

## Medical and biomedical research productivity from the Kingdom of Saudi Arabia (2008-2012)

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ABSTRACT

**Background:** Biomedical publications from a country mirror the standard of Medical Education and practice in that country. It is important that the performance of the health profession is occasionally documented. **Aims:** This study aimed to analyze the quantity and quality of biomedical publications from the Kingdom of Saudi Arabia (KSA) in international journals indexed in PubMed between 2008 and 2012. **Materials and Methods:** PubMed was searched for publications associated with KSA from 2008 to 2012. The search was limited to medical and biomedical subjects. Results were saved in a text file and later checked carefully to exclude false positive errors. The quality of the publication was assessed using Journal Citation Report 2012. **Results:** Biomedical research production in KSA in those 5 years showed a clear linear progression. Riyadh was the main hub of medical and biomedical research activity. Most of the publications (40.9%) originated from King Saud University (KSU). About half of the articles were published in journals with an Impact Factor (IF) of < 1, one-fourth in journals with no IF, and the remaining one-fourth in journals with a high IF ( $\geq 1$ ). **Conclusion:** This study revealed that research activity in KSA is increasing. However, there is an increasing trend of publishing in local journals with a low IF. More effort is required to promote medical research in Saudi Arabia.

**Key words:** Biomedical publications, Kingdom of Saudi Arabia, medical colleges, PubMed, research productivity

### INTRODUCTION

The Saudi government has been taking active steps since the mid-2000s to promote education, Research and Development (R&D) throughout the kingdom. To foster academic work and research, the government has implemented a National Science Technology and Innovation Program, whose aim is to provide the infrastructure necessary to develop the kingdom as an advanced knowledge-based economy which is competitive internationally in science and technology.<sup>[1]</sup> In addition, the kingdom has built numerous Centers of Research Excellence and Science Parks. Health services have also been improved, and the people of Saudi Arabia

have witnessed a dramatic increase in the number of undergraduate and postgraduate medical institutions. This should have been accompanied by an increase in scientific research output as there is strong positive correlation between the amount of money a country invests in R&D and its research publications.<sup>[2,3]</sup>

Qualitative and quantitative evaluation of publications is used to measure the scientific activities of research institutes and universities worldwide.<sup>[4-7]</sup> In fact, the research productivity/scientific publications in academic institutions constitute a crucial measure of their success<sup>[8]</sup> and the extent of their contributions to developing new knowledge.<sup>[9]</sup> Consequently, the research performance of the faculty, and their scientific publications are frequently regarded as an index of institutional prestige.

However, data on the publication activities of medical colleges and hospitals are scarce in Kingdom of Saudi Arabia (KSA). One of the studies evaluated KSA research productivity from 1982 to 2000,<sup>[4]</sup> but only one study that deals with the period after 2000 is available. Even that evaluated only 2 years, 2011 and 2012, and was a

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comparison of studies from KSA with those published in other countries during the same period.<sup>[10]</sup> Our aim was, therefore, to quantitatively analyze the biomedical publication records of the KSA in international journals indexed in PubMed over a 5-year period, from 2008 to 2012. This study focused on the existing scientific publication processes in Saudi Arabia.

## MATERIALS AND METHODS

This was an observational study. Scholarly productivity takes several forms such as authorship of books, journal publications and presentations at conferences. However, for the purposes of this study, research productivity was defined as the authorship of articles published or accepted for publication by peer-reviewed journals indexed in PubMed only. Due to the lack of a “Gold Standard definition” on what constituted research productivity, we used our own definition being aware of its limitations.

PubMed was selected out of all the databases, being the online version of Medline, which covers data collection for medicine, nursing, dentistry, veterinary medicine, the health care system, and the preclinical sciences. PubMed currently containing over 17 million bibliographic citations and author abstracts from more than 5200 journals in 37 languages<sup>[11]</sup> was used for the following reasons:

- The specialization of PubMed in biomedical bibliography
- The limitation of the citations revealed by PubMed to articles whose first author is a Saudi scientist
- A free popular internet tool that provides access to bibliographic information, primarily drawn from Medline and pre-Medline, as well as publisher-supplied citations.

