

## Stroke in the Arab World: A bibliometric analysis of research activity (2002–2016)



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### ABSTRACT

**Background:** The Arab world has an increasing prevalence of strokes, a leading cause of death in this part of the world.

**Aims:** The aim of this article is to quantify the stroke research activity in the Arab countries over the past 15 years taking into consideration the population, GDP, and DALY of each country.

**Methods:** A PubMed search was conducted to find stroke research articles published from the Arab countries between 2002 and 2016 (inclusive). Medical subject headings related to strokes and author origin/affiliation were used for this purpose.

**Results:** The Arab world only produced 0.51% of all the stroke-related publications on PubMed even though the stroke-related DALY percentage in this region was greater than 2.88% during the period we studied. In general, the number of publications increased in the last few years. Somalia came first regarding the percentage of stroke to non-stroke publications released. Lebanon had the highest number of publications per GDP (in US Billion Dollars), Qatar had the highest number of publications per million persons (PPMP), while Saudi Arabia had the highest number of publications per 1% of stroke DALY. In addition, a strong positive correlation was found between the number of stroke publications and GDP; however, the correlation between the number of stroke publication and either population size or DALY was a weak positive one.

**Conclusions:** A general increase in publications is noticed, but stroke research activity in the Arab world is still poor compared to other parts of the world.

### 1. Introduction

The Arab world, also known as the Arab nation, currently consists of the 22 Arabic speaking countries of the Arab League. These Arab states occupy a major part of the world, covering huge areas of Asia and Africa. When compared to Western and other Eastern populations, several characteristics of the Arab countries such as their life style and diet affect their stroke risk, type, and survival after stroke [1]. Stroke is the second leading cause of death and the third leading cause of disability-adjusted life-years (DALY) around the world [2].

From 1990 to 2013, a significant increase in stroke incidents and deaths for Ischemic and Hemorrhagic strokes as well as the number of DALYs due to ischemic stroke was recorded [3]. In the year 2013, 6.5 million deaths and 113 million DALYs were recorded due to strokes [3]. There is a significantly greater contribution of stroke deaths and stroke-

related DALYs in low and middle income countries than high income ones [4]. This can be explained by the lack of management and treatment of risk factors in developed countries [5,6]. From the 22 Arab countries, 16 countries belong to the low and middle-income economic groups [7].

Within the Arab world, stroke disease burden varies greatly. For example, the percentage of DALYs due to stroke is over 4% in Egypt, United Arab Emirates, and Tunisia in 2016, but less than 2% in Bahrain, Djibouti, and Qatar (Fig. 1). The relative burden has also changed differently in the Arab world between 2002 and 2016, for it has increased in some countries but decreased in others. However, according to the WHO Global Burden of Disease estimates from the University of Washington's Institute for Health Metrics and Evaluation, the overall average of stroke-related DALY percentage has decreased from 3.01% (2002) to 2.88% (2016) in the Arab countries [8].

