The Scientific Productivity of Arab Countries in the MENA Region: A Comparative Study with Three Non-Arab Countries

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ABSTRACT

Objectives: In the present study, we aimed to evaluate the scientific productivity of middle and high-income Arab countries of the Middle East and North Africa (MENA) region in the past 10 years and to compare this output with primary reports affiliated to three non-Arab countries of MENA region.

Methods: We included primary reports that are indexed in PubMed or SCI-expanded and were conducted within the middle and high-income Arab countries of the MENA region. The retrieved records were compared to primary reports conducted within the following non-Arab countries of the MENA region: Iran, Israel, and Turkey. The online search was limited between 1st January 2008 and 31st December 2017. The statistical analysis was carried out with SPSS software version 24.

Results: Egypt was the leading Arab country in the number of published original articles that was indexed in PubMed (N =1941) and SCI-expanded (N =745), followed by Saudi Arabia, Lebanon, and United Arab of Emirates. In total, the number of PubMed or SCI-indexed original articles, conducted within non-Arab MENA countries, was higher than those conducted within Arab countries, the difference between both groups was statistically significant (p =0.008). In total, the Arab countries had a statistically significant lower number of registered clinical trials compared to non-Arab countries of the MENA region (3150 vs. 8139 records, respectively; p= 0.012).

Conclusions: In conclusion, the past decade showed a prominent increase in the scientific productivity and performance of middle and high-income Arab countries; however, their scientific productivity is still lower than other countries in MENA region.

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1. Introduction:

Clinical research aims to answer a specific question regarding the biochemical or behavioral relations between **the** health conditions and human. The benefits of clinical research include not only the safety and efficacy of new drugs but also the causes of diseases and the proper prevention strategies (DiMasi et al., 2016; Lang & Siribaddana, 2012; Grant et al., 2005). On the other hand, this type of research needs a large number of physicians and specialized researchers who are aware of clinical research procedures and ethical rules. Moreover, it needs at least one to four years of hard work accompanied by spending huge sums to get valuable results (Giffin et al., 2010). Therefore, clinical research is based on the availability of funding sources, moral, and political support (Chatterjee & Srinivasan, 2013). Accordingly, the conduction of clinical research in developing countries faces many challenges (Holland, 2013).

Arab nations and Middle East countries try to overcome these challenges and participate in this scientific race. Despite the economic and political situation of these countries, some States have begun to register some new figures in this regard (Ali et al., 2017). Over the period from 2001 to 2005, about 16 Arab countries published 5775 original articles in high indexed peer-reviewed international journals. However, the output of these countries combined in these four years did not exceed half of what Israel (n= 13637) or Turkey (n= 10087) produced in the same period

(Benamer & Bakoush, 2009). These results are somewhat shocking because this is indicative of the fact that these countries do not give priority to this side like other countries such as Israel, Turkey, and Iran. This significant difference may be due to the funding support and political facilities provided by these countries for clinical trials. Recently, the number of publications of Arab nations increased from 15,868 to 35,211 in one decade. Moreover, the scientific contribution of Arab nations to all published literature within PubMed increased from 0.38 to 0.6% over two decades. Despite this increasing trend, the number of international publications from Arab countries was reported to not correspond to the rapid population growth and high incidence of chronic diseases (Bredan et al., 2011).

In the present study, we aimed to evaluate the scientific productivity of middle and high-income Arab countries of the Middle East and North Africa (MANA) region in the past 10 years and to compare this output with primary reports affiliated to the following non-Arab countries of MENA region: Iran, Israel, and Turkey.

2. Methodology:

In the present comparative study, we systematically compared the number and impact factors of primary studies conducted within Arab and non-Arab countries of the MENA region.

2.1. Inclusion and Exclusion Criteria:

We included primary reports that are indexed in PubMed or SCI-expanded and were conducted within any of the following middle and high-income Arab countries of MENA region: Egypt, Algeria, Bahrain, Iraq, Jordan, Kuwait, Lebanon, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, or United Arab Emirates. The retrieved records were compared to primary reports conducted within the following non-Arab countries of the MENA region: Iran, Israel, and Turkey. In addition, we included clinical trials records available in ClinicalTrials.gov that were affiliated to any of the abovementioned countries.

