



Scientific Performance in Endocrinology and Metabolism Over the Past 45 Years: A Scientometrics Study in the Middle-East Countries

Son 45 Yılda Endokrinoloji ve Metabolizmadaki Bilimsel Performans: Orta Doğu Ülkelerinde Bir Bilimmetri Çalışması

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Abstract

Objective: This study aimed to explore the scientific performance in research of endocrinology and metabolism and its correlation with the socioeconomic indicators in the Middle-East countries. **Material and Methods:** Scientometrics and social network analysis methods were used for this study. Data were extracted from the Web of Science, World Bank, and UIS data center of UNESCO. **Results:** The majority of scientific productions (79.6%) were published by authors affiliated with upper-middle and high income countries which includes Turkey, Israel, and Iran. From co-authorship analysis, Saudi Arabia, Egypt, and Turkey with most degree centrality, had the highest collaborative ranking with other Middle-East countries. The main Middle-East collaborators having scientific outputs in this field were the researchers from the USA, England, and Germany. Israel, Turkey, and Saudi Arabia had the most collaboration (63.8%) with other countries. Also, there was a strong positive correlation between total collaborations with global countries and the number of citations. **Conclusion:** Due to the correlation among scientific productions, citations, scientific collaborations, Gross domestic expenditure on research and development, and specialist human resources indicators, the supplementary budget should be directed toward research in the Middle-East countries and establishing global networks to conduct joint projects. This could increase the trend of scientific productions and obtain higher citations in the Web of Science, eventually leading to scientific, social as well as economic development in the region.

Keywords: Endocrinology; metabolism; Middle-East countries; social network analysis; scientometrics; socioeconomic indicators; scientific publications

Özet

Amaç: Bu çalışma, Orta Doğu ülkelerinde endokrinoloji ve metabolizma araştırmalarındaki bilimsel performansı ve sosyoekonomik göstergeler ile ilişkisini araştırmayı amaçlamıştır. **Gereç ve Yöntemler:** Bu çalışmada bilimmetri ve sosyal ağ analiz yöntemleri kullanılmıştır. Veriler; Web of Science, Dünya Bankası ve UNESCO'nun UIS veri merkezinden alınmıştır. **Bulgular:** Bilimsel üretimin çoğu (%79,6) Türkiye, İsrail ve İran'ı içeren üst-orta ve yüksek gelirli ülkelere bağlı yazarlar tarafından yayınlanmıştır. Ortak yazarlık analizine göre; merkeziliği en fazla olan Suudi Arabistan, Mısır ve Türkiye, diğer Orta Doğu ülkeleri ile en yüksek iş birliği oranına sahiptir. Orta Doğu ile iş birliği yapan ve bu alanda bilimsel çıktıları olan başlıca araştırmacılar ABD, İngiltere ve Almanya'dandır. Diğer ülkelerle en fazla iş birliği (%63,8) yapan ülkeler İsrail, Türkiye ve Suudi Arabistan'dır. Ayrıca küresel ülkelerle yapılan toplam iş birliği ile atıf sayısı arasında güçlü bir pozitif korelasyon vardır. **Sonuç:** Bilimsel üretimler, atıflar, bilimsel iş birlikleri, araştırma ve geliştirme harcamalarının gayrisafi yurt içi hasılaya oranı ve uzman insan kaynakları göstergeleri arasındaki korelasyon nedeni ile, ek bütçe ortak projeler yürütmek için Orta Doğu ülkelerindeki araştırmalara ve küresel ağlar kurmaya yönlendirilmelidir. Böylelikle bilimsel üretim eğilimi artabilir, Web of Science'da daha yüksek atıflar elde edilebilir ve sonuç olarak bu eğilim bölgede bilimsel, sosyal ve ekonomik kalkınma sağlayabilir.

Anahtar kelimeler: Endokrinoloji; metabolizma; Orta Doğu ülkeleri; sosyal ağ analizi; bilimmetri; sosyoekonomik göstergeler; bilimsel yayınlar

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Introduction

In the field of clinical sciences, endocrinology and metabolism (E&M) have considerable significance due to the high prevalence of related diseases and the subsequent socio-economic burden. Endocrinology is a branch of medical science that focuses on hormones and deals with the associated disorders applying multidisciplinary approaches (1). Endocrine diseases fall into broad categories, including thyroid disorders, pituitary tumors, disorders of bone and calcium homeostasis, and lipid and carbohydrate disorders.

In particular, among endocrine disorders, diabetes mellitus is the most common cause of hospitalization and death that has reached an epidemic level in most countries (2,3). About 38.7 million individuals with diabetes live in the Middle-East (ME) and Northern Africa. In 2017, diabetes was the leading cause of death in the ME (4). Moreover, other prevalent endocrine disorders are metabolic syndrome, osteoporosis, adrenal insufficiency, hyperthyroidism, hypothyroidism, panhypopituitarism, Cushing's syndrome, and acromegaly (1).

Science, technology, and innovation (STI) are the three main components for sustainability, adopted as a historical agenda for sustainable development up to 2030 by the United Nations General Assembly (5). Moreover, the World Health Organization (WHO), the Council on Health Research for Development (COHRED) and the Global Forum on Health Research have emphasized in order to improve health system performance at both national and global level, scientists should develop the capacity of conducting health research and utilizing the results (6). From this perspective, promotion in the fields of STI to achieve a high scientific level ranking globally and to be known as an active contributor to science is the primary concern of all societies, especially the developing countries (7). On the other hand, the capability of different countries concerning financial research resources, scientific research programs, and utilizing research-generated knowledge differs (8). Hence, scientific collaboration is often used by low- and middle-income countries as an effective way to access the knowledge and technology of the developed countries.

The size, economic, and political issues of a country, as well as migration and mobility, are factors that affect international research collaboration (9). Moreover, national and international research collaborations depend on the government and individual interest, scientist motivation, as well as an agreement between institutions. It is also influenced by similarities in regional conditions, lifestyle, and common health problems in the countries (10).

