

Evaluation of biomedical research in Saudi Arabia

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ABSTRACT

الأهداف: تحديد وتقييم كمية ونوع الابحاث الصادرة من السعودية في العامين 2010-2011م.

الطريقة: تم استخدام محرك البحث المعروف (PubMed) في حصر عدد الدراسات التي تمت في العامين 2010-2011م في سنة 2013م وذلك لإعطاء فترة عام على الأقل للنظر في عدد الاستشهادات لكل بحث (Number of citations). وقد تم تقييم عدد الأبحاث ومقارنتها بعدد الأبحاث الصادرة من دول أخرى بعد تعديلها على نسبة عدد السكان. كما تم تقييم نوعية الأبحاث في معظم المؤسسات الجامعية والصحية بالنظر إلى معدل عدد الاستشهادات بالبحوث (Number of citations) وعلى معامل قوة المجلة المنشور بها البحث (Impact Factor).

النتائج: إن إجمالي عدد الأبحاث هو 1905 بحث وبالمقارنة مع أكبر إنتاج بحثي وهو من دولة استراليا فإن السعودية تقع في المركز 16 من بين الدول التي تم ادراجها في البحث. كما تبين أن مدينة الرياض تمثل (65%) من الانتاج البحثي وأن مدينة جدة تأتي في المركز الثاني بنسبة (13%) كما تبين أن مجال طب المجتمع يحظى بالأغلبية في مجال البحث الطبي وبنسبة (15%) مقارنة بالتخصصات الأخرى. وأن نوعية الأبحاث التي يقوم بها مستشفى الملك فيصل التخصصي بالرياض هي الأولى بالنظر إلى عدد الاستشهادات بالبحوث (Number of citations) وعلى معامل قوة المجلة المنشور بها البحث (Impact Factor).

خاتمة: ما يزال الانتاج البحثي في المملكة العربية السعودية متأخراً وبحاجه الى مزيد من الجهد للتطوير مقارنة بالدول الأخرى كما يعد مستشفى الملك فيصل التخصصي بالرياض هو الرائد من ناحية نوعية البحوث المقدمة.

Objectives: To evaluate the quality and quantity of biomedical studies published in the Kingdom of Saudi Arabia (KSA) between 2010 and 2011.

Methods: This study was conducted on January 2013 at the Internal Medicine Department, Taif University, Taif, KSA. An online search was conducted on PubMed to collect the articles published from KSA using the country name (Saudi Arabia) as a keyword.

The search was limited to studies published in the period of 2 years from January 2010 to December 2011. The year 2012 was not included to give at least one year for citation. The total number of studies during the stated period was compared with those published from other countries in the same period, and adjusted per population size. Impact factor and number of citations were used to assess the quality of the studies.

Results: A total of 1905 published articles/studies were from KSA in the said period. Australia had the maximum number of studies (100%) published per million population (1258.571+). The KSA had 72.71 articles per million population, and was ranked 16th among the other countries. Most of the articles (65.3%) were published from Riyadh followed by Jeddah (13.3%), and most of them were from the fields of Community Medicine (15.5%), Pathology (13.7%), Medicine (13.2%), and Surgery (13.1%). King Faisal Specialist Hospital in Riyadh had the highest impact factor with a mean of 2.74 ± 3.45 .

Conclusion: The Kingdom of Saudi Arabia is lagging behind in biomedical research. While King Faisal Specialist Hospital and Research Centre appears to be doing better than other institutions in biomedical research, there is an urgent need for greater investment in biomedical research in the kingdom.