PubMed was searched for research articles published by “Saudi scientists” (for this article, this term includes Saudi or foreign scientists employed in KSA who are corresponding authors affiliated with any Saudi university/hospital/ministry of health). The keywords entered in PubMed to accomplish the objective of this study were “Saudi Arabia” as a country of affiliation. The study period chosen was January 1, 2008 till December 31, 2012. Fields of selected research were: Health sciences life sciences and basic sciences. “Limit Function” of the PubMed was used to refine the data and limit the search to medicine, biochemistry/molecular biology/ genetics, microbiology/immunology, pharmacology/ toxicology/ pharmaceuticals, psychology, health professions, neuroscience, nursing and dentistry. The sort order “Pub Date” was selected to sort out articles by publication date. We identified scientific publications within PubMed, which included original

works, reviews and case reports. Abstracts of meetings, corrections, news items, and book reviews were excluded. The search was completed within 2 hours on August 18, 2013 to guarantee unbiased results since PubMed was updated daily. By clicking “send to” button, entire data was downloaded and saved in a text file. In the validation phase, this text file was carefully reviewed for errors and false positive results. The articles that fell outside the biomedical field which was defined as any article reporting issue related to medical, biological or chemical research conducted to increase knowledge of medicine; OR articles in which the first author was not affiliated with KSA were labelled as false positive and eliminated. The same text file was then used in the extraction phase.

The extraction phase involved importing all identified articles into an Excel file in a tabular form for a manual search and further analysis. The five main fields of this excel file were authors’ names and full affiliation, year of publication, journal names, impact factors (IF), and type of study. In order to evaluate the journals that published these biomedical articles, the 2012 Science Edition of the Journal Citation Report (JCR) published by Thompson Reuters (New York, NY, USA) was utilized to retrieve Journal Impact Factor data. The JCR Science Edition was accessed as part of the Thomson Reuters web of knowledge package at its website.<sup>[12]</sup>

## RESULTS

A search of PubMed for publications affiliated to Saudi Arabia produced 1647 hits. These papers were then manually reviewed. Eighty-five papers were excluded because they were not associated with KSA, or their subject was not biomedical (false positives). This left 1562 biomedical papers affiliated with KSA published between 2008 and 2012.

The data for biomedical research production in KSA in last 5 years showed a clear linear increasing trend on a yearly basis [Figure 1]. There was a slight decline (7%) initially in publications from 2008 to 2009. However, after that, there was a continuous rise. The increase was more noteworthy in 2010 and 2012 in which publications increased 22.9% and 23.6%, respectively.

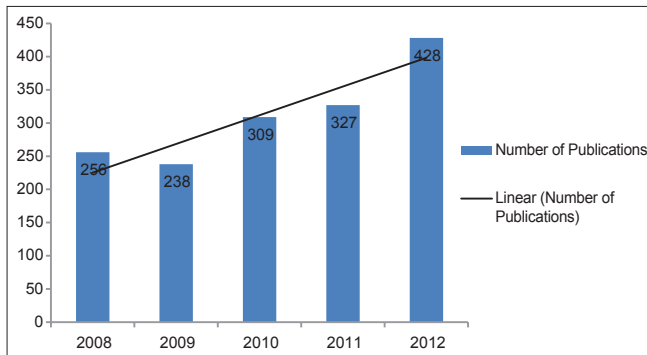
Riyadh was the main hub of medical and biomedical research activity [Table 1]. More than half (54.3%) of the Saudi citations originated from Riyadh, and 15.2% from Jeddah. Cities in the eastern province situated close to one another, Dammam, Dhahran, and Alkhobar, all together contributed 7% of research publications; other cities had little contribution.