We excluded non-biomedical articles, review articles, conference abstracts, editorial commentaries, and thesis.

2.2. Search Strategy:

Our search was limited between 1st January 2008 and 31st December 2017. Published records were retrieved from the following databases:

2.2.1. SCI-expanded

Firstly, SCI sensitive search field tag "cu" was used to search for the name of the country e.g. cu = Egypt to retrieve all publications conducted within Egypt. Then the retrieved records were refined to original research articles only; the results were limited to biomedical field only. We then exported the number of retrieved records, research fields, number of articles highly cited n the field, the impact factor, and the *h*-index.

2.2.2. PubMed:

We used the advanced search tool of PubMed to retrieve the indexed articles according to their affiliations, the filter functions were then used to limit the retrieved records to original articles only.

2.2.3. Clinicaltrials.gov:

We used the "studies map" and "advanced search" functions and retrieved the studies registered at ClinicalTrials.gov and for which the included countries are among the participating sites.

2.3. Statistical Analysis:

The statistical analysis was carried out with SPSS software (Statistical Package for the Social Sciences, version 24, SSPS Inc, Chicago, IL, USA). Frequency tables with percentages were used for categorical variables and descriptive statistics (mean and standard deviation) were used for numerical variables. Tests of association were carried out using Chi-square test for categorical variables and Mann-Whitney test for numerical variables. A p-value of less than 0.05 was considered statistically significant.

3. Results:

Throughout the past 10 years, Egypt was the leading Arab country in the number of published original articles that was indexed in PubMed (N =1941) and SCI-expanded (N =745), followed by Saudi Arabia, Lebanon, and United Arab of Emirates. However, Turkey had the highest number of original articles indexed in PubMed (N = 12994) and SCI-expanded (N = 2231) among all MENA countries. Notably, 35% of the SCI-expanded publications from Egypt were within the Gynecological or surgical fields, while oncology field shared by 15% of the total publications; however, internal medicine-related articles constituted the majority of publications (30%). Similarly, internal medicine and oncology constituted the majority of the published reports from Saudi Arabia, Lebanon, United Arab of Emirates, and Qatar. Regarding the non-Arab countries, general internal medicine, cardiovascular medicine, and oncology constituted the majority of the published reports from Turkey and Iran (Table.1).

In total, the number of PubMed-indexed original articles, conducted within non-Arab MENA countries, was higher than those conducted within Arab countries, the difference between both groups was statistically significant (4344 vs. 27781 articles, respectively; p =0.008). Similarly, the number of SCI-expanded indexed publications from Arab countries was