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Biomedical research plays a key role in the assessment and better formulation of health policy planning, and has a direct impact on improving patient care in an area.¹ It determines burden of health problems, establishes their clinical and epidemiological profiles, and reveals the outcome of therapies or interventions used for different medical conditions.² Regarding biomedical research, there exists a huge gap between the industrialized countries and the emerging economies.³ Economists have put forth biomedical research to have, in addition, to the individual benefits of improved health, great impact on human health, and longevity.⁴ Countries with high income contribute the majority of papers to high impact journals compared to those countries with low income.⁵ According to The World Bank Classification 2011, the Kingdom of Saudi Arabia (KSA) is a high income Arab country with a gross domestic product (GDP) of \$576.8 billion, gross national income (GNI) per capita of \$17,820, and population of 28.08 million.⁶ Benamer and Bakoush⁷ have reported that high income Arab Middle East countries lag behind high income non-Arab Middle East countries in biomedical research. To the present day, no study on biomedical research statistics is available from KSA. However, Al-Jumah et al⁸ have reported satisfactory attitude of the patients towards biomedical research. In this regard, we conducted an online search aiming to evaluate biomedical research statistics in KSA, in order to improve and enhance research activities in the kingdom. PubMed is a free database offered by National Center for Biotechnology Information (NCBI) that is a division of the National Library of Medicine (NLM). It provides the clinicians and consumers to review clinical effectiveness research by offering an open access to more than 20 million scientific citations, abstracts, and some full text articles on biomedical topics.⁹ Most of the publications from Arab world are quantitative. Impact factor measure and represents the quality of a journal, and it is still being used instead of much criticism.^{10,11}

Methods. This study was conducted in January 2013 at the Internal Medicine Department, Taif University, Taif, KSA. An online retrospective search was conducted on the most trusted search engine (PubMed) to collect articles published from KSA using the country name (Saudi Arabia) as a keyword, specifying city names and different medical fields. The search was limited to the studies published in the period of 2 years from January 2011 to December 2012. Biomedical research refers to the broad area of science that intends to prevent and treat the diseased conditions in human beings. Non-research

articles for example editorials, letters, supplementary, and case reports were not included in this study. Bias was controlled by using the same inclusion criteria, which was the same search engine (PubMed) and the filters like time-period, English language, and human studies, regardless of the type of articles/studies. The total number of studies during the stated period was compared with those published from other countries in the same period, adjusted per population size. Impact factor and number of citations were used to assess the quality of the studies published in the publications/journals of different universities or hospitals from all over KSA for one year (year 2011). The year 2012 was not included to give at least one year for citation.

Values, percentages, means and standard deviation were expressed in the form of tables using the Statistical Package for Social Sciences software version 16 (SPSS Inc, Chicago, IL, USA). T-test was applied to compare different groups.

Results. A total of 1905 articles/studies published from KSA in the said period were collected. Maximum articles (65.3%) were published from Riyadh followed by Jeddah (13.3%). **Table 1** shows the number of articles published from different cities of KSA. Maximum articles were related to Community Medicine (15.5%) followed by Pathology (13.7%), Medicine (13.2%), and Surgery (13.1%). **Table 2** shows the number of articles and percentages of publications in different fields of medical sciences. Australia had the maximum number of studies (100%) published per population size (1258.571) followed by Israel (1248.026). **Table 3** shows the comparison of publications from KSA and other countries (with low, as well as high economies) of the world. The Kingdom of Saudi Arabia stood at 16th number having in biomedical research among the other countries. A total of 1391 (73%) articles were selected randomly to assess the quality of the studies using the number of citations and impact factor. **Table 4** shows publications from different medical universities and hospitals with the total number of citations (in Google and PubMed Central (PMC) and their impact factors only for one year (year 2011). However, impact factor is calculated for 2 years, but here we calculated only for one year. The highest impact factor (2.74 ± 3.45) came out to be of King Faisal Specialist Hospital and Research Centre.

Discussion. The quality of health care system in any area owe to the competency of the health care professionals in that area. The competency of the health care providers depends upon the environment

Table 1 - Number of articles published from different cities of Saudi Arabia according to a study conducted at the Internal Medicine Department, Taif University, Taif, Kingdom of Saudi Arabia.

City	n	(%)
Riyadh	908	(65.3)
Jeddah	186	(13.3)
Al-Khobar	49	(3.5)
Al-Hassa	46	(3.3)
Abha	33	(2.4)
Dammam	33	(2.4)
Makkah	24	(1.7)
Dhahran	22	(1.6)
Qassim	17	(1.2)
Madinah	14	(1.0)
Khamis	12	(0.9)
Taif	12	(0.9)
Jizan	8	(0.6)
Al-Kharj	4	(0.3)
Others	23	(1.7)

Table 2 - Number of articles related to different medical fields in Saudi Arabia according to a study conducted at the Internal Medicine Department, Taif University, Taif, Kingdom of Saudi Arabia.

