of research productivity. Data on mean IF showed that the overall mean IF of all GCC countries has remained largely unchanged except Oman. Although Oman had a comparatively low mean IF value in 2011, they recorded a tremendous improvement in successive years.

Conclusion: All GCC countries underwent an increase in quantitative research productivity over the last 3 years. However, no increase in quality of research publications was noted based on the proxy reports of mean journal IF.

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The Gulf Cooperation Council (GCC) is a political and economic union of Arab states bordering the Persian Gulf. It includes Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates.¹ The headquarter of the GCC is in Riyadh, the capital of Saudi Arabia. Although great cultural and linguistic similarity is found between the GCC countries, they are diverse at the education and research institution level. Much of this diversity arises due to the disparity in monetary resources, population, and country's covered area. For instance, Saudi Arabia, the largest GCC country (spanning a total of 2,217,949 square kilometers) with a GDP of 748.4 billion US dollars,² has vastly different resources compared to Bahrain, the smallest GCC country with a total covered area of 678 square kilometers and a GDP amounting to 32.8 billion US dollars.³ Similarly, there are huge differences in population among the member countries. These economic and demographic differences also extend to the number of educational and research-generating institutes within each country in the GCC. This in turn affects the productivity of research activity in each country. Research activities in a country have a direct impact on improving health care and policy.⁴ The history of education and research in GCC member countries is not very old although research activities are promoted at governmental and institutional levels. Even the guidelines for academic promotions of the faculty working in most of the institutes in GCC countries put a heavy weight age on the research productivity.^{5,6} Publication in journals is the eventual outcome of scientific research. Several previous studies have examined bibliometric trends in Iran,⁷ Oman,⁸ United Arab Emirates,⁹ and Saudi Arabia.^{10,11} Studies for the whole GCC countries have also been carried out.¹²⁻¹⁶ This study aims to extend this knowledge by comparing the research productivity of GCC countries in the field of biomedical sciences over the last 3 years. Research productivity was measured in 2 dimensions. Firstly, all countries were compared in terms of the number and types of publications in Pubmed-indexed journals and secondly, the quality of the publications was determined taking journal impact factor (IF) as a measure of quality.

Disclosure. Authors have no conflict of interests, and the work was not supported or funded by any drug company.

Methods. This is a retrospective study conducted at the Department of Pharmacology, College of Medicine, Alfaisal University, Riyadh, Saudi Arabia. Data on biomedical publications, which originated from GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and United Arab Emirates) was retrieved from PubMed. PubMed was preferred over Embase due to 2 reasons. First, search results has shown overlapping with slightly more sensitivity with PubMed.¹⁷ Second, all investigators were more familiar with Pubmed and found it user-friendly. Each country's name was used as a keyword in the search feature of the website, and the search was limited by specific "pubdate". All publications published between January 2011 and December 2013 were retrieved.

All investigators were assigned to a specific country for search. The inclusion and exclusion criteria were clearly defined prior to the study. There was a fortnightly meeting of the whole group for updating. Any controversial issue regarding the inclusion or exclusion was resolved unanimously in the meetings. All abstracts that appeared in the results were transferred to a single word document. As already reported by Tadmouri and Bissar-Tadmouri,¹⁸ there are issues in the sensitivity of using Pubmed, each abstract was read carefully for any inclusion or exclusion criteria. The inclusion criteria for this study were 1) All studies that were conducted in, and published from, GCC countries - including regional and international collaborative studies in which GCC researcher(s) was/were also involved. There were few publications, which included authors from more than one GCC country. In those cases, credit was given to all countries. 2) All studies which were performed outside the GCC countries, but at the time of submission of papers and publication, the author(s) was/were working in any of the GCC countries. We verified this by looking at the place of study and current affiliation of the author(s). 3) All studies which were conducted in GCC countries, but at the time of publication, the author(s) was/were working outside GCC countries. Exclusion criteria were followed based in our previous study;⁸ 1) All studies, which were neither conducted in GCC countries nor belonged to any GCC scientists, were excluded. Such publication appeared in search results because the name of the country was mentioned in the text. This included some authors under the name "Oman", reference to some Omani family, reference to Bay of Oman or some previous study performed in any GCC country. 2) All studies not related to biomedical sciences; for example, publications belonging to pure physics, chemistry, and engineering were also excluded. Publications unrelated to any of the biological

