



## Research article

# Medical magnetic resonance imaging publications in Arab countries: A 25-year bibliometric analysis

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## ARTICLE INFO

## Keywords:

Bibliometric analysis

Scientometric analysis

The Arab region

magnetic resonance imaging

## ABSTRACT

Magnetic Resonance Imaging (MRI) is increasingly becoming a cornerstone in modern diagnostic healthcare, offering unparalleled capabilities in stroke, dementia, and cancer screening. Therefore, this study aims to map medical MRI literature affiliated with Arab countries, focusing on publication trends, top journals, author affiliations, study countries, and authors' collaboration, and keyword analysis. The scientific database used is the Scopus database. Microsoft Excel, VOSviewer software, and Biblioshiny for the Bibliometrix R package are the bibliometric tools used in this analysis. A total of 2592 publications were published between 1988 and 2022, with total citations of 22,115. Most of them were original articles (91,7%) and 89.9% were published in traditional journals. The number of total publications exhibited a steady increase over time, whereas total citations showed fluctuations, peaking in 2015 with 1571 citations for publications from that year. The most cited article was authored by Yaseen M. Arabi, receiving 286 citations. Saudi Arabia was the top active country. In addition, the most prolific author was Maha S Zaki, and the most prolific source was the "Egyptian Journal of Radiology and Nuclear Medicine". The most prolific affiliation was Cairo University. The "multiple sclerosis" and "case report" were the most trending keywords. The analysis revealed a significant growth in MRI research inside Arab countries, as shown by an increase in the total number of publications and international collaborations. Despite these developments, the results of this study suggest that there is still room for MRI research in the Arab region to advance. This can be achieved through increasing international collaboration and multidisciplinary work.

## 1. Introduction

Magnetic Resonance Imaging (MRI) is increasingly becoming a cornerstone in modern diagnostic healthcare [1], offering

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<https://doi.org/10.1016/j.heliyon.2024.e28512>

Received 13 January 2024; Received in revised form 19 March 2024; Accepted 20 March 2024

Available online 26 March 2024

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unparalleled capabilities in fields such as stroke, dementia, and cancer screening [2–5]. As the healthcare economic model shifts towards value-based care, MRI is challenged to demonstrate its cost-effectiveness to healthcare providers [1]. Innovations in protocols for rapid image acquisition and the potential integration of artificial intelligence (AI) and machine learning promise to make MRI procedures more efficient and tailored to individual patient needs. There is an urgent need for collaboration among industry, academia, and healthcare systems to standardize MRI techniques and research to improve patient outcomes and reduce costs [1].

Global utilization of MRI is on the rise due to various factors, including technological advancements and changes in healthcare policy. Concerns over the radiation risks associated with computed tomography (CT) scans have led to a marked increase in MRI use, particularly among children, signaling a shift towards safer imaging methods. This trend is especially noticeable in the United States and Canada, reflecting both medical trust in MRI and systemic incentives to use it [6]. Post-COVID-19, the MRI market is experiencing a strong rebound, aiming for a compound annual growth rate of 2.5% through 2024. Technological advancements, such as portable MRI kits, are expected to diversify and expand medical referrals for MRI scans. These factors collectively point to a global trend of increased MRI usage, influenced by technological innovation and healthcare systems' evolution [7].

Based on Sanna Törnroos et al., the research priorities of radiography science in Europe are related to the radiographers' profession, clinical practice, and the safe, high-quality use of radiation and technology for medical imaging [8]. The research priorities among Norwegian radiation therapists (RTs) focus on enhancing professional practice, specifically in the areas of new techniques and competence [9]. The study suggests an emphasis on treatment planning, radiation dose, and therapist education. While the Australian RTs priorities were advanced imaging technologies, optimizing techniques and equipment, accuracy in patient positioning, patient care, and addressing management and staffing issues [10]. This prioritization of research areas and categories offers a useful list for researchers to consider and determine whether their research ideas are of high priority. However, to date, there is scarce information about the research priority for the Arab countries, particularly in MRI. In addition, the utilization of MRI in the Arab countries is not well understood. This bibliometric analysis study could catalyze to initiate such investigations and improve understanding.

Bibliometrics and scientometrics are quantitative methods used for analyzing publication history and mapping the development of scientific output in specific research fields [11,12]. These methods evaluate the performance and research trends of authors, journals, countries, and institutions, shedding light on patterns of collaboration [13]. They serve to identify key contributors such as influential authors, seminal publications, core journals, leading countries, and significant institutions in each field. These analyses can indicate the range and diversity of research, its multidisciplinary nature, recent advancements, research directions, and prevalent topics [14]. Additionally, they are useful for identifying gaps in research and informing decisions in academic ranking, journal evaluation, and the allocation of research funding [15,16]. While prior bibliometric studies have explored global MRI trends [17,18], the specific trajectory within regions characterized by heterogeneity patterns of health outcomes remains underexplored, particularly among Arab countries [19]. Bibliometric studies are rare in this field and have usually been limited to other regions or specific medical applications.