Studies have confirmed significant growth in scientific productions on the E&M domain by researchers from ME and the world (3,8,11). Therefore, it is necessary to employ reliable integrated indicators to get an overview of the scientific status of a nation or region (5). In this respect, scientometrics is a method that help health policy-makers.

Scientometrics can be applied to evaluate and compare different levels of scientific output, including investigators, institutions, and countries at the national and international levels (12). One of the quantitative branches of scientometrics is mapping of scientific collaboration, which provides the scientific managers and researchers with objective information on the collaboration between researchers (13). Likewise, individual elements, related elements forming a network, and the interpretation of inter-element relations are the main components to be considered in the mapping of the scientific structure (12).

Most studies in scientometrics and bibliometric are based on the number of scientific publications on E&M and their citations. However, only a few studies deal with the co-authorship subject specific to the branch of E&M. Thus, conducting comprehensive research to evaluate the condition of scientific productions, citations, and the level of collaborations in the ME countries, as well as their comparison with socio-economic indicators, is essential. The results of this study could be used to understand further the favorable perspective and effective policy for the management of E&M.

Material and Methods

This study utilized scientometrics and social network analysis (SNA) methods to show national efforts in research productivity and its correlation with the socio-economic indi-

cators in E&M among ME countries. Social network analysts argue that networks operate on many levels, from friends up to the level of nations (14). Co-authorship is considered as an index for evaluation of scientific collaboration. Co-authorship among researchers leads to the development of social networks. These networks consist of network nodes and lines that show the authors and the relations between them, respectively. The nodes allocated specific places, and the number of links between them are representative of their collaboration (15).

All scientific outputs on E&M from ME countries indexed in the Web of Science database (WoS) were included in this study. The most appropriate and related keywords were chosen using a list from Medical Subject Headings (MeSH) provided by the National Library of Medicine (NLM)/PubMed. Eleven main descriptors of endocrine system diseases (Adrenal Gland Diseases, Diseases of Bone-Endocrine, Diabetes Mellitus, Dwarfism or Short Stature, Endocrine Gland Neoplasms, Gonadal Disorders, Parathyroid Diseases, Pituitary Diseases, Autoimmune Polyendocrinopathies, Thyroid Diseases, and Tuberculosis-Endocrine) were selected for the search. Descriptors of Metabolic and Bone Disorders were added separately. Keywords of "Entry Terms" and "see also" related to our descriptors were also selected. Similar descriptors were deleted to avoid duplication. All of the keywords were searched from the Title (TI) in the advanced search of the WoS. The information retrieved from WoS were downloaded as files containing 500 documents in the plain text format and all were merged for use in HistCite and Bibexcel software. It should be noted that 17 countries from the ME region included in the analysis were Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine or Gaza, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, and Yemen. World Bank Group and UIS data center of UNESCO were used to retrieve economic, social, and health information of the ME countries as Microsoft Excel files. Categories set by the World Bank were applied to label the countries as high income, upper-middle income, lower-middle income, and low in-

come. Low income economies were defined as those with a Gross National Income (GNI) per capita, calculated using the World Bank Atlas method, of \$995 or less in 2017 while lower-middle income economies are those with a GNI per capita between \$996 and \$3895. Upper-middle income economies are those with a GNI per capita between \$3896 and \$12055, while high income economies are those with a GNI per capita of \$12056 or more (16).

HistCite software (for bibliographic analysis of citation linkage) was used to calculate the production of documents and citations of the countries. The working matrices (net files) were built with Bibexcel scientometrics software, and UCINET and Netdraw SNA software were also applied for analysis (degree centrality and ego network metrics) and visualization of the collaboration networks. Finally, SPSS software was used to investigate the correlation between the research variables. As the studied variables showed a normal distribution using the one-sample Kolmogorov-Smirnov test, Pearson's correlation test was applied to evaluate the correlation between the variables. The study adhered strictly to the principles of the Declaration of Helsinki, and approval from the local ethics committee was also obtained.

Results

In 1972, researchers from ME (Israel and Iraq) indexed seven papers on E&M in the WoS for the first time. Scientific productions of the ME countries in this field showed an increasing trend with the highest rate of production (3473 documents) in 2016 (Figure 1). Based on scientometrics criteria, impact maturity time for a scientific document is at least two years (17). Since studied data have been collected in December 2018, one can certainly explain the fact that scientific productions related to the initial years (especially 3rd decade) have more opportunity to receive citations and obviously the number of citations has been decreased within the time. As expected the citations show a decreasing trend in the recent decade and the highest citations received in 2007 (26600 citations) and 2005 (26216 citations).

As indicated in Table 1, Turkey, with 14920 documents, allocated 41.25% of scientific productions in the ME. Israel and Iran with