sciences were excluded. Each abstract was analyzed meticulously for area of research, type of publication, year of publication, institute where the study was conducted, and the journal IF. The type of publication (original research article, review, case report, and so forth) was documented as classified by the journals themselves. The journal IF for 2013 was applied to all publications. Full-length original articles, review articles, and publications mentioning new research methods/new technique were assigned full IF of the journal. However, half of the journal IF was assigned to correspondences/commentaries, case reports/series, and short communications, as reported previously.⁸ This approach was adopted arbitrarily because this is simple without any other validated tool in differentiating the potentially highly cited scholarly publications from the less tedious case reports or commentaries. All these attributes of the publications were coded and entered into Microsoft Excel.

For some publications, all the required information was not available on Pubmed-retrieved abstract. In such situations, full text articles were accessed from the journal web sites. After entering all the data in the coded form, decoding was carried out on Excel sheet and figures and tables were generated for comparative analysis of biomedical publications among the GCC countries and within each country over the range of 3 years.

Normalization of number of publications with population. The size and population of GCC countries are highly variable making them unequal in human resources and the number of academic institutes. Therefore, total number of publications was normalized with population by dividing each country's total number of publications by total population of that country, then multiplying with 100,000 people. This yielded us the unit of number of publications per 100,000 people. The official population reported by the World Bank for 2013 was taken as the population of each country.¹⁹

Calculation of mean impact factor for a year. Journal IFs of all yearly publication by each country were summed up and then divided by the total number of publications in that year. This yielded the mean IF for that particular year, which was used for comparative analysis among the GCC countries as well as within each country over the selected 3 years.

Statistical methods. Statistical analysis was performed by the IBM SPSS Statistics for Windows version 21.0 (IBMCorp, Armonk, NY, USA). A log-linear analysis was performed to examine the numbers of publications categorized according to country, year, and type of publication. This was followed up by individual

Chi-square analysis, and significant effects were identified by examination of standardized residuals. The IF data were analyzed using the 2-way ANOVA, which was followed up by simple effects analyses using Fisher's LSD or Tukey's HSD post hoc tests as appropriate. For all analyses, statistical significance was defined using a probability level of $p < 0.05$

Results. We retrieved a total of 11,000 publications (between January 2011 and December 2013) from Pubmed. Based on the study's exclusion criteria, 9,222 biomedical publications were selected for analysis.

Table 1 shows the distribution of country-wise publications over 3 years. As evident, there has been a successive increase in the number of publications over the study time in almost every country. The most striking increase in the number of publications over the past 3 years was from Saudi Arabia.

Table 2 demonstrates the normalized data per 100,000 people of Table 1. Although Saudi Arabia tops the list with a total number of publications, it can be observed after intervention with normalization, the performance of Oman, Qatar, and Kuwait seems far better than Saudi Arabia in terms of research productivity. Furthermore, regression slopes were also plotted for normalized publication rates for all the countries as shown in Figure 1A. Statistical analysis revealed that the regression slope of Oman has a steeper slope than all except Qatar and Kuwait (Figure 1B). It was interesting to note that all 6 GCC countries are consistently performing better in terms of number of research publications even after normalization over time.

Table 3 depicts the trend of distribution of various types of publications in all 6 countries over 3 years. Original research articles were statistically significant $\chi^2(10) = 122.3$, $p < 0.001$, and residuals analysis showed that this was largely due to Oman's proportionately steep rise in this type of publication

Table 1 - Distribution of biomedical publications in Gulf Cooperation Council countries between January 2011 and December 2013.