This study aimed to map medical MRI literature affiliated with Arab countries, focusing on publication trends, top journals, author affiliations, study countries, and authors' collaboration, and keyword analysis. The research questions of this bibliometric analysis were as follows.

1. What are the publication and citation trends of MRI publications conducted in Arab countries?
2. Which Arab countries contribute most to MRI research?
3. Which Arab organizations are the most prolific in MRI research?
4. What are the leading journals for MRI publications affiliated with Arab countries?
5. Who are the most prolific authors in MRI research affiliated with Arab countries?
6. What are the top highly cited MRI publications affiliated with Arab countries?
7. What keywords and specific research areas are prevalent in MRI publications from Arab countries?

Regarding this, the primary aim of this study was to conduct a bibliometric analysis of MRI publications from Arab countries, focusing on the following objectives.

1. To identify the publication and citation trends of MRI publications affiliated with Arab countries.
2. To identify the top contributing Arabic countries in MRI research.
3. To identify the most prolific Arabic organizations in MRI research.
4. To identify the leading journals for MRI publications affiliated with Arab countries.
5. To identify the most prolific authors in MRI research affiliated with Arab countries.
6. To identify the top cited publications in MRI research affiliated from Arab countries.
7. To identify the prevalence of research keywords and areas within MRI publications from Arab countries.

## 2. Methods

### 2.1. Study design

This study was a comprehensive bibliometric analysis of MRI-related publications in the medical field within Arab countries. It focused on examining publication trends, identifying leading journals, analyzing author affiliations, exploring contributing countries, assessing authors' collaborations, and conducting keyword analysis.

## 2.2. Search strategy and data collection

This study used the Scopus database to perform bibliometric analysis. Scopus is a vast database containing abstracts and citations for academic research literature, covering various disciplines, including engineering, medicine, social sciences, art, and humanities. For citation data, Clarivate Analytics' Web of Science (WoS) and Elsevier's Scopus are the primary sources used for bibliometric analysis [20]. Although WoS was the first data source available and is widely recognized in the academic community, Scopus has become a suitable alternative [21], with more comprehensive content coverage in some domains [22], higher than WoS [23,24]. Moreover, Scopus offers individual profiles for all authors, institutions, and serial sources [25], and it contains a more recent and wider range of journals [26]. To avoid errors caused by the integration of data from different databases, having different formats, this study used a single database to retrieve the data [27].

We performed the following search strategy that focused on the title, abstract, and keywords: TITLE-ABS-KEY (("magnetic resonance imag\*" OR "resonance imag\*" OR "nuclear magnetic imag\*" OR nmr OR mri OR mris OR "Echo Imag\*" OR "Spin Echo" OR "Cine MRI" OR "Cine Magnetic Resonance" OR "Echo-Planar Imag\*" OR "Magnetization Transfer Contrast Imag\*") AND (algeria\* OR bahrain\* OR egypt\* OR iraq\* OR jordan\* OR kuwait\* OR lebanon\* OR libya\* OR morocco\* OR oman\* OR palestine\* OR qatar\* OR saudi\* OR ksa\* OR somalia\* OR sudan\* OR syria\* OR tunisia\* OR emirat\* OR yemen\* OR "middle east\*" OR "north africa\*" OR "mena region")) AND AFFIL (algeria\* OR bahrain\* OR egypt\* OR iraq\* OR jordan\* OR kuwait\* OR lebanon\* OR libya\* OR morocco\* OR oman\* OR palestine\* OR qatar\* OR saudi\* OR ksa\* OR somalia\* OR sudan\* OR syria\* OR tunisia\* OR emirat\* OR yemen\* OR "middle east\*" OR "north africa\*" OR "mena region") AND (LIMIT-TO (SUBJAREA, "MEDI"))).

## 2.3. Inclusion and exclusion criteria

We included all MRI-related publications that were conducted in and affiliated with Arab countries, encompassing a variety of publication types such as original research articles, books, conference papers, reviews, and others. The time span for included publications extended from the inception of the field to December 31, 2022. The search was limited to publications within the field of Medicine. To ensure the relevance of the retrieved publications to the study objectives, two authors (AA and AMA) manually reviewed a random sample of approximately 25% of the publications. Subsequently, the data were exported as a comma-separated values (CSV) file, incorporating all variables provided by Scopus.