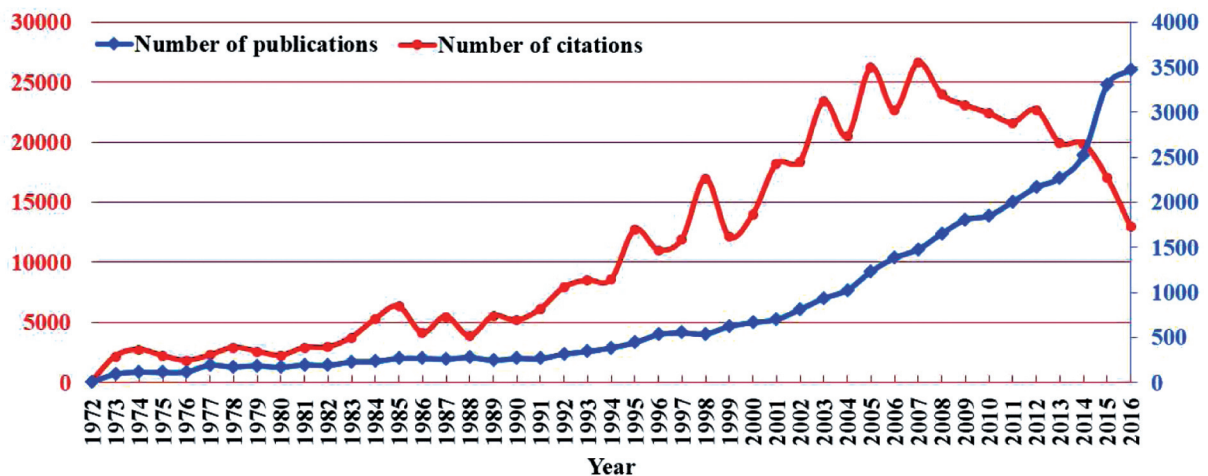


Figure 1: Historical trend of publications and citations on E&M in ME region (45 years).

26.67% and 11.71% scientific outcomes achieved the second and third places in the ME, respectively. These countries contributed to 79.63% of ME scientific productions in this field. However, Palestine and Syria place at the bottom of the table due to the lowest rate of scientific productions 2 and 51 documents, respectively.

Considering the number of citations, Israel (239832 citations) achieved the first ranking, followed by Turkey and Iran. Conversely, Palestine and Yemen achieved the lowest ranking due to the small number of citations. The fact that Israel (24.86), United Arab Emirates (UAE) (23.96), and Syria (23.45) received the largest number of citations per publication indicated that they present high-quality scientific productions to the world.

Concerning the scientific productions per gross domestic product (GDP), Israel, with 88.5 documents per one billion US\$, achieved the first ranking, followed by Turkey (49.2), and Jordan (30.2). However, Palestine and UAE with 0.3 and 0.5 documents per GDP were placed at the bottom of the table, respectively. Moreover, Israel, with the average production of 1128.7 documents per one million people and a high life expectancy index (82.4), achieved the first ranking followed by Turkey (187.6) and Cyprus (153.8). Iran (52.7) was allocated the 9th ranking among the ME countries.

The collaboration network of ME countries in E&M is shown in Figure 2. In this network,

the color and size of nodes represent the number of countries with scientific collaborations among the ME countries. Moreover, the thickness of links indicates the number of collaborations between authors from different ME countries. The results demonstrate 1872 scientific collaborations (links) among 17 ME countries (nodes) that include the thickest link with 253 collaborations and the thinnest link with one collaboration. Furthermore, countries with more scientific collaborations are placed in the center of the network while isolated countries with few collaborations are far from the center.

In Table 2, ME countries are ranked based on degree centrality in the related network (Figure 2). "Degree" of a node is a measure of local centrality. Moreover, the central node is not necessarily at the center of the network physically. A node in a position with high degree centrality can influence the group by withholding or distorting information during transmissions. Furthermore, nodes with high degree centrality could be identified as the informal leaders of the group (quoted in 14). Saudi Arabia (416), Egypt (366), and Turkey (175) showed the highest degree centrality concerning the co-authorships in the ME region (Table 2).

"Ego network is a network containing a central node and all the nodes that collaborate with the central node in a defined time (collaborations between the other nodes are not considered in the ego-network)" (18). In this study the number of collaborator coun-

Table 1. Comparison of resources and scientific outputs on E&M among ME countries.

Countries	Pub	% of Pub		Cit	% of Cit	Cit/Pub	GDP/one Billion US\$ (Mean 1972-2016)	Pop/million (2016)	Life expectancy (2016)
Turkey	14920	41.25	129787	25.69	8.69	79.512426	303	75.755	75.755
Israel	9646	26.67	239832	47.46	24.86	8.546000	109	82.407	82.407
Iran	4236	11.71	42363	8.38	10	80.277428	196	75.953	75.953
Saudi Arabia	2582	7.14	28322	5.60	10.96	32.275687	243	74.561	74.561
Egypt	2199	6.08	21318	4.22	9.69	95.688681	92	71.484	71.484
Lebanon	583	1.61	12725	2.52	21.82	6.006668	22.6	79.584	79.584
Kuwait	566	1.56	7094	1.4	12.53	4.052584	52.1	74.694	74.694
Jordan	336	0.93	5195	1.03	15.46	9.455802	11.1	74.329	74.329
Qatar	277	0.77	4737	0.94	17.1	2.569804	41.9	78.184	78.184
Oman	205	0.57	3323	0.66	16.2	4.424762	23.5	77.029	77.029
Cyprus	180	0.5	2584	0.51	14.35	1.170125	11	80.508	80.508
Iraq	151	0.42	2159	0.43	14.29	37.202572	83.2	69.862	69.862
Bahrain	116	0.32	2414	0.48	20.81	1.425171	12.5	76.9	76.9
UAE	65	0.18	1558	0.31	23.96	9.269612	131	77.256	77.256
Yemen	56	0.15	673	0.13	12.01	27.584213	17	64.953	64.953
Syria	51	0.14	1196	0.24	23.45	18.430453	15	70.31	70.31
Palestine	2	0.006	21	0.0042	10.5	4.551566	6.65	73.473	73.473
Mean	2127.7	...	29723.59	...	15.68	...	80.62	75.13	75.13
Total	36171	100	505301	100	...	422.4436	1370.5	...	...
Current health									
Countries	Expenditure Per Capita		Pub/GDP	GDP per capita US\$		GERD per capita PPP\$ (Mean 1996-2016)	expenditure% of GDP (Mean 2000-2015)	GERD% of GDP (Mean 1996-2016)	Categories set by the World Bank (2018)
	Int\$ (Mean 2000-2015)	Pub/Pop		(Mean 1972-2016)	(Mean 1996-2016)				
Turkey	410.8378	187.6	49.2	4527.61	96.87756	4.873	0.64	Upper-middle income	Upper-middle income
Israel	1980.766	1128.7	88.5	16643.57	1130.192	7.095	3.89	High income	High income
Iran	279.1565	52.7	21.6	3120.82	64.9727	6.318	0.46	Upper-middle income	Upper-middle income
Saudi Arabia	674.717	79.9	10.6	11578.98	167.3286	4.022	0.35	High income	High income
Egypt	97.36432	22.9	23.9	1221.73	34.75787	4.889	0.38	Lower-middle income	Lower-middle income
Lebanon	569.2503	97.1	25.7	5408.64	Not available	8.295	Not available	Upper-middle income	Upper-middle income
Kuwait	993.8704	139.6	10.8	22114.42	112.5699	2.875	0.16	High income	High income
Jordan	244.3166	35.5	30.2	1995.83	30.74299	8.515	0.37	Upper-middle income	Upper-middle income
Qatar	1328.722	107.7	6.6	34157.05	630.9721	2.285	0.49	High income	High income
Oman	432.7495	46.3	8.7	8860.08	83.59843	2.856	0.19	High income	High income
Cyprus	1553.471	153.8	16.3	14882.27	110.2947	5.962	0.37	High income	High income
Iraq	123.5336	4.1	1.8	3463.69	5.207714	3.187	0.04	Upper-middle income	Upper-middle income
Bahrain	701.8577	81.4	9.2	13954.67	46.71356	3.570	0.10	High income	High income
UAE	1169.068	7.01	0.5	32927.47	524.5698	3.112	0.77	High income	High income
Yemen	54.62278	2.03	3.3	783.76	Not available	5.030	Not available	Low income	Low income
Syria	72.44795	2.7	3.4	1156.93	Not available	4.051	Not available	Low income	Low income
Palestine	Not available	0.44	0.3	1852.73	Not available	Not available	0.33	Lower-middle income	Lower-middle income
Mean	628.6324	126.44	18.3	10508.84	233.7537	4.808	0.61	...	...
Total	10686.751	...	...	...	...	...	...	...	...