Country	2011	2012	2013	Mean of all 3 years
Bahrain	57	59	79	65
Kuwait	258	235	335	276
Oman	65	234	442	247
Qatar	148	182	268	199.3
Saudi Arabia	1605	1924	2585	2038
United Arab Emirates	244	245	257	248.7
Total	2377	2879	3966	3074

over 3 years (residuals: -7.4, 0.8, 6.7). Marginally significant residuals were found in Saudi Arabia in 2013 (-2.0) and Kuwait in 2011 (2.1). Case reports were statistically significant $\chi^2(10) = 32.5, p < 0.001$, and residuals analysis showed that Oman in 2011 had fewer (-2.6) and Kuwait had higher (2.7) numbers of publication than expected. In addition, UAE had fewer (-2.3) case reports than expected in 2013. Review articles had statistically significant values of $\chi^2(10) = 23.8, p = 0.008$ with further analysis demonstrating that Oman had fewer (-2.8) publications of this type in 2011 than expected. Research methodology publications were statistically significant $\chi^2(10) = 38.0, p < 0.001$. Oman had fewer publications of this type in 2011 and 2012 (-2.0, -2.8) and more in 2013 (3.2) than expected. United Arab Emirates had fewer (-2.2) publications of this type in 2013 than expected. Also, statistically significant were the short communications and other articles with values of $\chi^2(10) = 50.0, p < 0.001$. This was largely due to changes for Oman and UAE over the years 2011 to 2013; Oman was increasing (-3.6, 0.6, 2.4) and UAE was decreasing (1.9, 2.5, -3.4).

Mean yearly IFs of all the biomedical publications emanating from the GCC countries are presented in Table 4. The data shows that the overall IF of all GCC countries has remained largely unchanged with the exception of Oman, which started at a lower IF value but improved considerably in the following years.

Discussion. Biomedical research is very crucial for the development of health care systems and their improvement. Quantity and quality of biomedical research publications are useful tools for assessing the productivity of biomedical research in a particular country.¹⁰ There are 2 previous studies, which have analyzed the increase in number of biomedical research publications from the GCC countries over a 10 year period (1990-1999)¹⁴ and 40 year period (1970-2010).¹⁶ However, there are some methodological differences. Deleu et al (2001)¹⁴ did not take into account the relative

size of the countries while comparing the research productivity of GCC countries, and both studies included all the publications retrieved from Pubmed without excluding the false positive publications as mentioned in the methods.^{14,16} Keeping in mind the false retrievals from the Pubmed, this study was conducted which evaluates the research advancement of biomedical research in the GCC countries using meticulous inclusion and exclusion criteria to have a

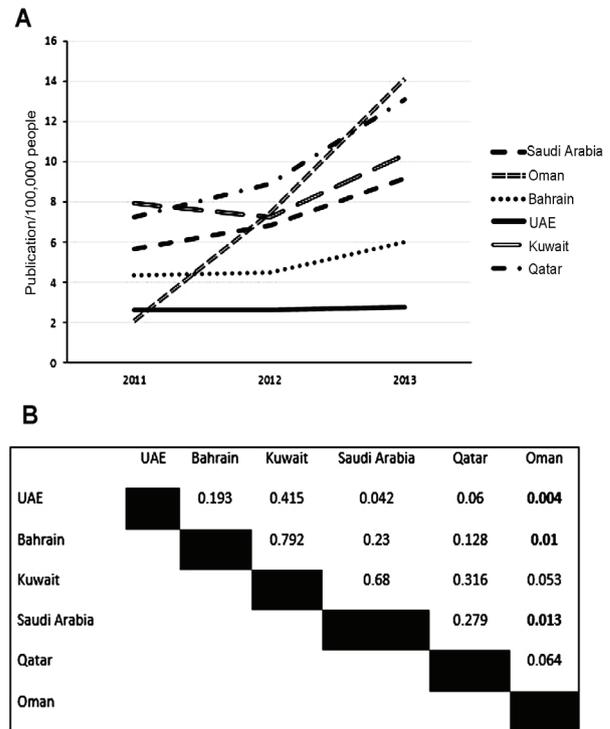


Figure 1 - Regression slopes of all countries after normalization with population. A) Normalized publication rate slopes for the 6 Gulf Cooperation Council countries and B) p value of the comparative analysis of regression slope. Normalization of publications per year for each country was performed by dividing the total number of publications in a year with the population of that country.