Table 1: *The publications status of the included countries.*

Category	Country	Number of PubMed-index Publications (%)	Number of SCI-index Publications (%)	Number of Publications according to specialty (%)					Number of Articles highly cited in the field
				Gyna. & Obs.	Internal Medicine	Oncology	CVS	General Surgery	
Arab	Egypt	1941 (44.7)	745 (31.2)	148 (19.9)	226 (30.3)	105 (14)	52 (9.6)	115 (15.4)	7
	Algeria	18 (0.4)	14 (0.5)	-	9 (64.2)	4 (28.6)	-	-	1
	Bahrain	11 (0.2)	20 (0.8)	-	16 (80)	2 (10)	3 (15)	1 (5)	1
	Iraq	65 (1.4)	23 (0.9)	-	-	-	-	-	2
	Jordan	244 (5.6)	107 (4.4)	11 (10.2)	32 (29.9)	15 (14)	10 (9.3)	8 (7.5)	0
	Kuwait	99 (2.2)	92 (3.9)	3 (3.3)	47 (51.1)	2 (2.2)	9 (9.8)	11 (11.9)	1
	Lebanon	560 (12.9)	222 (9.3)	9 (4.1)	101 (45.5)	45 (20.3)	22 (9.9)	7 (3.2)	5
	Morocco	54 (1.2)	34 (1.4)	-	11 (32.4)	11 (32.4)	-	1 (2.9)	1
	Oman	44 (1.01)	4 (0.1)	-	2 (50)	-	-	-	0
	Qatar	170 (3.9)	434 (18.2)	19 (4.4)	137 (31.7)	60 (13.8)	14 (3.2)	31 (7.1)	9
	Saudi Arabia	681 (15.7)	502 (21.04)	-	273 (54.4)	71 (14.1)	75 (14.9)	45 (8.9)	15
	Syria	34 (0.7)	11 (0.5)	1 (9)	3 (27.1)	2 (18.1)	1 (9)	1 (9)	11
	Tunisia	190 (4.3)	49 (2.05)	1 (2)	23 (46.9)	13 (26.5)	5 (10.2)	1 (2)	2
	UAE	233 (5.3)	128 (5.4)	6 (4.7)	48 (37.5)	12 (9.4)	10 (7.8)	12 (9.4)	8
	Total	**4344**	**2385**	**199**	**928**	**342**	**201**	**233**	**63**
Non-Arab	Iran	7670 (27.6)	2229 (34.2)	182 (8.9)	1045 (44.6)	66 (3.2)	31 (1.5)	182 (8.9)	126
	Israel	7117 (25.6)	2054 (31.5)	110 (4.9)	915 (44.5)	326 (14.6)	311 (13.9)	125 (5.6)	5
	Turkey	12994 (46.8)	2231 (34.3)	151 (6.8)	760 (34.1)	244 (10.9)	246 (11)	338 (15.1)	45
	Total	**27781**	**6514**	**443**	**2720**	**636**	**588**	**645**	**176**
P-value		**0.008**	**0.008**	**-**	**-**	**-**	**-**	**-**	**0.04**

significantly lower than in non-Arab countries (2385 vs. 6514 articles, respectively; p =0.008).

With regard to biomedical research performance of_ MENA countries, the_ average_ impact factor of the original articles conducted within Arabic countries was 11.9, compared to an average impact factor of 16.86 from non-Arab countries (p =0.612; Figure 1). Similarly, there was no statistically significant difference between Arab and non-Arab countries in terms of average *h*-index (15.9 vs. 40.98, respectively; p =0.09; Figure 2); however, the number of articles highly cited in the field was significantly higher in non-Arab countries compared to Arab countries (58.6 vs. 4.5; p =0.04).

In terms of registered clinical trials at ClinicalTrials.gov in which Arab countries are one of the contributing sites, Egypt had the highest number of registered, as well as completed, clinical trials; followed by Saudi Arabia, Lebanon, and Tunisia. Notably, Israel was one of the contributed sites in 5024 registered trials, making it the MENA country with the highest number of registered trials, followed by Turkey and Iran. In total, the Arab countries had a statistically significant lower number of registered clinical trials compared to non-Arab countries of the MENA region (3150 vs. 8139 records, respectively; p= 0.012) (Table.2).

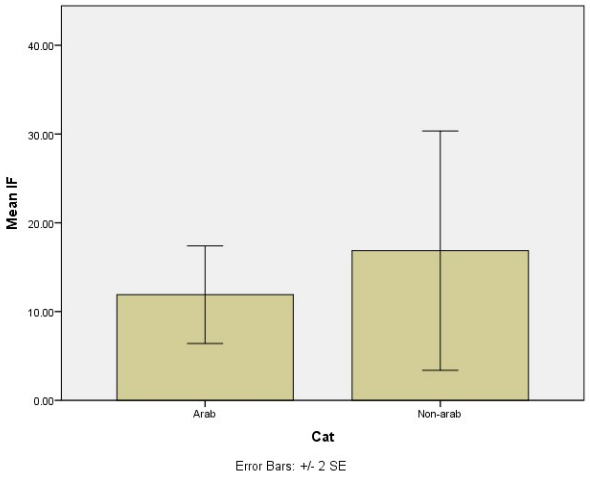

Figure 1. Impact Factor of Arab and non-Arab Publications.