Pub: Publications; Cit: Citations; GDP: Gross Domestic Product; Pop: Population; GERD: Gross Domestic Expenditure on Research and Development.

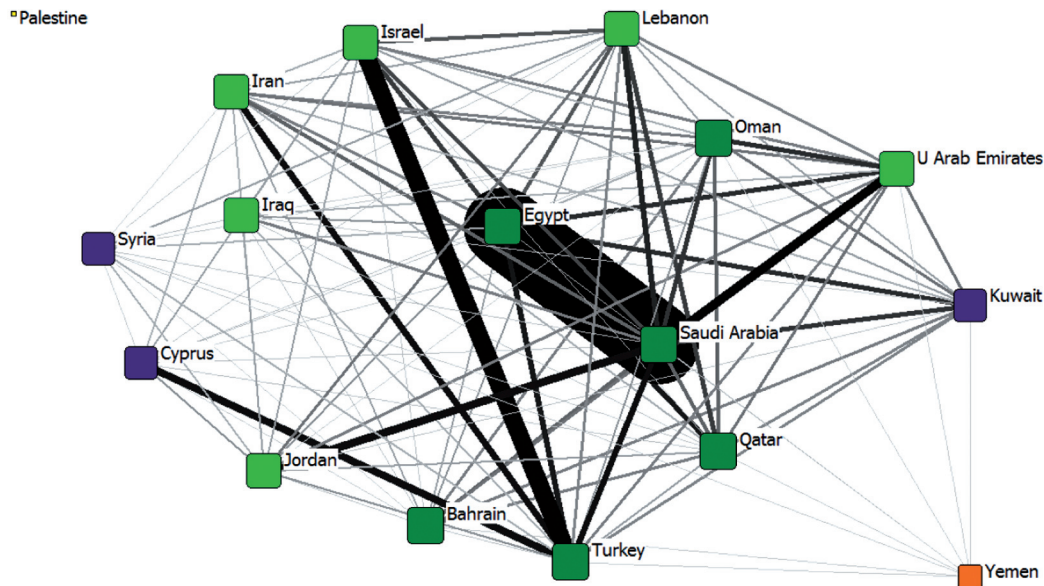


Figure 2: Co-authorship network of E&M field among the ME countries for the period 1972-2016.

tries (NCC) with each ME countries has been considered. Regarding the Ego network, Saudi Arabia, Egypt, Turkey, Qatar, Oman, and Bahrain, each with 15 co-authorship have the most scientific collaboration with other ME countries. Also, researchers from Saudi Arabia and Egypt (253 collaborations), Israel and Turkey (55 collaborations), as well as Saudi Arabia and UAE (28 collaborations) are the most important scientific collaborators. However, Palestine does not have any collaboration with other ME countries (Figure 2, Table 2).

As shown in Figure 3, 126 countries from different parts of the world collaborated with 17 ME countries on E&M. In this network, ME countries are shown in blue and other collaborative countries are shown in red. The size of the nodes based on degree centrality is a representative of the international scientific collaborations of the countries. Israel (6523), Turkey (3121), and Saudi Arabia (1890) have the most collaborations with other countries (63.81%). These countries located in the center of the network are in the neighborhood with developed and renowned countries in this field of medical science. Turkey, Israel, and Saudi Arabia have 129, 127, and 124 scientific collaborations with other countries, respectively. Researchers from the USA (3522), England (1273), Germany (922), Italy (783), Canada

(743), and France (706) are the main collaborative countries of the ME countries on E&M. The strongest scientific link was observed between Israel and the USA (1733 collaborations), Turkey and the USA (601 collaborations), as well as Israel and Germany (403 collaborations) (Table 2).