Table 2 - Distribution of biomedical publications in Gulf Cooperation Council countries between January 2011 and December 2013 after normalization with respective population as mentioned in the methods.

Country	2011 (Publications/100000 people)	2012 (Publications/100000 people)	2013 (Publications/100000 people)	Mean of all three years (Publications/100000 people)
Bahrain	4.32	4.48	5.99	4.93
Kuwait	7.94	7.23	10.31	8.49
Oman	2.07	7.45	14.08	7.87
Qatar	7.22	8.88	13.07	9.72
Saudi Arabia	5.67	6.80	9.14	7.20
United Arab Emirates	2.65	2.66	2.79	2.70

Table 3 - Distribution of types of biomedical publications in Gulf Cooperation Council countries between January 2011 and December 2013.

Type of publications	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE
<i>Original research articles</i>	128	581	329	349	3535	379
2011	34 (59.6)	180 (69.8)	18 (27.7)	82 (55.4)	973 (60.3)	119 (48.8)
2012	46 (75.4)	166 (70.6)	100 (42.7)	116 (63.7)	1204 (62.6)	114 (46.5)
2013	48 (60.0)	235 (70.1)	211 (47.7)	151 (56.3)	1358 (52.5)	146 (56.8)
Mean	42.7 (65.0)	193.7 (70.2)	109.7 (39.4)	116.3 (58.5)	1178.3 (58.5)	126.3 (50.7)
<i>Case reports + case series</i>	34	139	211	111	1056	109
2011	11 (19.3)	50 (19.4)	33 (50.8)	29 (19.6)	251 (15.6)	35 (14.3)
2012	6 (9.8)	38 (16.2)	72 (30.8)	34 (18.7)	315 (16.4)	41 (16.7)
2013	17 (21.2)	51 (15.2)	106 (24.0)	48 (17.9)	490 (18.9)	33 (12.8)
Mean	11.3 (16.8)	46.3 (16.9)	70.3 (35.2)	37 (18.7)	352 (17.0)	36.3 (14.6)
<i>Review articles</i>	14	51	94	40	691	85
2011	3 (5.3)	16 (6.2)	8 (12.3)	6 (4.0)	158 (9.8)	27 (11.1)
2012	2 (3.4)	14 (6.0)	39 (16.7)	11 (6.0)	203 (10.5)	26 (10.6)
2013	9 (11.2)	21 (6.3)	47 (10.6)	23 (8.6)	330 (12.8)	32 (12.4)
Mean	5.3 (7.7)	17 (6.1)	31.3 (13.2)	13.3 (6.2)	230.3 (11.0)	28.3 (11.4)
Research methods + new technique	1	16	26	23	137	26
2011	0	1 (0.4)	0	4 (2.7)	24 (1.5)	8 (3.3)
2012	0	8 (3.4)	0	5 (2.7)	43 (2.2)	12 (4.9)
2013	1 (1.2)	7 (2.1)	26 (5.9)	14 (5.2)	70 (2.7)	6 (2.3)
Mean	0.3 (0.4)	5.3 (2.0)	8.7 (2.0)	7.7 (3.6)	45.6 (2.1)	8.7 (3.5)
<i>Short communications + letters + commentaries + others</i>	18	41	81	75	695	147
2011	9 (15.8)	11 (4.3)	6 (9.2)	27 (18.2)	199 (12.4)	55 (22.5)
2012	5 (8.2)	9 (3.8)	23 (9.8)	16 (8.8)	159 (8.3)	52 (21.2)
2013	4 (5.1)	21 (6.3)	52 (11.8)	32 (11.9)	337 (13.0)	40 (15.6)
Mean	6.3 (10.1)	13.7 (4.8)	27 (10.3)	25 (13.0)	231.7 (11.2)	49 (19.8)

Data are expressed as number and percentage (%)

Table 4 - A comparative analysis of year-wise mean impact factor (IF) in 3 years for all Gulf Cooperation Council countries. Mean IF for each country was calculated by summing the IFs of all the publications of the year divided by the total number of publications in that year.