Specialty	n	(%)
Community medicine	216	(15.5)
Pathology	191	(13.7)
Medicine	185	(13.2)
Surgery	182	(13.1)
Pediatrics	121	(8.7)
Ophthalmology	86	(6.1)
Obstetrics/Gynecology	65	(4.7)
Dentistry	65	(4.7)
Genetics	58	(4.2)
Biochemistry	34	(2.4)
Pharmacology	30	(2.1)
Dermatology	24	(1.7)
Physiology	23	(1.7)
Microbiology	22	(1.6)
Anesthesiology	22	(1.6)
Radiology	15	(1.1)
Otorhinolaryngology	17	(1.2)
Anatomy	13	(0.9)
Psychiatry	11	(0.8)
Others	11	(0.8)
Total	1391	

and quality of education they obtain. The quality of education attributes to the learning environment that is objectively evaluated. Continuous biomedical research is an important measure to assess and improve the quality of education. The KSA has witnessed expeditious advancement in health care system. Although health care professionals contributed a lot to biomedical research, but research in medical fields is still lacking in KSA.

Table 3 - Publications from different countries according to a study conducted at the Internal Medicine Department, Taif University, Taif, Kingdom of Saudi Arabia.

Countries	No. of articles	Population (million)	Articles per million population	(% out of Australia)
Australia	28192	22.4	1258.571	(100.0)
Israel	9485	7.6	1248.026	(95.3)
Finland	6357	5.3	1199.434	(94.5)
New Zealand	5235	4.4	1189.773	(84.0)
Canada	36166	34.2	1057.485	(66.1)
USA	257918	309.9	832.262	(47.7)
United Kingdom	37201	62.0	600.0161	(45.9)
Germany	47152	81.6	577.8431	(38.8)
France	31986	65.5	488.3359	(30.3)
Japan	48496	127.3	380.9584	(23.4)
Lebanon	1264	4.3	293.9535	(12.1)
Kuwait	471	3.1	151.9355	(7.4)
South Africa	4634	49.9	92.86573	(5.9)
Malaysia	2129	28.3	75.22968	(5.9)
United Arab Emirates	359	4.7	76.38298	(5.8)
Saudi Arabia	1905	26.2	72.70992	(2.9)
Egypt	2896	78.8	36.75127	(1.6)
Morocco	631	31.9	19.78056	(1.2)
India	17750	1184.6	14.98396	(1.0)
Pakistan	2200	170.3	12.91838	(0.9)
Sudan	360	31.9	11.28527	(0.5)
Yemen	139	24.3	5.720165	(0.4)

In our study, KSA stands 16th among the countries of the world in biomedical research with reference to population size. Most of the leading countries in medical research (that is, Australia, Israel, Finland, New Zealand, Canada, USA, UK, Germany, France, Japan, Kuwait and United Arab Emirates [UAE]) belong to high economies except Lebanon, South Africa, and Malaysia, which have upper middle economies. We have mentioned in the introduction section that KSA is a high income Arab country with gross domestic product (GDP) \$576.8 billion, gross national income (GNI) per capita \$17,820 and population 28.08 million.⁶ In this regard, KSA is lagging behind the other high income countries in medical research. However, KSA is leading in biomedical research among most of the Arab countries except Lebanon, Kuwait and UAE. Lebanon belongs to upper middle income countries. Mazboudi and Ben Abdelaziz¹² still reports lack of biomedical research in Lebanon due to financial problems and instability of the region. In this regard, KSA being a high-income country requires more medical research and trained professionals to conduct research as

Table 4 - Publications from different medical universities and hospitals of Saudi Arabia with the total number of citations according to a study conducted at the Internal Medicine Department, Taif University, Taif, Kingdom of Saudi Arabia.