The bulk of all publications (40.9%) originated from KSU [Figure 2]. About half of the articles were published in journals with an IF of <1, one-fourth were published in journals with no IF, and the remaining one-fourth in journals with a high IF ( $\geq 1$ ) [Table 2]. The highest impact-factor journals that published Saudi citations (2008-2012) was Lancet (IF = 39.06) [Table 3]. The contribution by the universities was the highest while university hospitals contributed the lowest in biomedical publications [Table 4]. Approximately, 76% of publications were original research articles [Table 5].

The university sectors accounted for approx. 54.6% of all biomedical publications between 2008 and 2012, with the bulk of all publications (40.9%) originating from KSU [Figure 2]. King Abdul Aziz University (KAU) and King Saud Bin Abdul Aziz University for Health Sciences were second and third with contributions of 13.6% and 9.8%, respectively. Of the hospitals, King Faisal Specialist Hospital and Research Center had the highest contribution (8.8%), followed by Riyadh Military Hospital (6.7%) and KAAU-Hospital (5.2) in the second and third positions, respectively [Figure 2].

## DISCUSSION

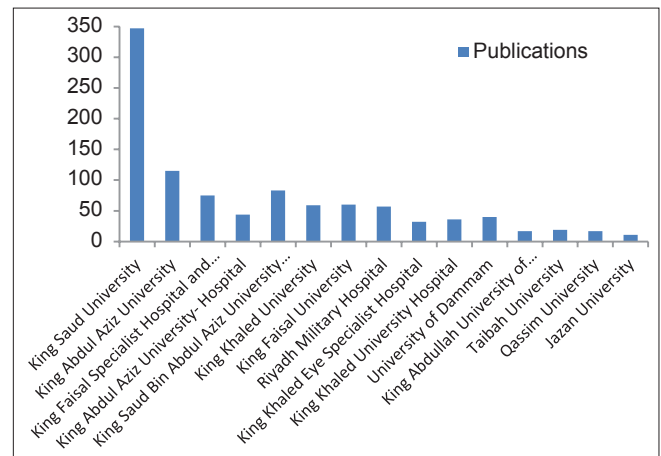
Biomedical research production in KSA in last 5 years showed a clear linear increase. This trend may be attributed



**Figure 1:** Year-wise distribution of medical and biomedical publications from Kingdom of Saudi Arabia from 2008 to 2012

to the realization by government of the importance of academic research as the pillar of human activity in the country. It improves the quality-of-life, brings long-term sustainable development and is the basis for further possible research. A report issued by the Ministry of Higher Education, showed that there had been a growth at the rate of 400% in Medicine and Medical Sciences related colleges in the KSA between 2003 and 2009.<sup>[13]</sup> According to Corbyn, the average annual spending in R&D increased from 600 million Saudi Riyals to 2 billion riyals in 2008, and was to increase over the next 5 years (starting from 2008) to 8 billion riyals.<sup>[14]</sup> According to the Ministry of Higher Education's forecast, the KSA would be recognized as a regional leader in science, technology, and innovation by 2015; an Asian power by 2020; and by 2025 would have changed into a knowledge-based economy and advanced industrial nation.<sup>[13]</sup>

According to the world bank statistics,<sup>[15]</sup> KSA spent 0.05% of its Gross Domestic Product (GDP) on R&D in 2004, which decreased to 0.04% in 2005 and 2006. This reduction might underlie the slight decline in publications observed in 2009. However, the government now invests heavily (0.08% of GDP) in R&D though this is still less than other countries such as Israel (4.46%), Korea (3.56%), Japan (3.36%), Germany (2.8%), and US (2.90%).<sup>[15]</sup>



**Figure 2:** Contribution of various institutes in Kingdom of Saudi Arabia to biomedical publications from years 2008 to 2012