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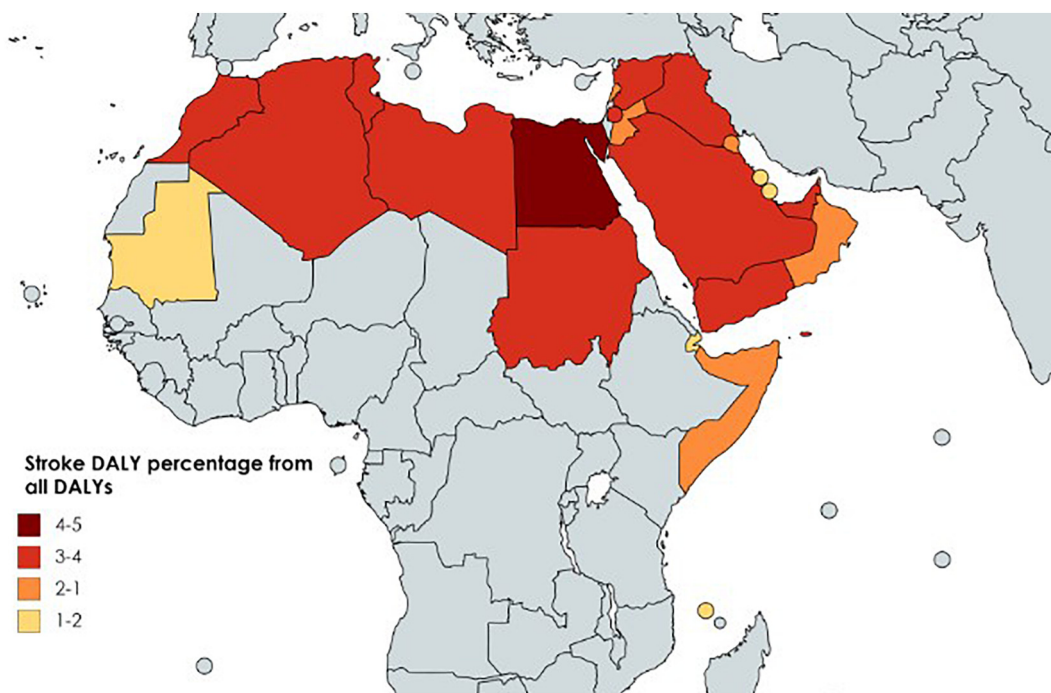


Fig. 1. Stroke DALY percentage from all DALYs in the Arab world.

Stroke was the leading cause of death in middle-income countries in 2010, which included Algeria, Egypt, Iraq, Jordan, Lebanon, Libya, Morocco, Palestine, Sudan, Syria, and Tunisia [9]. On the other hand, in low-income countries (Comoros, Djibouti, Mauritania, Yemen, and Somalia), stroke was in the top ten causes of death, ranking fifth in 2010 [9]. The global burden of stroke continues to increase, where it is expected that stroke will move to the fourth place as the commonest cause of an ongoing disease burden by 2020 [10]. Based on what we have mentioned, there is a serious need for an active stroke-related research activity in the Arab world.

## 2. Aims

The aim of this article is to examine the research activity related to stroke in the Arab world through the quantification of the published articles. For this purpose, we will find the number of publications released on strokes per country by checking the author location according to institutional affiliation from 2002 to 2016 (inclusive).

## 3. Methods

To find publications related to strokes, we conducted a search using the database PubMed provided by the National Center of Biotechnology Information (NCBI) during the month of July 2017. For the purpose of this study, the following 22 Arab countries were included: Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine (West Bank and Gaza), Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen.

For each country, we obtained the yearly population size from the Population Reference Bureau (PRB) [11], gross domestic product (GDP) from the World Bank [12], and the percentage of DALYs due to stroke from WHO Global Burden of Disease [8]. Then, in order to remove bias between Arab countries, we divided the total number of publications released in each country by the average of its population size, GDP value, and DALY percentage due to stroke-only during this period. This gave us the corresponding number of publications per million persons (PPMP), per billion GDP, and per 1% DALY due to stroke for each

country. For example, Comoros has an average of 1.79% stroke-related DALYs from total DALYs while Egypt has 4.59%. We divided the total number of stroke publications of Comoros by 1.79, and that of Egypt by 4.59 to standardize the stroke-related research output of both countries with respect to DALY.

Finally, the relationship between the average number of stroke research publications produced over this 15-year period with respect to the population size (in millions), GDP (in billions of US dollars), and burden of stroke disease (DALYs) of the Arab countries was assessed by linear regression using SPSS.

## 4. Search strategy and selection criteria

To sort out the publications by their primary institution of publication, we used the Boolean operator (AND, OR and NOT) and the [ad] operator to indicate the country of publication we are looking for and exclude other countries. Related publications were identified by searching for the following terms: “stroke”, “cerebrovascular accident”, “CVA”, “ischemic stroke”, “Cerebral He(a)morrhage” and “subarachnoid He(a)morrhage”. For example, to find Stroke related publications in Bahrain, we searched for: “Stroke” [mesh] OR “Ischemic Stroke” [mesh] OR “Cerebral He(a)morrhage” [mesh] OR “Subarachnoid He(a)morrhage” [mesh] AND “Bahrain” [ad]. Moreover, we indicated the publication date filter to be from 2002 until 2016 (inclusive). The publications from Lebanon County, Pennsylvania (US) were excluded.