Cities	Universities/Hospitals	No. of articles	No. of citations (Google)	Google citation	No. of citations (PMC)	PMC citations (mean ± SD)	Impact factor (mean ± SD)
Riyadh	King Saud University	398	1593	(4 ± 10.96)	248	(0.62 ± 2.52)	(1.59 ± 2.23)
Riyadh	King Faisal Specialist Hospital and Research Centre	176	972	(5.55 ± 7.67)	166	(0.95 ± 2.78)	(2.74 ± 3.45)
Jeddah	King Abdulaziz University Hospital	142	407	(3.48 ± 4.5)	51	(0.43 ± 0.83)	(1.07 ± 1.15)
Riyadh	King Abdulaziz Medical City	128	582	(4.55 ± 6.97)	70	(0.55 ± 1.15)	(1.46 ± 1.63)
Riyadh	King Fahad Medical City	39	223	(5.72 ± 33.29)	35	(0.897 ± 11.84)	(1.256 ± 2.29)
Al-Hasa	King Faisal University	39	126	(3.231 ± 4.22)	13	(0.33 ± 0.73)	(0.899 ± 0.472)
Al-Khobar	King Fahad University Hospital	37	111	(3 ± 2.26)	12	(0.32 ± 1)	(0.94 ± 0.79)
Riyadh	Prince Sultan Military Medical City	36	101	(2.81 ± 5.05)	9	(0.25 ± 0.49)	(1.35 ± 1.15)
Riyadh	Ministry of Health	25	131	(5.24 ± 6.09)	19	(0.76 ± 0.93)	(1.329 ± 2.32)
Abha	King Khalid University	25	76	(3.17 ± 5.89)	6	(0.25 ± 0)	(0.75 ± 0.763)
Riyadh	King Khaled Eye Specialist Hospital	19	42	(2.21 ± 2.97)	7	(0.37 ± 0.41)	(1.39 ± 1.27)
Riyadh	King Abdulaziz University Hospital	19	36	(1.89 ± 2.97)	7	(0.37 ± 1.52)	(1.19 ± 1.45)
Dammam	King Fahad Specialist Hospital	18	96	(4.56 ± 5.33)	16	(0.89 ± 1.26)	(1.55 ± 1.15)
Makkah	Umm Al-Qura University	18	48	(2.82 ± 6.59)	7	(0.412 ± 0.41)	(1.36 ± 2.49)
Qassim	Qassim university	16	63	(3.94 ± 7.13)	8	(0.5 ± 1.34)	(0.9099 ± 0.635)
Dhahran	Saudi ARAMCO Medical Services	15	63	(4.2 ± 5.97)	8	(0.53 ± 0.52)	(0.84 ± 0.82)
Riyadh	Prince Salman Center for Kidney Disease	13	26	(2 ± 2.37)	2	(0.15 ± 0)	(0.39 ± 0.29)
Jeddah	King Faisal Specialist Hospital and Research Centre	12	24	(2.08 ± 3.6)	2	(0.167 ± 0)	(1.41 ± 1.37)
Al-Khobar	Saad Specialist Hospital	12	26	(2.16 ± 2.81)	8	(0.67 ± 0.89)	(1.62 ± 0.52)
Khamis Mushayt	Armed Forces Hospital	12	15	(1.25 ± 1.32)	0	0	(1.06 ± 0.67)
Jeddah	King Fahad Armed Forces Hospital	9	32	(3.55 ± 3.82)	5	(0.55 ± 1.15)	(1.024 ± 0.505)
Madinah	Taibah University	9	33	(3.66 ± 4.82)	4	(0.44 ± 1.4)	(1.62 ± 1.48)
Riyadh	Sultan Bin Abdulaziz Humanitarian City	8	8	(1 ± 1.34)	1	(0.125 ± 0)	(0.38 ± 0.23)
Jizan	University of Jizan	8	63	(7.875 ± 10.27)	6	(0.75 ± 0)	(1.603 ± 0.763)
	Assir Central Hospital	8	30	(3.75 ± 6.21)	6	(0.75 ± 2.83)	(1.115 ± 0.45)
Dammam	Dammam University	6	17	(2.833 ± 3.30)	2	(0.333 ± 0)	(0.92 ± 0.73)
Taif	Al Hada Armed Forces Hospital	6	12	(2 ± 2.45)	5	(0.83 ± 0.71)	(0.904 ± 0.84)
Jeddah	King Abdulaziz Medical City	5	13	(2.6 ± 1.26)	3	(0.6 ± 0)	(0.79 ± 1.28)

PMC - PubMed Central, SD - standard deviation

biomedical publications of a country monitor research trends and lead to a better formulation of health policy planning and management.