We also evaluated the correlation between scientific, economic, and social indicators of the ME countries on E&M. The results (Table 3) showed a significantly positive correlation between the number of publications and the number of citations ($r=0.850$; $P=0.000$), total collaborations with global countries ($r=0.803$; $P=0.000$), GDP ($r=0.746$; $P=0.001$), GERD% of GDP ($r=0.533$; $P=0.050$) and population size ($r=0.504$; $P=0.039$). Moreover, the results also showed a significantly positive correlation between the number of citations and other indicators, such as total collaborations with global countries ($r=0.980$; $P=0.000$), GERD% of GDP ($r=0.893$; $P=0.000$) and GERD per capita ($r=0.655$; $P=0.015$). Although a positive correlation was also observed between citations per publications with GERD per capita ($r=0.692$; $P=0.009$) and GERD% of GDP ($r=0.546$; $P=0.044$), it showed a significantly negative correlation with the population of the ME countries ($r=-0.589$; $P=0.013$). There is also a significant positive correlation be-

Table 2. Ranking of ME countries based on their co-authorship with each other and with other countries in the world on E&M research.

Countries	Rank	ME region			The most collaborative countries	Rank	Global			The most collaborative countries
		TC	NCC				TC	NCC		
		No.	%			No.	%			
Saudi Arabia	1	416	22.22	15	Egypt (253), UAE (28), Jordan (24)	3	1890	10.46	124	USA (254), Egypt (253), England (170), Canada (118), India (69)
Egypt	2	366	19.55	15	Saudi Arabia (253), Turkey, Qatar (16)	4	1434	7.93	111	Saudi Arabia (253), USA (246), England (94), Germany (68), Japan (66)
Turkey	3	175	9.35	15	Israel (55), Cyprus (24), Saudi Arabia (20)	2	3121	17.27	129	USA (601), Germany (257), England (256), Italy (199), France (132)
Israel	4	123	6.57	14	Turkey (55), Egypt (12), Saudi Arabia (11)	1	6523	36.08	127	USA (1733), Germany (403), England (361), Italy (325), France (302)
UAE	5	120	6.41	14	Saudi Arabia (28), Egypt, Oman (14)	11	327	1.8	100	Saudi Arabia (28), USA (20), Egypt, Oman (14), England (10), Bahrain, Canada, Iran, Kuwait, Qatar (8)
Lebanon	6	92	4.91	14	Saudi Arabia (15), Qatar (12), Egypt, Israel (10)	6	787	4.35	114	USA (147), France (89), England (31), Canada (25), Germany (23)
Qatar	7	86	4.59	15	Egypt (16), Lebanon (12), Oman, Saudi Arabia (9)	7	580	3.21	108	England (80), USA (73), Italy (30), France (29), Germany (22)
Oman	8	79	4.22	15	UAE (14), Saudi Arabia (13), Qatar (9)	10	372	2.06	105	England (32), USA (22), Canada (16), India (14), UAE (14)
Jordan	9	77	4.12	14	Saudi Arabia (24), Lebanon (8), UAE (7)	9	397	2.2	107	USA (66), Saudi Arabia (24), England (21), Italy (16), Canada (11)
Kuwait	9	77	4.12	13	Egypt (14), Saudi Arabia (13), Oman, UAE (8)	12	319	1.76	58	USA (49), England (41), Australia (15), Egypt (14), Saudi Arabia, Sweden (13)
Iran	10	75	4.01	14	Turkey (18), Saudi Arabia (9), UAE (8)	5	1178	6.52	117	USA (242), England (105), Canada (87), Australia (58), Malaysia (43), Germany (42)
Bahrain	11	62	3.31	15	Saudi Arabia (9), UAE (8), Kuwait, Oman, Qatar (7)	13	265	1.47	105	England (14), Tunisia (12), Saudi Arabia (9), Italy, Netherlands, UAE (8), Kuwait, Oman, Qatar, USA (7)
Cyprus	12	50	2.67	13	Turkey (24), Jordan (5), Israel (4)	8	432	2.39	104	Greece (65), England (40), USA (34), Turkey (24), Italy (20)
Iraq	13	39	2.08	14	Saudi Arabia (7), Egypt (5), Israel, Jordan (4)	14	257	1.42	103	England (10), USA (9), China, Saudi Arabia (7), Iraq, Italy, Malaysia (6), Egypt (5)
Syria	14	25	1.34	13	Lebanon (4), Egypt, Jordan, Turkey (3)	15	148	0.82	93	Germany (11), England, USA (6), France (5), Lebanon, Tunisia (4)
Yemen	15	10	0.53	9	Egypt (2)	16	46	0.25	22	USA (13), Malaysia (11), Egypt (2), England (2)
Palestine	16	0	0	0	...	17	1	0.01	1	Malaysia (1)

TC: Total Collaborations; NCC: Number of Collaborator Countries.

tween total collaborations with ME countries and GDP ($r=0.596$; $P=0.012$) and the population of these countries ($r=0.504$; $P=0.039$). Total collaborations between ME and global countries also shows a significant positive correlation with GERD% of GDP ($r=0.900$; $P=0.000$), GERD per capita ($r=0.678$; $P=0.011$) and GDP ($r=0.501$; $P=0.040$). Besides, the scientific collaboration of ME countries with most countries in the world showed a significant association with the life expectancy index of the ME countries ($r=0.527$; $P=0.030$).