**Table 1**  
Main bibliometric information for publications between 1988 and 2022.

Main information	Total
<b>Productivity</b>	
Number of total publications	2592
Number of active years of publication	35
Productivity per active year	74.1
Annual Growth Rate %	17.9
<b>Types of publication</b>	
Original	2378
Reviews	114
Conference papers	15
Books	3
Others	83
<b>Impact</b>	
Total citations	22,115
Average Citations per publication, %	8.53
Number of cited publications	1978
Citations per cited publication	11.18
h-index	52
g-index	77
<b>Authorship</b>	
Co-authored publications	2449
Sole-authored publications	143
Number of contributing authors	16,181
Authors	12,426
Authors of sole-authored publications	134
Co-Authors per publication	6.3
Local co-authorships %	73.6
<b>Collaboration</b>	
Annual collaboration index	5.24
Collaboration index	6.2
Collaboration coefficient	0.84
International co-authorships %	26.4

## 2.4. Bibliometric indices and data analysis

The retrieved data were exported to Microsoft Excel and Biblioshiny [28]. The following bibliometric indices were calculated using Microsoft Excel: Total number of publications (TP), total citations (TC), average citations (AC), sole-authored publications (SA), co-authored publications (CA), number of contributing authors (NCA), annual collaboration index (ACI), number of cited publications (NCP), citations per cited publication (CCP), collaboration index (CI), collaboration coefficient (CC), average citation per year (AC/Y) and authors indices (h-index, g-index, and global h-index). These bibliometric indices were estimated for each publication year. Additionally, to explore the relationship between authors and their publication output, we calculated the distribution of the productivity of authors and the number of publications based on Lotka's law, using Biblioshiny.

## 2.5. Visualization techniques

The Biblioshiny and VOSviewer software were used to analyze and visualize the relationships between authors, sources, countries, affiliations, and authors' keywords [29–31]. These relationships were depicted through science mapping. Biblioshiny was employed to examine the productivity of authors over time, with a focus on the 20 most productive authors. Additionally, a map illustrating the scientific production of countries was presented using graduated colors, where darker blue indicates higher productivity. A three-field plot was also provided to analyze the relationship among the most frequent countries, authors, and keywords.

We also performed a co-authorship network analysis to identify the most influential authors. In this analysis, publications involving more than 25 authors were omitted to maintain focus on core collaborations, setting a threshold of at least five publications and citations for individual authors. Similarly, for the analysis based on countries of co-authors, we excluded publications that included contributions from more than 25 countries, considering only those countries contributing to at least five publications. However, we placed no limitation on the number of citations in the co-authorship analysis by countries.

In our co-occurrence analysis aimed at uncovering prevalent topics related to MRI in Arab countries, we included only those author