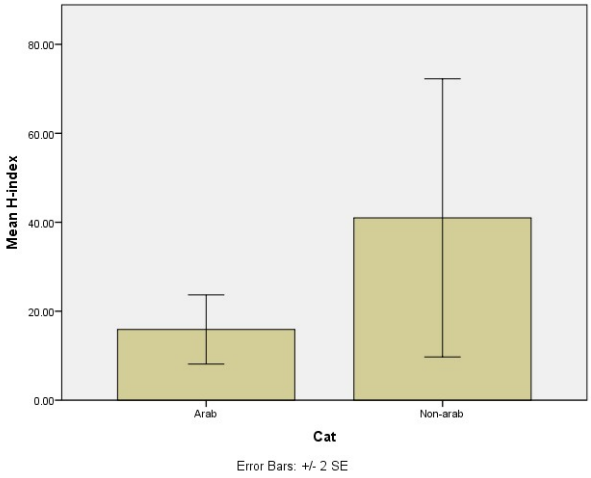

Figure 2. h-index of Arab and non-Arab Publications.

4. Discussion:

In the past seven decades, biomedical research has played a critical role in the outstanding advancements in healthcare services. Thus, the scientific activities and productivity of individual countries are key factors which drive the country's role in improving the quality of healthcare services and citizens' well-being (Nass et al., 2009). MENA region is a trans-continental area of a group of countries tied together by economic, cultural, and academic relationship. In early centuries, MENA countries were considered as the land of sciences; however, the current figures showed a major lag in the scientific productivity of those countries compared to other regions (Nair et al., 2013). Arab countries constitute the majority of MENA region with an overall population of approximately 409 million inhabitants, exceeding the total population size of other three non-Arab countries within the MENA region (Turkey, Iran, and Israel) by almost 240 million inhabitants (Unies,

Table 2: *The clinical registry status of the included countries*

Category	Country	Number of Registered Trials	Number of Completed Trials
Arab	Egypt	1736	117
	Algeria	46	12
	Bahrain	16	1
	Iraq	19	0
	Jordan	113	20
	Kuwait	40	10
	Lebanon	303	70
	Morocco	66	23
	Oman	18	6
	Qatar	64	9
	Saudi Arabia	376	62
	Syria	59	3
	Tunisia	203	48
	UAE	91	26
	Total	**3150**	**407**
Non-Arab	Iran	852	28
	Israel	5024	708
	Turkey	2263	515
	Total	**8139**	**1251**
P-value		**0.012**	**0.001**

2017). Moreover, the Arab countries showed a striking increase in the incidence of chronic diseases and disabling conditions throughout the past decades (Mokdad et al., 2014). Therefore, it is expected that the scientific activities and productivity of Arab countries are high to meet the increased demands of their populations.

A growing body of evidence has shown considerable growth in the number of scientific activities from Arab countries with 50% increase in the number of PubMed-indexed publications between two decades (Bredan et al., 2011). For example, a prominent increasing trend is observed for biomedical research production from Lebanon and the United Arab Emirates in the past two decades (Bissar-Tadmouri & Tadmouri, 2009). Similarly, the number of scientific publications from Egypt and Saudi Arabia has increased exponentially from 1996 to 2010 (Afifi, 2007; Helal et al., 2014). Despite these increasing trends, it was reported that the scientific publications from Arab countries represent less than 1% of all PubMed-indexed publications (Bredan et al., 2011), which does not match with the contribution of these countries to the global population or their high disease burden.