Discussion

The results of this study showed an increasing trend in scientific productions in ME coun-

tries on E&M during 1972-2016. About 36171 scientific productions have been indexed in the WoS from these countries. This finding is consistent with that of Cavacini (19). Moreover, Zhao et al. (8) indicated an increasing growth rate of 1.09 times in the scientific productions on E&M worldwide (2010-2014). However, the amount of visibility or citations of these documents has decreased in the world. It can be concluded that despite an increasing trend in the production of the scientific documents in this field in the ME countries, its quality has significantly decreased in the recent decade. This finding is somewhat similar to the result of a study by Emami et al. (12). Turkey with 41.2% of the documents, is on the top, followed by Israel

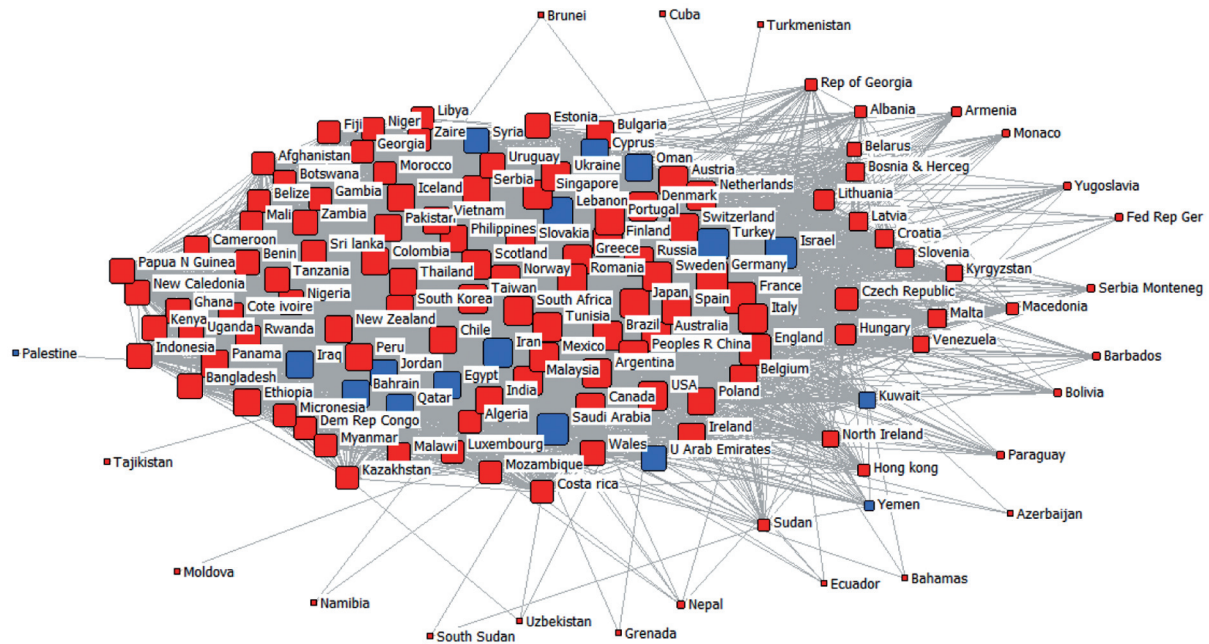


Figure 3: Co-authorship network of collaborative countries with the ME countries in E&M field for the period 1972-2016.

and Iran standing with a significant difference in the second and third places in the ME, respectively. Collectively, the scientific productions of these countries consist of 79.6% of the ME documents on E&M which somewhat follows Pareto Principles (80/20 rule). This productivity can be attributed to the population, national income, or overall scientific activity of a country (20). Other studies suggest that the increasing trend of research outputs in the field of medicine in Iran is mainly due to the indexing of Iranian journals in international bibliographic databases. Additionally, the enhancement of the scientific performance of Turkey is due to a several-folds increase in the budget allocated by the government towards research and development (R&D). In addition, Iran and Turkey have been successful in the development of their universities in the ME (19,21-23). Azizi's study (11) indicated that Iran achieved 18th world ranking in endocrinology and placed before Turkey and Israel. Comparatively, our results compared to the results of Azizi (11) showed a 2-level decrease in the ranking of Iran. Which is consistent with results from a previous study (2,10,13,24). Similarly, Sweileh et al. (20) in their study regarding the scientific productions of ME Arab countries in the field of

diabetes, indicated that Saudi Arabia and Egypt have the highest rank while Syria, Yemen, and Palestine have the lowest rank. Considering the number of received citations, the fact that Israel achieved the first rank, is indicative of Israel's high-quality scientific production, similar to the ranking of ME countries in different fields of science (19). Similar to the results of previous studies, Israel achieved the first rank due to the highest received citations per document (10,19). Moreover, Cavacini (19) showed that Syria and the UAE achieved the next ranks in this respect following Israel. On the other hand, the average citations per document in this field of medical science received by China, Southern Korea, and Japan are reported between 19.4 and 23.8 (3). Only five ME countries received more than 19.4 citations per document. Despite a large number of scientific productions, Iran and Turkey received the 15th and 17th ranks, respectively, regarding the number of citations per document. Moreover, Peykari et al. (10) showed an increasing trend in scientific productions and citations on diabetes in Iran compared to ME countries.

Israel achieved the best rank compared to the other ME countries, followed by Turkey and Jordan with regard to the GDP, and published 88.5 documents per one Billion US\$.

Table 3. Pearson's correlation coefficient between the scientific, economic and social indicators of the ME countries in E&M.