**Table 2**  
Bibliometrics by the year of publication for total publications.

Year	TP	TC	AC	SA	CA	NCA	ACI	NCP	CCP	CI	CC	h-index	g-index
1988	1	17	17.0	0	1	5	4.00	1	17.00	5.00	0.80	0	1
1989	1	12	12.0	0	1	5	4.00	1	12.00	5.00	0.80	0	1
1990	2	37	18.5	0	2	7	2.50	1	37.00	3.50	0.71	1	2
1991	8	281	35.1	1	7	29	2.63	8	35.13	3.63	0.72	7	8
1992	7	128	18.3	1	6	32	3.57	7	18.29	4.57	0.78	5	7
1993	8	137	17.1	0	8	36	3.50	7	19.57	4.50	0.78	5	8
1994	11	458	41.6	1	10	53	3.82	10	45.8	4.82	0.79	8	11
1995	8	455	56.9	1	7	37	3.63	7	65.00	4.63	0.78	6	8
1996	7	70	10.0	0	7	30	3.29	5	14.00	4.29	0.77	4	7
1997	8	151	18.9	2	6	23	1.88	5	30.20	2.88	0.65	5	8
1998	12	106	8.8	2	8	47	2.92	8	13.25	3.92	0.74	5	10
1999	14	162	11.6	1	13	64	3.57	12	13.50	4.57	0.78	7	14
2000	22	468	21.3	2	20	116	4.27	21	22.29	5.27	0.81	11	21
2001	22	368	16.7	4	18	92	3.18	20	18.40	4.18	0.76	9	19
2002	38	493	13.0	3	35	192	4.05	32	15.41	5.05	0.80	14	21
2003	38	857	22.6	1	37	196	4.16	36	23.81	5.16	0.81	16	29
2004	40	664	16.6	5	35	184	3.60	37	17.95	4.60	0.78	17	25
2005	44	832	18.9	6	38	184	3.18	36	23.11	4.18	0.76	15	28
2006	62	869	14.0	4	58	320	4.16	56	15.52	5.16	0.81	16	28
2007	40	381	9.5	4	36	196	3.90	31	12.29	4.90	0.80	9	18
2008	67	935	14.0	7	60	349	4.21	52	17.98	5.21	0.81	17	29
2009	81	854	10.5	4	77	414	4.11	70	12.20	5.11	0.80	17	25
2010	84	835	9.9	6	78	423	4.04	69	12.10	5.04	0.80	15	26
2011	108	1035	9.6	10	98	504	3.67	93	11.13	4.67	0.79	18	26
2012	117	954	8.2	10	107	546	3.67	99	9.64	4.67	0.79	17	23
2013	136	1492	11.0	8	128	716	4.26	114	13.09	5.26	0.81	20	31
2014	130	1364	10.5	9	121	729	4.61	109	12.51	5.61	0.82	20	29
2015	113	1571	13.9	6	107	722	5.39	97	16.20	6.39	0.84	19	37
2016	128	1251	9.8	6	122	809	5.32	110	11.37	6.32	0.84	19	26
2017	126	1307	10.4	5	121	766	5.08	113	11.57	6.08	0.84	21	27
2018	165	1167	7.1	5	160	1028	5.23	141	8.28	6.23	0.84	16	24
2019	171	763	4.5	6	165	1031	5.03	138	5.53	6.03	0.83	12	17
2020	241	784	3.3	7	234	1539	5.39	180	4.36	6.39	0.84	10	16
2021	262	624	2.4	8	254	1905	6.27	162	3.85	7.27	0.86	10	16
2022	270	233	0.9	8	262	2852	9.56	90	2.59	10.56	0.91	6	10
<b>Total</b>	<b>2592</b>	<b>22,115</b>	<b>8.53</b>	<b>143</b>	<b>2449</b>	<b>16,181</b>	<b>5.24</b>	<b>1978</b>	<b>11.18</b>	<b>6.2</b>	<b>0.84</b>	<b>52</b>	<b>77</b>

**Notes:** TP = Total number of publications, TC = Total citations, AC = Average Citations, SA= Sole-authored publications, CA= Co-authored publications, NCA= Number of contributing authors, ACI = Annual collaboration index, NCP= Number of cited publications, CCP= Citations per cited publication, CI=Collaboration index, CC= Collaboration coefficient.

keywords that appeared in publications at least nine times. To sharpen the focus on scientific themes, we excluded names of countries and regions, as well as synonyms of MRI, to prevent confusion. Additionally, To eliminate redundancy in similar keywords that define the same concept, we applied normalization based on the strength of association.

### 3. Results

Table 1 presents the main bibliometrics information. Between 1988 and 2022, a total of 2592 have been published and cited 22,115 times, with an average of 8.53 citations per publication. Most of publications were original articles (TP = 2378), followed by reviews (TP = 114), others (TP = 83), conference papers (TP = 15), and books (TP = 3). The research had a collective impact, as highlighted by the h-index of 52 and the g-index of 77. The academic domain spans 772 distinct journals and involves 12,426 authors. In total, there were 2449 publications that were co-authored, and out of these, 25.4% were international co-authorships. The collaboration index was 6.2 and collaboration coefficient was 0.84. While 143 publications were solo-authored by 134 different authors.