Here arises a question “Why KSA is lagging behind in biomedical research while it belongs to high income countries?” There are many reasons for lack of medical research in KSA that is, lack of funding, research skills, publication issues, methodological conflicts and academic recognition.¹³ Benamer and Bakoush⁷ conducted a systematic review on biomedical research comparing Arab nations and other Middle

Eastern countries. They reported that Arab nations lag behind other Middle East nations in medical research pointing out lack of research resources in these areas. The United States of America is leading the world in medical research because it has doubled the expenditure on medical research in the last decade.¹⁴ Alsayed et al¹⁵ carried out a cross-sectional study at King Abdulaziz University Faculty of Medicine and reported lack of time and training in research methods as major obstacles for medical interns in the way of biomedical research. Bahammam¹⁶ reports lack of adequate technical staff

and awareness as causes of lack of research in KSA. Therefore, KSA government and medical associations need to consider these obstacles seriously in order to improve advanced biomedical research and health care quality in KSA.

Riyadh is the capital of KSA, and therefore, the leading city in the production of biomedical research in the country. It is because of that the maximum number medical colleges and universities are situated in Riyadh. King Saud University, King Faisal Specialist Hospital and Research Centre, King Abdulaziz Medical City, King Fahad Medical City, Riyadh Military Hospital, Ministry of Health, King Khaled Eye Specialist Hospital, King Abdulaziz University Hospital, Prince Salman Center for Kidney Disease, and Sultan Bin Abdulaziz Humanitarian City are situated in Riyadh. The King Faisal & Specialist Hospital and Research Centre¹⁷ has been established in 1975. It has several departments, which stand as the backbone of different research program. The centers got a lot of international award of excellence. The distinguish budget spent annually, collaboration with international centers, recruitment of excellent expertise from both national and international countries are possible factors that may contribute to our result. The impact of each one of those factors on research production require further detailed information that look for the exact budget of different centers, number of staff involved in research, incentive, and the exact vision of each institute. This information is very difficult to get from each center, and we focus here in this study to look for quantity and quality of research using the impact factor and number of citations.

On the other hand, this study reveals that other cities of KSA lack standard and equal distribution of medical institutions and research centers. So, establishment of standard hospitals in other cities equally, recruitment of skilled research specialists, high incentives, and enormous funding for research can play an important role to enhance medical research in SA and improved health care system subsequently. Moreover, each year KSA has to request skilled medical professionals from other countries like Pakistan, India, and USA.¹⁸ More medical research centers should be built and run. Skilled medical professionals can be hired from other countries to educate the health professionals in KSA.

Our study revealed that KSA is producing more research in the fields of community medicine, pathology, medicine and surgery. However, none of these institutes or hospitals is designated for research in any specialized field. Here arises a question, if none of the institutes is designated to perform research in any special field, then

why KSA is producing maximum articles in Community Medicine, Pathology, Medicine and Surgery? Maybe, these are the major medical fields in the world that is why, research trend is more in these fields. However, PubMed shows maximum published articles (3244652) in the field of medicine.¹⁹ The notion of research culture may explain some of these differences and other many factors that have been explained in the above section. We think the study message on this part is to show the weakness in biomedical research production in KSA in comparison with other countries. Therefore, further studies are required to answer this question.

The quality of the journal and its articles is measured in terms of impact factor. Impact factor depends on the number of articles and number of citations to those articles. The higher the quality, the higher would be the number of citations to such articles. From KSA, King Faisal Specialist Hospital and Research Centre came out to be with highest impact factor that is 2.74 ± 3.45 . The New England Journal of Medicine (53.298) and Lancet (38.278) have the highest impact factor.²⁰ It shows that KSA biomedical research also lags behind other countries in quality. However, there are many controversies regarding the validity and affectivity of impact factor as the quality of a journal.¹¹ Regardless of the scientific merit, number of citations to the articles can be increased through publicity and instructions from the editors to include certain references during peer-reviewed processing.²¹ However, impact factor is still considered a quality measure for the journals.

There are some limitations to our study. We have observed that some of the institutes or hospitals in KSA generated a good number of articles, while others produced very small number of biomedical articles. In this regard, disparities in funding may account for differences in the number of articles. Although the funding of each hospital or institute is an important factor, but such information was very hard to get accurately, and the main aim of the study was to look for quantity and quality of study regardless of the contributing factors, which require detailed information and further studies that look for exact budget of different centers, number of staff involved in the research, incentives, and the exact vision of each institute. We used only impact factor only for one year to assess the quality of the publications in KSA. Also, we did not assess the impact factors of journals from other countries. We recommend further studies to evaluate biomedical research using different methodologies and measures other than impact factor such as SCImago Journal Rank (SJR), Journal Impact Factor (JIF), or Source Normalized Impact per Paper (SNIP).