Year	Bahrain	Kuwait	Oman	Qatar	KSA	UAE
2011	2.105	1.421	0.209	1.945	1.480	1.775
2012	2.415	1.456	0.730	1.714	1.549	1.813
2013	1.724	1.769	1.043	2.080	1.794	1.808
Mean of 3 years	2.081	1.549	0.661	1.913	1.580	1.799

KSA - Kingdom of Saudi Arabia, UAE - United Arab Emirates

realistic view. As a result of manual scrutiny of each abstract, more than 16% publications were excluded from the analysis since these were found to be false positive. These differences in the analytic methods yielded more realistic data. For example, agreeing with Deleu et al (2001),¹⁴ Saudi Arabia tops the GCC countries in terms of absolute number of publications. All countries showed a linear growth in number of publications over the three years. Similar findings were reported by Latif (2015)¹¹ for Saudi Arabia in a recent study. However, when we normalized these absolute numbers with the populations of the countries, Qatar's performance was found to be much better followed by Kuwait and Oman. The greatest surge in the relative

number of publications during the study's selected time period was observed in Oman. Apart from comparative analysis, each country has remarkably increased its number of publications over the years.

Original articles are the reflection of research activities compared to other types of publications. These are the most important types of publications since these provide new information based on original research, and are supported by in-depth statistical analysis.²⁰ Our data shows that Kuwait (>70% of its total publications in three years) produced the most original articles followed by Bahrain (65%). It was also interesting to note that Oman had the lowest (39%) number of original articles published during the study period. Omani researchers'

publications heavily relied on case reports and series (35%). A similar pattern of reliance on case reports, and the series by Omani researchers, was also shown in a previous report in the years 2005-2009.⁵ The magnitude of original papers from the remaining 3 countries (Saudi Arabia [58%], Qatar [58%], and UAE [51%]), remained stable during 2011-2013.

Apart from the number of publication, an additional objective of the study was to determine and compare the quality of publications published by GCC countries. Journal IF was employed as a proxy for the quality of publication. The journal IF is a parameter based on the number of times that a paper in a particular journal has been cited by other journals.²¹ The questions have been raised as the whether the journal IF can be used as a surrogate marker for the quality of the publication.^{22,23} However, we used this indicator in our study because in most of the situations, journals with high IF are considered as the ones in whom it is relatively difficult to publish and vice versa.²⁴ This shows that it is still useful as a proxy for the quality of the research. In the present study, it was observed that the mean IF of the publications from individual countries remained similar over 3 years for the purposes of this study, and no significant change except publications from Oman. In addition to quantity, the quality of publications from Oman also serially increased from 2011 to 2013. However, when we compared the mean journal IF of all the countries, Bahrain was ahead with mean IF of 2.1 followed by Qatar (1.9).

Study limitation. There are few limitations in the current study. Firstly, our analysis consisted of publications indexed on Pubmed alone. While Pubmed is a premier database for biomedical publications, other publications, which could not be retrieved from Pubmed, are not included in this study. Many journals originating from the GCC countries are not indexed in Pubmed and majority of the papers published in such journals are by local researchers. If included, such publications might change the overall data as far as the number of publications is concerned. Secondly, Journal IF was used as testament of the quality of publication. However, it is debatable whether IF is a true measure of research publication quality.²⁵ Finally, we arbitrarily assigned half of the journal IF to publications such as case reports and commentaries, as we have carried out previously.⁸ The sole purpose of this was to differentiate them from more scholarly, time-consuming and expensive original studies.²⁶ In the absence of any other validated tool to differentiate these types of publications, we used this convenient method.

In conclusion, all 6 GCC countries are consistently producing more number of publications over time. Saudi Arabia leads with an absolute number of publications, Oman with number of publications normalized with population, Kuwait with percentage of original articles and Bahrain with mean IF of the biomedical publications. However, the quality of publications remains similar for the individual countries over time and needs to be improved by publishing in good quality journals with high IF.

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