## 5. Results

The average population size, gross domestic product (GDP) and stroke related DALY percentage for the 22 Arab countries over the 15 years period (2002–2016) is shown in Table 1. From 2002 to 2016, the Arab world had only published 511 publications (0.51%) from the 100,029 stroke related publications released on PubMed (Table 2), even though stroke accounted for more than 2.8% of the Arab disease burden, as measured by DALYs over this period (Table 1).

In the Arab countries, the percentage of stroke to non-stroke publications ranged from zero in Algeria, Comoros and Mauritania to a

**Table 1**  
Average population (Millions), GDP (USD Billions) and stroke related DALY percentage for the Arab countries (2002–2016)/\*\* (West Bank and Gaza).

Saudi Arabia	27.8	496.9	3.24	HIC
Somalia	9.4	5.8	2.02	LMIC
Sudan	39.3	54.5	3.04	LMIC
Syria	19.9	37.5	3.62	LMIC
Tunisia	10.5	39.3	3.92	LMIC
United Arab Emirates	6.3	271.9	3.88	HIC
Yemen	23.4	26.2	3.06	LMIC
Average	15.88	85.94	2.88	–

**Table 2**  
Number of publications and percentage of Stroke to Non-stroke publications. \*\* (West Bank and Gaza).

Kuwait	25	4617	4642	0.54
Lebanon	48	7239	7287	0.66
Libya	2	700	702	0.29
Mauritania	0	52	52	0
Morocco	29	5325	5354	0.54
Oman	21	3571	3592	0.59
Palestine**	4	949	953	0.42
Qatar	42	4506	4548	0.93
Saudi Arabia	136	32,768	32,904	0.42
Somalia	1	34	35	2.94
Sudan	4	2066	2070	0.19
Syria	1	998	999	0.1
Tunisia	32	10,633	10,665	0.3
United Arab Emirates	18	4482	4500	0.4
Yemen	5	781	786	0.64
Total	511	130,033	130,544	0.39

maximum of 2.94% in Somalia and 1.41% in Djibouti. Regarding the number of stroke-related articles published in the Arab countries, Egypt ranked the second (79 publications) after Saudi Arabia who had released a total of 136 publications (Table 2).

However, the population size should be considered when comparing these countries to avoid any kind of bias. MEDLINE publications (1988–2002) showed that, when normalized to population size, Arab countries with relatively small population size (e.g., Kuwait and Lebanon) were more productive as they had higher PPMP than the largest Arab publishers such as Egypt and Saudi Arabia [13]. Therefore, we calculated the PPMP using the average population size for each country during this period. In PPMP, Qatar ranked first with 30 publications and Bahrain ranked second with 14 publications per million persons (Fig. 2).

Moreover, given the fact that most research work needs funding, economic performance should be taken into consideration. Knowing that GDP has long been the most widely used measure to assess national economies and compare between them [14], we calculated the average

gross domestic product (GDP) for these countries during this period. Then, we obtained the number of publications per billion USD and found that Lebanon had the highest value of approximately 1.446 and Jordan came closely as second with an insignificantly lower value of 1.441 (Fig. 3).