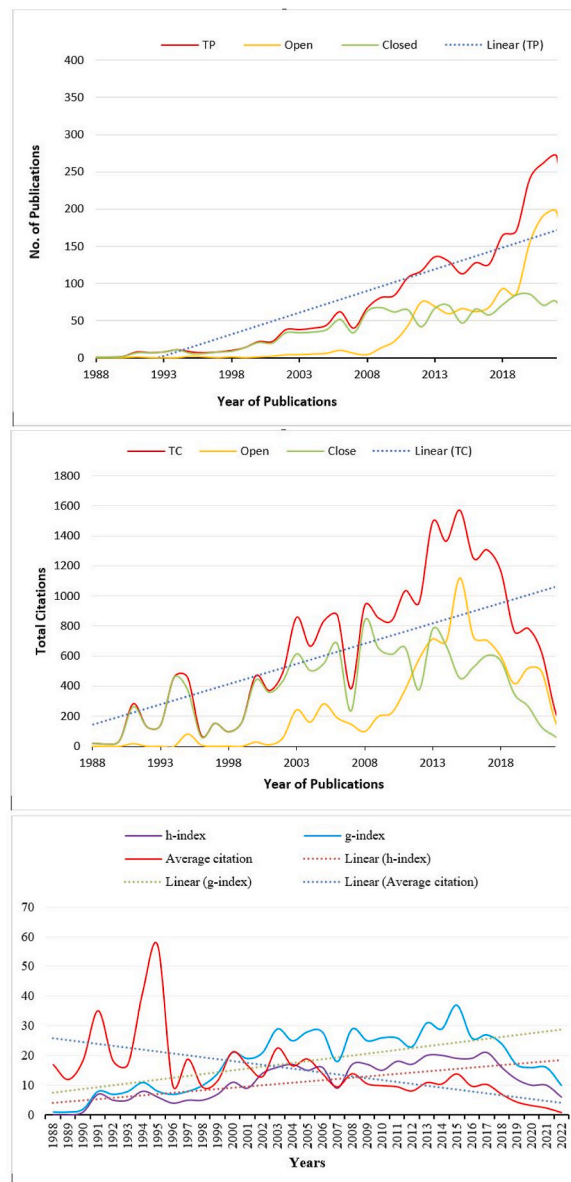


Fig. 1. The total number of publications (a), and total citations (b). Average citation, h-index, and g-index by year (c). Note: TP: Total publications, TC: Total citations.

### 3.1. Annual publications and citations trend

The trend of publications by the year of publication is comprehensively illustrated in Table 2. The publications steadily increased over time with an annual growth rate of publication was 17.9%. The number of publications ranged between 1 in 1988 and 270 in 2022. Correspondingly, the TC of these publications displayed an increase over time, with a minimum of 17 in 1988 and a maximum of 233 in 2022. All bibliometric indices have relatively improved over the years of publication.

Fig. 1 shows the productivity and impact of the research over time across the types of journal (traditional and open-access journals). The total number of publications steadily increased annually until 2013; there was an exponential growth in publications. In contrast, open-access journals had a lower number of publications until 2010, after which they also experienced exponential growth, transcending the number of publications in traditional journals from 2012 and later (Fig. 1a).

The total citations by year of publication have increased for all types of publications. The total citations for the publications published in open-access journals reached a peak in 2015 (TC = 1118) and transcends the total citation for publications in traditional journals in 2012, except for the year 2013. We noticed a sharp drop in the number of citations for the total citations of all publications and publications published in open-access journals after 2015 (Fig. 1b). Additionally, the annual h-index and g-index values have improved over time, peaking in 2017 (h-index = 21) and in 2015 (g-index = 37), which indicates growing recognition and impact in the field (Fig. 1c). While the annual average citation has reduced, with a peak of 56.88 in 1995.

### 3.2. The most prolific countries

A total of 124 countries have contributed to the identified publications. Fig. 2 and Table 3 represent the most productive countries. Leading the ranking was Saudi Arabia (TP = 724, TC = 6915), followed closely by Egypt (TP = 713, TC = 5854), and Tunisia (TP = 272, TC = 2294).

Fig. 3 represents the network mapping of coauthorship-countries. There were 41 connections. The most collaborative Arab country with the largest total link strength (TLS) was Saudi Arabia (TLS = 443), followed by Egypt (TLS = 410), and Tunisia (TLS = 306). The most contributing non-Arabic countries were the USA (TLS = 318), followed by France (TLS = 223), and the United Kingdom (TLS = 196).

### 3.3. The most prolific affiliations

Table 4 presents the top 20 active affiliations according to the number of publications. Cairo University was the most productive affiliation (TP = 605), followed by the Ain Shams University (TP = 373), King Faisal Specialist Hospital And Research Center (TP = 345), King Saud University (TP = 297), and King Saud Bin Abdulaziz University For Health Sciences (TP = 281). Seven of the top 20 affiliations are based in Egypt, six from Saudi Arabia, three from Jordan, two from Oman, one from Lebanon, and one from Sudan.

### 3.4. The most leading journal

Table 5 presents the top 20 most leading journals in the field. The top-ranked journal is the *Egyptian Journal of Radiology and Nuclear Medicine* (TP = 117), followed by the *Saudi Medical Journal* (TP = 86) and *Neurosciences* (TP = 79). The most impactful journal was *The Journal of Natural Products* (TC = 1,377, AC = 29.93), followed by *Saudi Medical Journal* (TC = 465, AC = 5.41), and *The Egyptian Journal of Radiology and Nuclear Medicine* (TC = 435, AC = 3.72). The *American Journal of Medical Genetics* and *Revue Neurologique* have the highest collaboration index (CI = 9.77 and CI = 6.96, respectively).