Variables		Pub	Cit	Cit/Pub	TC (ME)	NCC (ME)	TC (G)	NCC (G)
Pub	Correlation	1	0.850**	-0.175	0.294	0.221	0.803**	0.424
	Sig.		0.000	0.502	0.252	0.393	0.000	0.090
	N	17	17	17	17	17	17	17
Cit	Correlation	0.850**	1	0.161	0.198	0.177	0.980**	0.391
	Sig.	0.000		0.537	0.446	0.496	0.000	0.121
	N	17	17	17	17	17	17	17
Cit/Pub	Correlation	-0.175	0.161	1	-0.289	0.242	0.161	0.246
	Sig.	0.502	0.537		0.261	0.350	0.538	0.342
	N	17	17	17	17	17	17	17
TC (ME)	Correlation	0.294	0.198	-0.289	1	0.409	0.357	0.475
	Sig.	0.252	0.446	0.261		0.103	0.160	0.054
	N	17	17	17	17	17	17	17
NCC (ME)	Correlation	0.221	0.177	0.242	0.409	1	0.248	0.878**
	Sig.	0.393	0.496	0.350	0.103		0.337	0.000
	N	17	17	17	17	17	17	17
TC (G)	Correlation	0.803**	0.980**	0.161	0.357	0.248	1	0.466
	Sig.	0.000	0.000	0.538	0.160	0.337		0.059
	N	17	17	17	17	17	17	17
NCC (G)	Correlation	0.424	0.391	0.246	0.475	0.878**	0.466	1
	Sig.	0.090	0.121	0.342	0.054	0.000	0.059	
	N	17	17	17	17	17	17	17
Pop	Correlation	0.504*	0.210	-0.589*	0.504*	0.214	0.222	0.280
	Sig.	0.039	0.420	0.013	0.039	0.409	0.391	0.277
	N	17	17	17	17	17	17	17
Life expectancy	Correlation	0.271	0.426	0.407	0.054	0.306	0.454	0.527*
	Sig.	0.292	0.088	0.105	0.837	0.232	0.067	0.030
	N	17	17	17	17	17	17	17
GDP	Correlation	0.746**	0.481	-0.365	0.596*	0.331	0.501*	0.480
	Sig.	0.001	0.051	0.150	0.012	0.194	0.040	0.051
	N	17	17	17	17	17	17	17
GDP per capita	Correlation	-0.101	0.029	0.398	0.020	0.277	0.062	0.171
	Sig.	0.699	0.911	0.113	0.940	0.283	0.813	0.512
	N	17	17	17	17	17	17	17
GERD per capita	Correlation	0.285	0.655*	0.692**	-0.045	-0.033	0.678*	0.249
	Sig.	0.345	0.015	0.009	0.885	0.916	0.011	0.412
	N	13	13	13	13	13	13	13
GERD % of GDP	Correlation	0.533*	0.893**	0.546*	0.041	0.064	0.900**	0.276
	Sig.	0.050	0.000	0.044	0.890	0.829	0.000	0.340
	N	14	14	14	14	14	14	14
Current Health Expenditure Per Capita	Correlation	0.166	0.454	0.425	-0.033	0.159	0.482	0.236
	Sig.	0.538	0.077	0.101	0.904	0.556	0.059	0.379
	N	16	16	16	16	16	16	16
Current health expenditure% of GDP	Correlation	0.231	0.333	0.069	-0.032	-0.135	0.333	0.228
	Sig.	0.390	0.207	0.801	0.905	0.618	0.208	0.395
	N	16	16	16	16	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed).

Pub: Publications; Cit: Citations; TC (ME): Total Collaborations (Middle-East); NCC (ME): Number of Collaborator Countries (Middle-East); TC (G): Total Collaborations (Global); NCC (G): Number of Collaborator Countries (Global); Pop: Population; GDP: Gross Domestic Product; GERD: Gross Domestic Expenditure on Research and Development.

The results showed that the economic and political tensions, war, and poverty are causes of inadequate allocation of the budget toward R&D in medical sciences in some countries such as Palestine, Iraq, Yemen, and Syria, consistent with a study by Cavacini (19). The Israeli researchers allocated an average of 3.89% of GDP toward R&D. Consequently, producing the highest number of documents per population and promoting the standards of life and index of life expectancy in the country. This study showed that despite having considerable economic indices involved in research, some of the ME countries like UAE, Qatar, and somewhat Bahrain and Oman did not have an appropriate ranking in the field of E&M similar to that reported by Peykari et al. (19). Moreover, Iran achieved 9th place in scientific productions in E&M proportion to the population size. However, it is unfavorable considering the human resource specialists (10) and allocation of an average of 0.46% of GDP to R&D. Overall, the results suggested that most research on E&M in the ME are carried out in the upper-middle and high income countries which are partly in line with that reported by Zhao et al. (8). The analysis of collaboration networks of ME countries based on the degree centrality of social networks suggested that Saudi Arabia, Egypt, and Turkey are at the high rank of co-authorship with other ME countries. It is representative of the adherence of the above countries to the power-law distribution because these three countries have performed about 51.12% of the collaborations existing in the ME countries network. Saudi Arabia, Egypt, Turkey, Qatar, Oman, and Bahrain have collaborated with most ME countries, which supported the results from Moed's study (25), emphasizing the mediation role of Saudi Arabia among Islamic countries. Researchers from Saudi Arabia have the most collaboration with Egypt and the UAE. This could be asserted by their membership in the "Gulf Cooperation Council," "League of Arab States," "Organization of Islamic Cooperation," in which cultural, linguistic, and regional ceremonies, as well as the economic-political relationship between them, also facilitate scientific collaboration among researchers. This finding is consistent with the results of the study by Sarwar and

Hassan (9). On the other hand, among the ME countries, Turkey has the most collaborations with Israel that may be due to the mutual relationship between them as a regional strategic ally. Moreover, Turkey is known as the main scientific collaborator of Iran in the ME (26). The geographic proximity of Turkey and Iran, the same language and oral communication as the residents of some provinces of Iran, the emigration of Iranian students for taking of sabbatical in Turkey (or vice-versa), and concluding the scientific memorandums between research centers of two countries have had a considerable effect on producing a joint scientific compilation. The results also showed the collaboration of researchers from ME with 126 countries in E&M. Israel, Turkey, and Saudi Arabia had the most partnerships (63.8%) with other countries in the world. Moreover, the USA, England, Germany, Italy, Canada, and France, the world-leading nations in E&M (8), are the most important scientific collaborator of ME countries in this field of medical science. Previous studies also reported the robust scientific relationship between these and the ME countries in the field of endocrinology (10,13,20,27,28). The most robust relationship is reported between the USA and Israel as well as Turkey. Israel is a multinational country, with most of its researchers immigrated from other countries. It is considered the main ally for the USA and European countries, which explains the collaboration of scholars in E&M and their native countries. Iran has had moderate ranking regarding the international collaborations (9), and is in the 5th place among ME countries. However, Iran has the most robust scientific collaboration with the USA, England, and Canada, consistent with the results of other studies (25,28-30). Mansoori believed that the majority of international collaborations with these three countries is interestingly, although all the three have had fairly challenging international relations with Iran over the last four decades. While the negative impacts that the imposed trade sanctions have had on Iran's research activities should not be overlooked, it seems that international scientific collaborations had been established and/or maintained regardless of the political atmosphere (30).