**Table 1: Geographical distribution of biomedical research in KSA between 2008 and 2012**

	Riyadh	Jeddah	Abha	Al ahsa	Dammam	Dhahran	Khobar	Taif	Qassim	Makkah	Madina	Others
2012	213	82	22	13	16	7	6	8	11	4	14	32
2011	178	47	17	14	14	5	2	5	6	9	3	27
2010	188	32	13	16	18	5	9	6	8	4	2	7
2009	118	47	6	21	3	4	7	5	2	9	2	14
2008	151	30	10	24	5	2	5	6	2	3	3	15
Total	848	248	68	28	56	23	29	30	29	29	24	96
Percentage	54.3	15.2	4.4	5.6	3.6	1.5	1.9	1.9	1.9	1.9	1.5	6.1

KSA: Kingdom of Saudi Arabia

**Table 2: IF of the journals that published articles affiliated to Saudi Medical Institutions (2008-2012)**

Journal's IF	Number of articles (%)
No IF	367 (23.5)
<1	765 (48.98)
1-1.99	217 (13.89)
2-2.99	116 (7.43)
3-3.99	53 (3.39)
4-4.99	18 (1.15)
5-5.99	19 (1.22)
6-6.99	3 (0.19)
≥7	4 (0.26)
Total	1562

IF: Impact-factor

**Table 3: Highest IF journals that published Saudi citations (2008-2012)**

Journal name	IF
Lancet (2012)	39.06
Gastroenterology (2009)	18.82
Circulation (2010)	15
Acta neuropathol (2010)	9.7

IF: Impact-factor

**Table 4: Relative contribution of the university sector, university hospitals, and other institutes in biomedical publications**

Institutes	Publications	Percentage
Universities	853	54.6
University hospitals	101	6.5
Others (hospitals, research centers, ministry of health)	608	38.9

**Table 5: Different article categories in biomedical publications**

Article category	Number of articles	Percentage
Original	1182	75.99
Case report	243	15.56
Review	137	8.45

This study found that the hospitals and research centers in KSA had made a very limited contribution to international medical publications. Most publications resulted from work conducted by universities/medical colleges. The location of these institutions in the capital city of Riyadh or its suburbs explains the data of Table 1, KSU the country's topmost university in research and King Faisal Specialist Hospital and Research Center, one of the kingdom's top research hospitals are both in Riyadh. KAAU the second in the rank of publications from universities (13.6%) accounted for 15.2% of publications from Jeddah.

A detailed analysis of IFs of journals that published biomedical research from KSA revealed that only a small fraction of papers 4 (0.26%) appeared in the journals with a high IF ( $\geq 7$ ) listed by JCR 2012 Science Edition. These journals were Lancet (39.06), Gastroenterology (18.82), Circulation (15), and ActaNeuropathol (9.7). The principal journal destination was the Saudi Medical Journal with an IF of 0.619, where 545 (34.9%) of the total of 1562 articles were published. This was followed by Neuroscience (Riyadh) with an IF of 0.317 in which 198 (12.7%) articles were published. About half of the articles were published in journals with IF of  $< 1$ , one-fourth were published in journals with no IF, and the remaining one-fourth in journals with varying IF between 1 and 7. We infer from this that most publications were in journals without a calculated IF or with a low IF, and that publications in high impact-factor journals were almost non-existent.

Next, we examined the relative contributions of the different types of institutions that is, universities versus others like hospitals, research centers and Ministry of Health. A point worth noting here is that all publications in high IF journals were from hospitals, research centers, and the Ministry of Health. None of the high IF publications were from any of the kingdom's universities or teaching hospitals affiliated with universities. Universities contributed 853 papers (54.6%), teaching hospitals 101 papers (6.5%), and hospitals that were not explicitly affiliated to medical colleges contributed 608 papers (38.9%).