Country Scientific Production

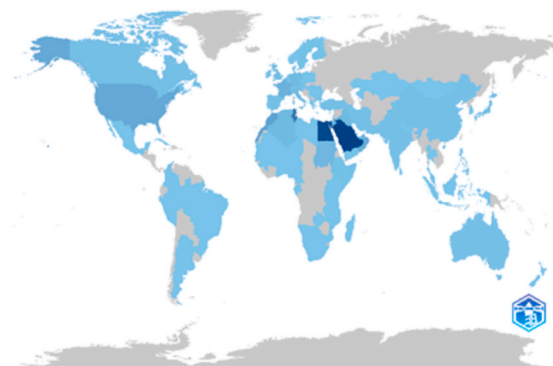
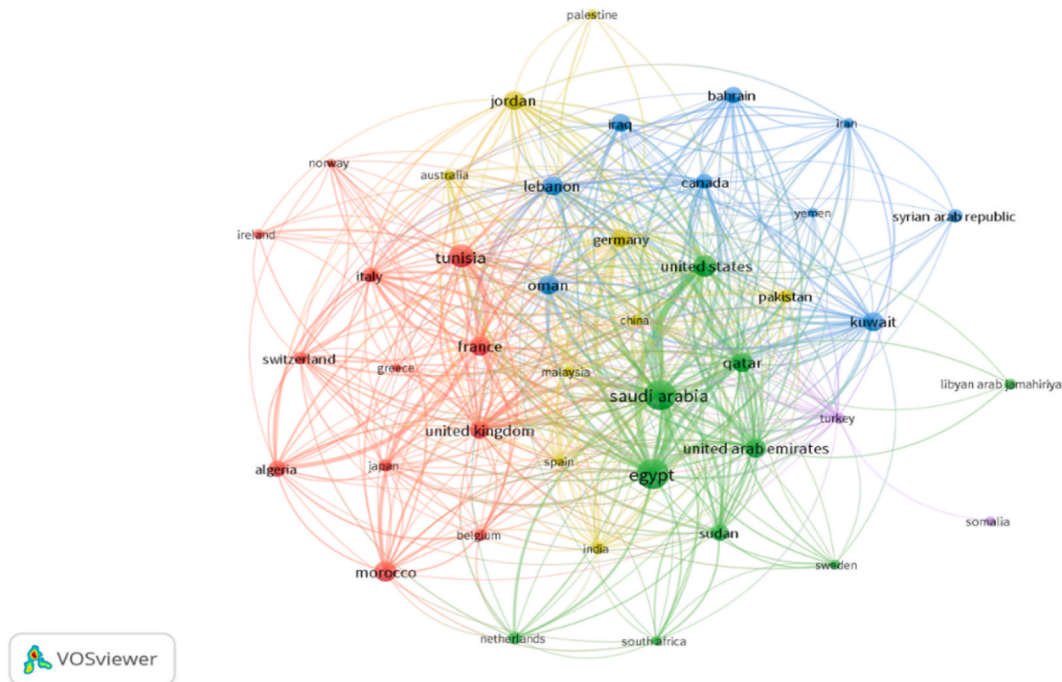


Fig. 2. The most prolific countries, the darker the blue color, the higher the productivity.

**Table 3**  
The top 20 productive countries.

Rank	Country	TP	TC	AC	TLS
1	Saudi Arabia	724	6915	9.55	443
2	Egypt	713	5854	8.21	410
3	Tunisia	272	2294	8.43	306
4	United States	182	3366	18.49	125
5	Morocco	143	1200	8.39	185
6	Kuwait	126	1212	9.62	206
7	France	125	1909	15.27	177
8	Jordan	125	938	7.50	135
9	Oman	122	937	7.68	125
10	Qatar	120	1369	11.41	158
11	United Arab Emirates	109	943	8.65	66
12	Lebanon	108	1378	12.76	112
13	United Kingdom	92	1974	21.46	82
14	Iraq	87	376	4.32	173
15	Germany	74	1631	22.04	101
16	Algeria	70	1007	14.39	103
17	Bahrain	57	209	3.67	81
18	Sudan	55	589	10.71	104
19	Italy	46	1105	24.02	49
20	Canada	41	432	10.54	40

Notes: TP = Total Publications, TC = Total Citations, AC = Average Citations, TLS = Total link strength.