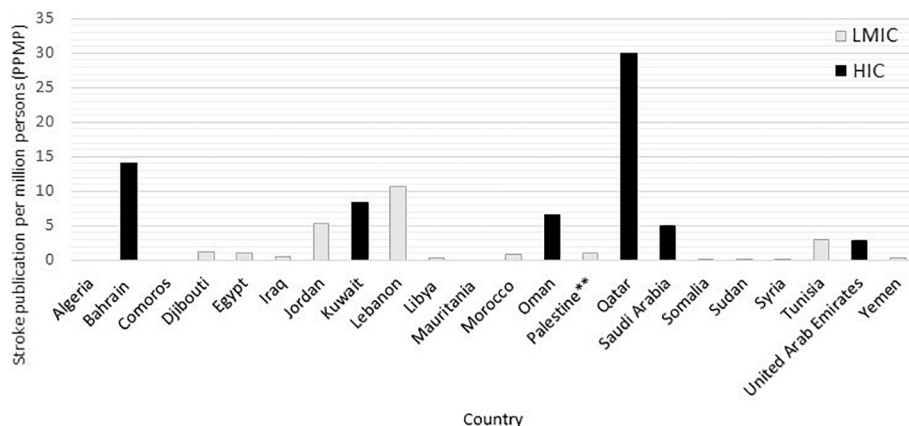
The fact that the burden of stroke differs between Arab countries as reflected by DALYs might account for the variation in the number of stroke publications as well. Researchers and funding agencies in countries with higher stroke DALYs are expected to be more interested in stroke-related research than countries with lower DALYs are. Saudi Arabia ranked first in number of stroke publications per 1% DALY with 41.98 publications, followed by Qatar with 23.6 publications (Fig. 4).

The number of publications was compared by country population (Millions), GDP (Billions US\$) and DALYs. In the Arab world, there was a strong positive correlation between the number of stroke publications and the GDP ( $r = 0.79$ ) (Fig. 5). Moreover, a weak positive correlation was found between the stroke publications and population size ( $r = 0.37$ ), and between stroke publications and DALYs ( $r = 0.28$ ).

### 6. Discussion

Although Saudi Arabia and Egypt had the highest number of stroke publications in the last 15 years. It is crucial to normalize the number of publications by different indicators. These indicators include: population size, GDP and DALYs and may impact research activity assessment greatly [15]. This became evident as Qatar had the highest research activity when we normalized to population size, Lebanon when we normalized to GDP and Saudi Arabia when we normalized to DALY. From the three different normalizing measures, we found GDP to be the most representative of stroke publication output because of the strong positive correlation they exhibited. Population size and DALY had a weaker positive correlation. Therefore, the number of publications per billion USD is the best measure to assess and compare the stroke publication output of the various Arab countries. Lebanon might be one of the most active stroke publishers seeing as stroke is its second leading cause of death accounting for 40 deaths per every 1000 population [16,17]. Consequently, stroke can be perceived as a high morbidity disease that highly burdens Lebanon from all perspectives: governmental, academic, institutional, healthcare provider wise, and the consequent social perspectives. Studies are still lacking regarding these aspects, and research is encouraged to generate data and help decision makers with policymaking.

As our results indicated, only 0.51% of the publications related to strokes that had been released in the past 15 years were published in Arab countries. Although our results show that the study of stroke exhibited a general upward trend over the past 15 years (Fig. 6), the Arab world is still lagging behind other regions. As an example, the United States alone holds 26,058 publications, or 26.05% of all stroke



**Fig. 2.** Stroke publication per Million Persons (PPMP) values for the Arab countries. (2002–2016)/\*\* (West Bank and Gaza).