Moreover, the scientific production of middle and high-income Arab countries of the MENA region was reported to be lagging behind other countries within the

same region. Benamer and Bakoush (2009) compared the scientific performance of Arab world to other Middle Eastern non-Arab countries during 2001-2005, Arab countries published significantly lower PubMed and SCI-expanded indexed original articles than Turkey, Iran, and Israel. Moreover, the publications from the Arab countries also have significantly lower citations frequency. In continuation of this effort, we compared the number of Arab countries-affiliated original articles, which are either PubMed or SCI-expanded indexed, to the number of those affiliated to non-Arab countries. Our results showed that the contribution of Arab countries to PubMed and SCI-expanded original articles was significantly lower than Turkey, Iran, and Israel. In addition, the number of articles highly cited in the field was significantly higher in non-Arab countries compared to Arab countries. Like our findings, Sweileh and colleagues (2015a), found that the scientific productivity of Arab countries in the field of infectious disease was apparently lower than the scientific production from the three non-Arab countries. Another report showed similar results in the field of obesity-related research (Sweileh et al., 2014). While an additional report showed that the research productivity related to breast cancer from Arab countries was lower than that of Israel and Turkey (Sweileh et al., 2015b).

This constant lagging of the Arab countries' scientific production in the past decades can be attributed to many factors. Firstly, lack of resources, infrastructure, and the extremely low expenditure on research in some countries may partly explain such difference in the scientific productivity (Tijssen, 2007), especially with the high rates of brain drain in some Arab countries due to the lack of proper resources (Aboulghar, 2011). However, lack of resources and low expenditure do not fully explain this low productivity as a recent report showed a slight increase in the number of published reports from upper-income Arab countries compared to more than 300% increase in upper-middle Arab countries (Bredan et al., 2011).

Another possible explanation is the tendency of Arab scientists to publish their work in local journals and conferences rather than pursuing international well-recognized publications (Bredan et al., 2011). Although there is no clear evidence that explains this tendency, it can be assumed that the lack of proper education about the importance and process of international publication lead Arab scientists to publish their work locally. Additionally, the international publication was not a requirement for academic promotion in most of the Arab universities till recently. The slow growth of the scientific productivity of Arab countries can be also explained by the regional instability and conflicts in the past decades (Tadmouri & Bissar-Tadmouri, 2013).

We observed a significant variation in the scientific productivity of the Arab region at the country level as well. The majority of published original articles, indexed in PubMed and SCI-expanded, came from Egypt; which was followed by Saudi Arabia, Lebanon, and United Arab of Emirates. Publications from these countries in the past 10 years represented 78% of the total publications affiliated to Arab countries. These results are in concordance with previous reports that showed that Egypt produced almost 35% of the articles that come from Arab countries; and that both Egypt and Saudi Arabia produced almost 60% of the research generated by the Arab world (Benamer & Bakoush, 2009; Shaban & Abu-Zidan, 2003).

Although assessing the quantity of research output of Arab countries is a valid proxy for the scientific productivity of those countries, the importance of the relative quality of such productivity has become evident (Benamer & Bakoush, 2009); Sebire, 2008). In the present study, we used three indicators to evaluate the academic performance of Arab-affiliated clinical research production. Impact factor, which measures the citations frequency per average published articles in particular year, has been widely used as a proxy for journal quality and impact. While *h*-index is calculated as published papers (N) that have been cited N or more times, thus, it measures the quantity (and the quality of the publication (Garfield, 2006; Díaz et al., 2016). Our analysis showed that the average impact factor and *h*-index of non-Arab countries publications were prominently higher, however, it does not reach the level of statistical significance. On the contrary, the number of articles highly cited in the field was significantly higher in non-Arab countries compared to Arab countries. Benamer and Bakoush (2009) reported that the number of publications in top medical journals, the impact factor, and the *h*-index were all significantly higher in the three non-Arab countries. Similarly, the *h-i*ndex of breast cancer documents published from Arab countries was much lower than that of Israel, though it was higher than that of Turkey and Iran (Sweileh et al., 2015b).

5. Conclusion:

In conclusion, the past decade showed a prominent increase in the scientific productivity and performance of middle and high-income Arab countries; however, their scientific productivity is still lower than in other countries in the MENA region. Future research should be directed toward investigating the causes and strategies to improve the biomedical research status in Arab countries.

Conflict of Interest:

All authors confirm no financial or personal relationship with a third party whose interests could be positively or negatively influenced by the article's content.

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