Another finding of this study was the inability of the new universities to produce a significant number of biomedical publications. It could be argued that the newer medical colleges were created principally to educate and train more health workers and provide clinical service to their local populations. However, we believe that a medical college should actively engage in research, and that "education pedagogy" should go hand in hand with research training. Furthermore, the promotion of academic staff in KSA depends on the number of their publications in scientific journals, signifying that research and publication are considered part of the mission of all Saudi medical colleges. We also believe that a comparison of universities was unfair since there are very old and new universities. For example, KAAU and KSU produced relatively more publications in 5 years. These two universities are the oldest in the country and, therefore, most of their academic staff has experience in dealing effectively with many of the barriers to research such as teaching overload, lack of funding/research grants, and technicians. These two universities also have better infrastructure, human resources, facilities, and funds than some of the other universities.

Another thing that was evident from our results was the spread of research culture and facilities from the capital city, Riyadh to other cities of KSA. A previous study stated that biomedical research productivity from Riyadh in 1988 to 2000 was 70%, and all the remaining cities together as 30%.<sup>[4]</sup> We observed that cities other than Riyadh are at present contributing a lot to research. This change is possibly due to the establishment of new universities, medical colleges, hospitals, and research centers in these cities.

A comparison of the results of our study with those of other studies is difficult due to the disparities in the definitions and methodologies used. While some authors defined research productivity as the “publication counts,”<sup>[16]</sup> others included the journal’s IF,<sup>[17]</sup> research grants,<sup>[18]</sup> and citation counts<sup>[19]</sup> in the definition. Then, there are variations in the way data were collected. While some authors used PubMed,<sup>[20]</sup> others used Science Citation Index-expanded.<sup>[4,21]</sup> Some authors relied on the data provided by the website,<sup>[4]</sup> others manually searched the data to exclude false positive results.<sup>[20]</sup> Such disparities in the definitions and methodologies make comparison difficult and may lead to conflicting deductions.

## CONCLUSION

The general conclusion drawn from this study on research productivity and is that research in KSA is on the increase. Nevertheless, there is always room for improvement. In order to further increase research output of KSA to the level of western countries, it is the duty of Saudi academics to set strategic goals for research. This should include training, and most importantly the provision of adequate and sustained funding for this crucial activity by government. Both short-term and long-term targets should be set, and performance against the targets monitored and assessed on a regular basis.

## STRENGTH AND LIMITATIONS

This is the first study which has analyzed biomedical research productivity in KSA in the last 5 years. We collected data from highly reliable sources in the scientific literature such as PubMed and ISI web of knowledge. The best was done to avoid flaws that are inevitable when probing scientific bibliographic databases. Each citation was handled manually which though time consuming helped to exclude false positives. These citations may appear twice with slightly different details. We acknowledge that there are certain limitations to present study: (1) Our study provides only a quantitative analysis of the number of publications, and does not discuss their quality or their worth and benefits to the general public. They are only

intended to give an idea of the level of research activity in the medical field in Saudi Arabia. (2) We used Journal IFs to give a sense of the quality of the publications, but whether they reflect the true quality of the journal is a matter for debate. Some authors support the use of IFs as a clue to the quality of publications.<sup>[22,23]</sup> While others are wary of such an approach.<sup>[24,25]</sup> It is also important to stress that the IF or the count of the number of publications does not indicate the value of these publications to the local community.<sup>[26]</sup> (3) We searched journals indexed in PubMed database. Therefore, our search missed papers published in local journals and other periodicals, none of which are indexed by PubMed. Furthermore, PubMed uses the first author’s affiliation as the country of the publication’s origin, which means that collaborative publications in which the first author is not affiliated to Saudi Arabia were missed. It has been estimated that using PubMed leads to underreporting by about 15%.<sup>[22,27]</sup> Even if that is the case, the increase in the number of publications of KSA will only be by about 234 articles, and that will have a negligible effect on the principal findings of this study. Consequently, the results of this study should be interpreted in the context of these limitations.

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