**Fig. 3.** Network visualization map for co-authorship countries (international collaboration).

### 3.5. he most prolific authors

Most authors (n = 10,506) have one publication, 1784 authors have two to five publications, 332 authors have six to 20 publications, and only two authors have more than 20 publications. Table 6 shows the top 20 authors ranked based on the total publications. The top 20 published authors had more than 12 publications on the topic (range 12–25). Among them, nine were from Saudi Arabia, six were from Egypt, three were from Tunisia, one was from Sudan, and one was from Kuwait. Maha S. Zaki was the most productive author (TP = 25), followed by Fowzan Alkuraya (TP = 22), and Majid Alfadhel, (TP = 18). Regarding the total citation, the most impactful author was Fowzan Alkuraya (TC = 335, h-index = 10). Although Saeed Bohlega has only 14 publications, he was an impactful author (TC = 332, h-index = 11). Fig. 4 represents the productivity of the top 20 authors over time. Fig. 5 illustrates the network of author co-authorship showing that the largest set of connected authors consists of 85 authors within 12 clusters. Because

**Table 4**

Top 20 productive affiliations that contributed to MRI research.

Rank	Affiliations	Publications	Countries
1	Cairo University	605	Egypt
2	Ain Shams University	373	Egypt
3	King Faisal Specialist Hospital And Research Center	345	Saudi Arabia
4	King Saud University	297	Saudi Arabia
5	King Saud Bin Abdulaziz University For Health Sciences	281	Saudi Arabia
6	National Research Centre	203	Egypt
7	American University Of Beirut Medical Center	200	Lebanon
8	University Of Khartoum	184	Sudan
9	Zagazig University	177	Egypt
10	Sultan Qaboos University Hospital	154	Oman
11	King Abdulaziz University	146	Saudi Arabia
12	Mansoura University	140	Egypt
13	Kuwait University	134	Kuwait
14	Alexandria University	134	Egypt
14	Assiut University	112	Egypt
15	Jordan University Hospital	105	Jordan
16	Sultan Qaboos University	99	Oman
17	Imam Abdulrahman Bin Faisal University	91	Saudi Arabia
18	University Of Jordan	88	Jordan
19	King Khalid University Hospital	84	Saudi Arabia
20	Jordan University Of Science And Technology	71	Jordan

**Table 5**

A bibliometric analysis of the most prolific journals.

Rank	Journals Title	TP	TC	AC	SA	CA	NCA	ACI	NCP	CI	CC	Local h-index	Global h-index	g-index
1	Egyptian Journal of Radiology and Nuclear Medicine	117	435	3.72	7	110	418	2.57	96	3.57	0.72	9	19	12
2	Saudi Medical Journal	86	465	5.41	14	72	333	2.87	71	3.87	0.74	12	62	16
3	Neurosciences	79	305	3.86	12	67	310	2.92	56	3.92	0.75	10	28	14
4	Egyptian Journal of Neurology Psychiatry, and Neurosurgery	76	163	2.14	–	76	373	3.91	43	4.91	0.80	7	16	9
5	Journal of Medical Case Reports	47	171	3.64	2	45	263	4.6	33	5.60	0.82	7	39	10
6	Pan African Medical Journal	47	117	2.49	–	47	247	4.26	35	5.26	0.81	7	47	8
7	Journal of Natural Products	46	1377	29.93	3	43	301	5.54	46	6.54	0.85	24	175	36
8	American Journal of Medical Genetics	35	412	11.77	–	35	342	8.77	30	9.77	0.9	12	129	19
9	Sultan Qaboos University Medical Journal	34	106	3.12	1	33	159	3.68	29	4.68	0.79	5	34	7
10	Oman Medical Journal	33	126	3.82	–	33	170	4.15	21	5.15	0.81	5	44	10
11	Annals of Medicine and Surgery	30	72	2.40	1	29	187	5.23	12	6.23	0.84	4	42	8
12	Bahrain Medical Bulletin	29	12	0.41	6	23	84	1.9	9	2.90	0.65	1	14	2
13	Journal of Child Neurology	28	347	12.39	1	27	151	4.39	27	5.39	0.81	12	125	17
14	International Journal of Surgery Case Reports	27	54	2.00	–	27	135	4.00	17	5.00	0.8	5	28	6
15	Jordan Medical Journal	27	9	0.33	3	24	114	3.22	4	4.22	0.76	2	10	2
16	Revue Neurologique	25	125	5.00	–	25	174	5.96	20	6.96	0.86	7	77	10
17	Annals of Saudi Medicine	24	133	5.54	4	20	113	3.71	22	4.71	0.79	6	54	10
18	Natural Product Communications	23	240	10.43	1	22	128	4.57	23	5.57	0.82	9	61	14
19	Egyptian Rheumatologist	21	67	3.19	1	20	138	5.57	14	6.57	0.85	4	21	7
20	American Journal of Case Reports	19	55	2.89	1	18	93	3.89	11	4.89	0.80	4	53	7

Notes: TP = Total number of publications, TC = Total citations, AC = Average Citations, SA= Sole-authored publications, CA= Co-authored publications, NCA= Number of contributing authors, ACI = Annual collaboration index, NCP= Number of cited publications, CI=Collaboration index, CC= Collaboration coefficient.

some names may overlap, others may not be shown.