In conclusion, KSA lags behind other high income and some upper middle-income countries in the quantity as well in the quality of biomedical research. In other words, overall KSA medical research production is much less than that of developed countries. The KSA requires releasing more funds, recruiting skilled research professionals in the country, hiring competent medical professionals from other countries for some period, and resolving publication and methodological issues in way of medical research.

References

- Hyder AA, Corluka A, Winch PJ, El-Shinnawy A, Ghassany H, Malekafzali H, et al. National policy-makers speak out: Are researchers giving them what they need? *Health Policy Plan* 2011; 26: 73-82.
- Lowrance WW, Collins FS. Identifiability in genomic research. *Science* 2007; 317: 600-602.
- Bachelet VC. The biomedical publishing gap between the first world and the emerging world - can it be overcome? *Medwave* 2011; 11: e5076.
- Nabel EG. Linking biomedical research to health care. *J Clin Invest* 2009; 119: 2858.
- Patel V, Kim YR. Contribution of low and middle-income countries to research published in leading general psychiatry journals 2002-2004. *Br J Psychiatry* 2007; 190: 777.
- The World Bank: Saudi Arabia. [cited 2013 Mar 27]. Available from: <http://data.worldbank.org/country/saudi-arabia>
- Benamer HTS, Bakoush O. Arab nations lagging behind other Middle Eastern countries in biomedical research: a comparative study. *BMC Med Res Methodol* 2009; 9: 26.
- Al-Jumah M, Abolfotouh MA, Alabdulkareem IB, Balkhy HH, Al-Jeraisy MI, Al-Swaid AF, et al. Public attitude towards biomedical research at outpatient clinics of King Abdulaziz Medical City, Riyadh, Saudi Arabia. *East Mediterr Health J* 2011; 17: 536-545.
- PubMed Health. [cited 27 Mar 2013]. Available from: <http://www.ncbi.nlm.nih.gov/pubmedhealth/about/>
- Yung WKA. Impact factor number reflects sustained high quality. *Neuro Oncol* 2010; 12: 893.
- Smith ER. The journal impact factor. *Can J Cardiol* 2006; 22: 787-788.
- Mazboudi A, Ben Abdelaziz A. Medical research productivity of Lebanon: a bibliometric study of papers indexed in Medline, 1985-2004. *Tunis Med* 2010; 88: 579-585.
- Bin abdulrahman KA. The value of medical education research in Saudi Arabia. *Med Teacher* 2012; 34: S1-S3.
- Malik TG. Muslims and the Medical Research: Past, Present, Future. *Oman Med J* 2011; 26: 383-384.
- Alsayed N, Eldeek B, Tayeb S, Ayuob N, Al-Harbi A. Research practices and publication obstacles among interns at King Abdulaziz University Hospital, Jeddah, Saudi Arabia, 2011-2012. *J Egypt Public Health Assoc* 2012; 87: 64-70.
- Bahammam AS. Sleep medicine in Saudi Arabia: Current problems and future challenges. *Ann Thor Med* 2011; 6: 3-10.
- The Research Centre. Research at King Faisal & Specialist Hospital and Research Centre. [cited 2013 Jul 03]. Available from: <http://rc.kfshrc.edu.sa/Research.asp>
- Bajammal S, Zaini R, Abuznadah W, Al-Rukban M, Moyn Aly S, Boker A, et al. The need for national medical licensing examination in Saudi Arabia. *BMC Med Educ* 2008; 8: 53.
- PubMed. Medicine. [cited 03 July 2013]. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/?term=medicine>
- Medical Journal Impact Factors 2012. [cited 28 Mar 2013]. Available from: <http://impactfactor.weebly.com/medicine.html>
- Branch TA. Citation patterns of a controversial and high-impact paper: Worm et al. (2006) "Impacts of biodiversity loss on ocean ecosystem services". *PLoS One* 2013; 8: e56723.

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Bissar-Tadmouri N, Tadmouri GO. Bibliometric analyses of biomedical research outputs in Lebanon and the United Arab Emirates (1988-2007). *Saudi Med J* 2009; 30: 130-139.