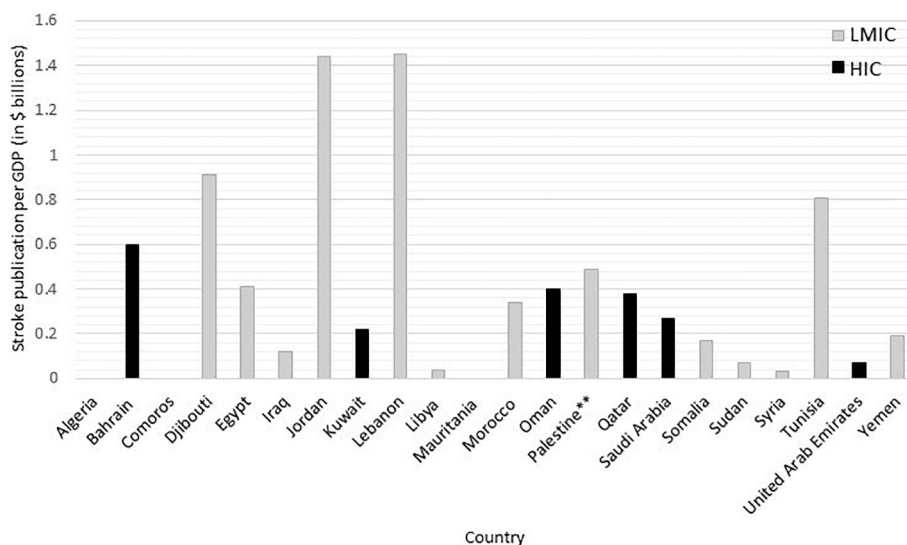


Fig. 3. Stroke publication per Gross Domestic Product (in USD billions 2002–2016)\*\*(West Bank and Gaza).

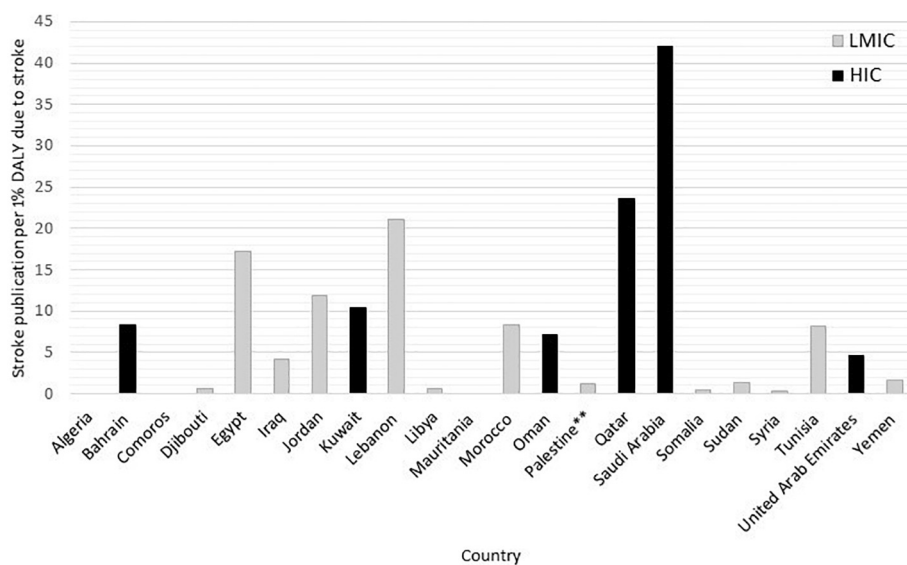


Fig. 4. Stroke publication per 1% stroke related DALY (2002–2016)\*\*(West Bank and Gaza).

publications within the last 15 years. This agrees with the global significant difference in biomedical publications that exists between developed and developing countries [18], as all Arab countries are classified to be developing economies [19]. In general, Arab countries are not considered a major contributor in the biomedical research field [20].

Several factors may play a role in hindering stroke publications and research activity in the Arab world. One main reason leading to a relatively low research activity is the lack of funding in most Arab countries; only six Arabian Gulf countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United Arab Emirates) belong to high-income economic groups [7]. Aside from these Gulf Countries, there is a lack of funding for biomedical research and allocation of resources to other needs and purposes in the Arab world [21]. This was reflected by the strong and positive relationship that we found between GDP and stroke research activity in the Arab world. In general, Arab countries focus on relatively low-cost retrospective research and data collection studies rather than expensive research and development to overcome this issue of insufficient funding [22].

Moreover, this poor research activity has been attributed to the political instability in the Arab world [23]. The political conflicts

during the Arab Spring lead to several crises such as the Egyptian and Yemeni crises and civil wars (Yemen, Syria). These struggles created an insecure environment and decreased the funds allocated for research activity, thus, further impeding the research activity in the Arab countries. In 2002, Arab nations used to dedicate an amount up to 60 billion USD (10%) from their 600 billion USD yearly GDP for military equipment and expenditure, while only 0.9 billion USD (0.15%) were allotted for research and developmental purposes [24]. The military spending share of GDP is expected to have increased during the Arab uprisings at the cost of research and development allocated share.