Pearson's correlation coefficient=between scientific, social, and economic indicators related to ME countries on E&M indicated that UAE and Syria have better performance compared to Israel, Turkey, and Iran, due to the average received citations per publications. Overall, it can be said that the most productive ME countries in this field of medical science have also been the most cited countries. Previous studies (24,30) also showed a significant correlation between the number of scientific documents and the number of received citations. As previously shown by Meo et al. (22), Zhao et al. (8) and Lyu et al. (3), the positive correlation between the number of publications and indices such as total collaborations with global countries, GDP, GERD% of GDP and population size can be explained by an increase in the GDP of ME countries and allocation of a higher proportion GDP to the R&D (GERD). The correlation between the population size and scientific productions in ME countries is due to the increase in the number of scholars and professional specialists of E&M similar to that reported by Zhao et al. (2015). Furthermore, similar to the study by Meo et al. (22), our results did not show a significant positive correlation between GDP per capita and research outcomes. Although our findings differ from a study conducted by Lyu et al. (3) for China and South Korea countries regarding the lack of correlation between expenditure on health care and the number of publications, it is in-line with that of a Japanese's study. It is evident that an increase in the number of scholars, as well as the budget of R&D, will positively affect scientific productions (3). However, the current study did not show any significant correlation between indicators of current health expenditure per capita and current health expenditure% of GDP with other indicators in the ME countries. This might be due to over-consumption of health budget on care and treatment, thus over-looking R&D in E&M.

A very strong positive correlations between total collaborations with global countries and the number of citations is representative of the fact that the top ME countries benefit from the ideas and facilities of scholars in other countries through collaboration. They increase the total citations of their country by receiving a large number of citations by

their well-known collaborators in the collaborative publications.

Besides, increased expenditure on R&D (GERD% of GDP and GERD per capita indicators) leads to an improvement in the research quality (number of citations and citations per publication indicators) in the ME countries. This is essential for the promotion of this field of medical science and decreasing the load of the related diseases. A negative correlation between ME countries' populations and citations per publications indicated that an increase in population is associated with a decrease in the quality of the scientific productions as well as the number of received citations. Thus, suggesting that in most ME countries, the number of specialist scholars is lower in proportion to the number of population. Furthermore, an increase in the general population leads to restriction in research opportunities and a decrease in the allocation of research capitation to scholars. Thus, the majority of research in highly populated countries is the result of less important projects published in low Impact factor journals (30). However, highly populated ME countries with upper-middle income such as Iran and Turkey are trying to promote their scientific ranking in the world through an increase in the quality of the scientific outcomes by increasing the number of universities and research centers. Nevertheless, Israel, a high income country with considerable research capitation, is a serious competitor of these countries (19,23,25,31).

The positive correlation between the economic indicators and total collaborations with the ME and the world suggested that the allocation of research budgets toward scientific diplomacy is essential for such international collaboration. The results showed that the number of collaborations with ME countries and the number of ME collaborator countries did not affect scientific productions and the number of citations. Moreover, like the current study, Rostami Dovom et al. (13) and Nasli-Esfahani et al. (28) indicated the ME scholars do not desire to collaborate with the regional countries but they are interested in collaboration with the Western Europe and northern America countries to increase the quality and quantity of their scientific productions. To summarize, with an exception for Israel, none of the ME counties could im-

prove the index of life expectancy by using their scientific publications and research potential. The results also suggested that scientific collaboration of the ME countries with more countries globally and the subsequent transfer of science from those countries have a positive impact on methods of treatment of endocrine diseases and increasing longevity of the populations of the ME countries. Similarly, Moghadami et al. (32) demonstrated a positive correlation between the scientific productions in the field of psychiatry and the index of life expectancy in the scientific leading countries (USA, England, and Germany) from the Scopus database.

Conclusion

Overall, considering the normalization of indicators of publications, citations, and collaborations, few ME countries such as Israel, Turkey, Iran, Saudi Arabia, and Egypt competitively publish a large number of scientific productions. Moreover, these countries compensate for the defect of other regional countries through co-authorship with different countries in the world to promote the scientific level of ME in the field of E&M. On the other hand, citations of scientific documents in the ME countries, which decreased qualitatively over time, required the health authorities to adequately support the researchers to publish high-quality scientific documents in international valid journals. In addition, attempt to familiarize and encourage researchers to establish more English specialist journals in the E&M field, possibly in collaboration with the prominent international editorial board. Our study showed that the ME countries spend more on R&D with a significant volume of research papers published in WoS indexed journals. As a result, the scientific productions of the scholars in this region will rapidly increase, and the visibility of their research will rise that could provide the scholars and researchers with the facilities of collaboration with other countries. Considering the allocation of a small percentage of the budget of ME countries toward R&D in the E&M field, health policy-makers should gather networks of the ME scholars in groups and associations and share the costs and facilities by designing joint projects. Consequently, the researchers of the low income countries will be attracted to the networks. Increasing the

scientific collaborations of the ME countries with each other and with other countries leads to the distribution of the existing resources between low and high income countries. As a result, more scientific productions with high quality could be published.

The results of the present study suggest that more collaboration between scholars is needed for regional health promotion. Accordingly, we recommend the R&D policy-makers in the field of E&M in the ME countries to hold regional and international conferences, encourage the scholars, and financially support them to attend international conferences. Also, encourage the scholars to take a sabbatical in scientific leading countries to achieve a superior position in the ranking systems of science.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

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