The presence of research facilities is crucial for a significant biomedical study activity. The lack of these facilities in many Arab countries can be handled through the cooperation between these nations to exchange resources and knowledge. Qatar recognized and started working on overcoming this obstacle as it has collaborated with several institutions to further improve its research activity [25]. This includes funding research in low and middle-income countries by the wealthy Arab nations, as well as facilitating inter-Arab journals' publications by overlooking biases and conflicts when it comes to research and knowledge.

Another factor would be the patient-care oriented programs in Arab

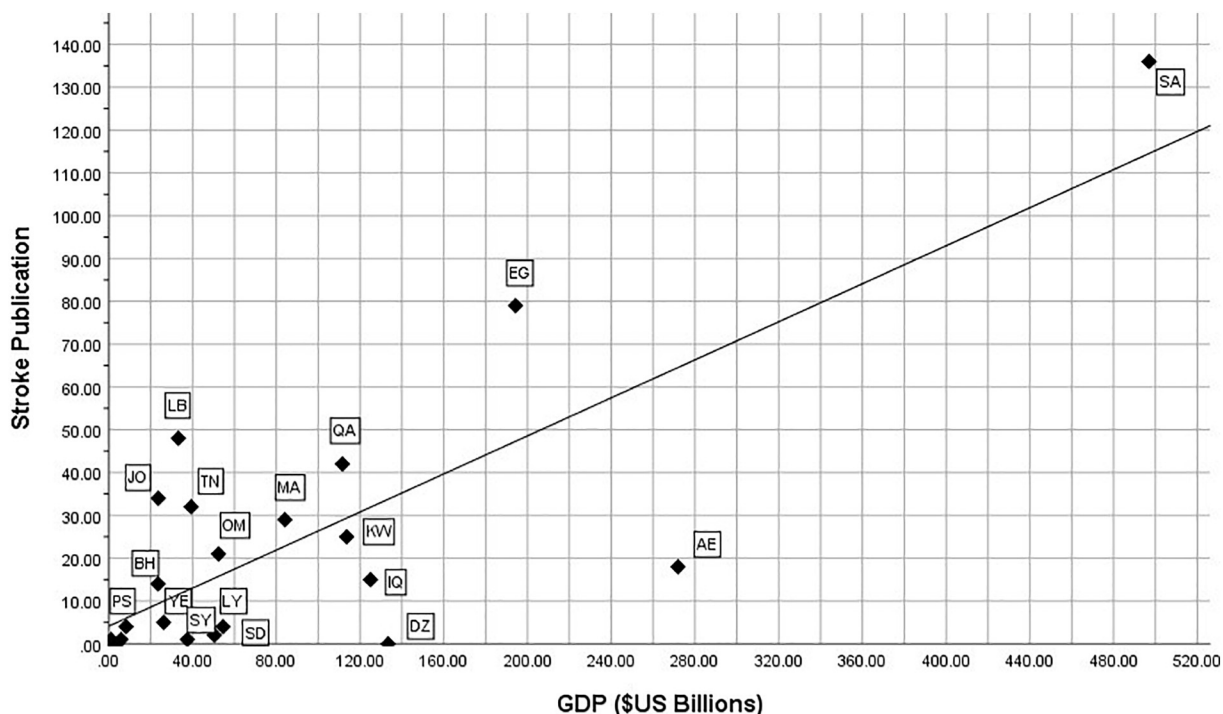


Fig. 5. Comparison of number of publications on stroke in relation to Gross Domestic Product (in USD billions)/AE: United Arab Emirates, BH: Bahrain, DZ: Algeria, EG: Egypt, IQ: Iraq, JO: Jordan, KW: Kuwait, LB: Lebanon, LY: Libya, MA: Morocco, OM: Oman, PS: Palestine (West Bank and Gaza), QA: Qatar, SA: Saudi Arabia, SD: Sudan, SY: Syria, TN: Tunisia, YE: Yemen.

medical schools, where clinical research is culturally belittled [26]. It was not until recently that Qatar and Saudi Arabia became the first to grant huge funds to increase their biomedical research activity, endorsing local and international scholars [27]. After allocating greater funds, Qatar took a step further as it has initiated research training programs for clinicians, and several medical journals were established for the purpose of boosting its biomedical publications [28].

The limitations related to our study included the fact that we used

only one database (PubMed) to obtain the released publications. Ongoing studies may also be relevant to consider, as well as other references such as university hospitals and medical institutions' internal documents. This might affect the credibility of our results, as we might have underestimated the number of publications at the level of separate countries and the Arab World as a whole. We also note that no costs per country related to type or size of research were shown; in future studies, such information could be useful to better assess the research nature per

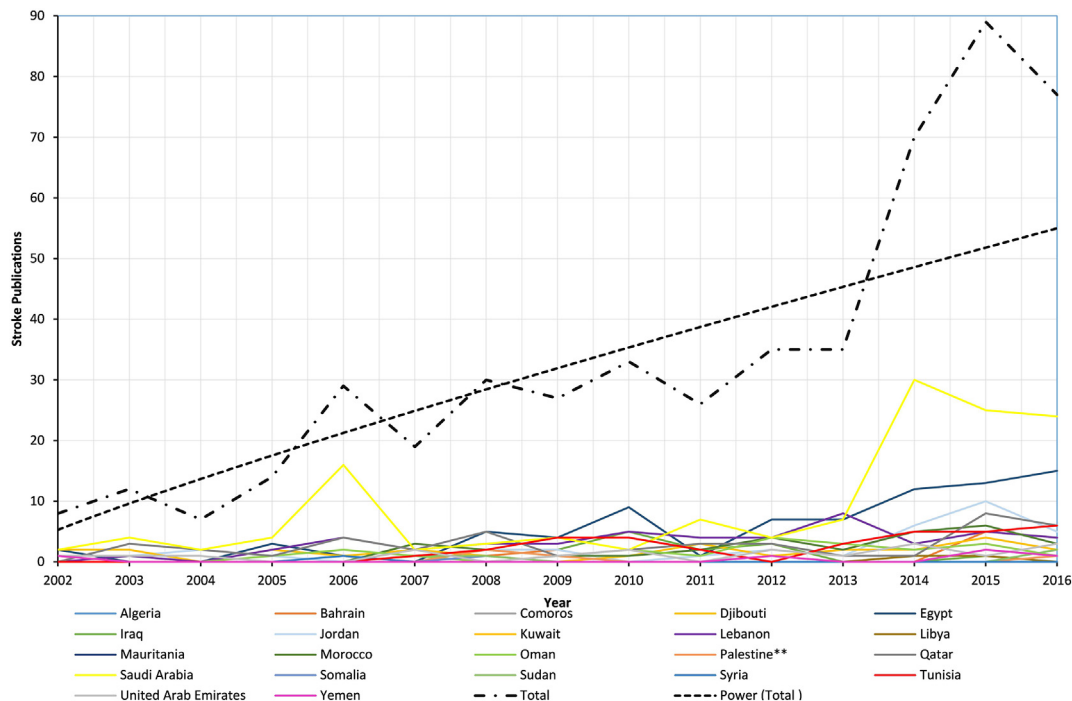


Fig. 6. Number of Stroke Publications in each Arab country from 2002 to 2016. \*\*(West Bank and Gaza).

country. Moreover, data gathered from health insurances, treating institutions, medical universities, and patient organizations can also be used to complete the picture.

## 7. Conclusion

As far as we know, this is the first bibliometric analysis to study the stroke research activity in the Arab nations. In the last 15 years, stroke research productivity was very low in the Arab World compared to other regions of the world due to several impeding factors. This has been concluded by most reports regarding different research topics [29]. Given the high burden of stroke in the Arab nations, there is a serious need for an increased high-quality research activity. Biomedical research is our way for a healthier patient care through improved medical programs and enhanced health policy management [30]. Therefore, clinical research must be emphasized in medical programs, and Arab nations are encouraged to collaborate with each other and allocate more funds to improve stroke research activity.

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