### 3.6. The most cited publications

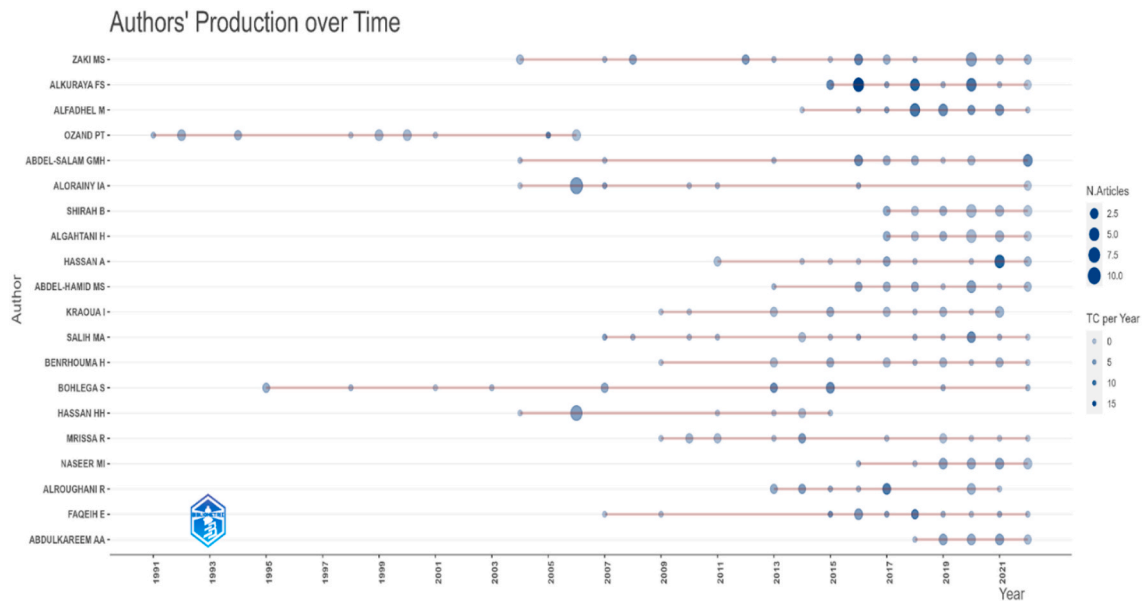
Table 7 shows the 20 most impacted publications. The study titled *Severe neurologic syndrome associated with Middle East respiratory*



**Table 6**  
The most relevant authors.

Rank	Rank of citation	Author	TP	TC	AC	Local h-index	Global h-index	g-index	PY_start	Country
1	3	Maha S Zaki,	25	310	12.4	11	44	17	2004	Egypt
2	1	Fowzan S Alkuraya	22	335	15.23	10	67	18	2015	Saudi Arabia
3	8	Majid Alfadhel	18	183	10.17	8	30	13	2014	Saudi Arabia
4	10	Ghada M.H Abdel-Salam	17	178	10.47	7	31	13	2004	Egypt
5	4	Ibrahim Alorainy	17	213	12.53	9	19	14	2004	Saudi Arabia
6	18	Bader H Shirah	17	48	2.82	4	11	6	2017	Saudi Arabia
7	19	Hussein A Algahtani,	16	48	3.00	4	15	6	2017	Saudi Arabia
8	14	Hassan Amer	16	81	5.06	5	18	8	2011	Egypt
9	11	Mohamed. Abdel-Hamid	15	104	6.93	5	17	10	2013	Egypt
10	15	Ichraf Kraoua	15	70	4.67	5	11	7	2009	Tunisia
11	5	Mustafa A.M. Salih	15	213	14.2	9	25	14	2007	Sudan
12	16	Hanène Benrhouma	14	68	4.86	5	7	7	2009	Tunisia
13	2	Saeed A Bohlega	14	332	23.71	11	39	14	1995	Saudi Arabia
14	13	Hamdy H Hassan	14	98	7.00	6	11	9	2004	Egypt
15	12	Ridha Mrissa	14	102	7.29	7	12	10	2009	Tunisia
16	17	Muhammad I Naseer	14	64	4.57	5	22	7	2016	Saudi Arabia
17	7	Raed A Alroughani	13	183	14.08	9	33	13	2013	Kuwait
18	6	Eissa A Faqeih	13	212	16.31	8	40	13	2007	Saudi Arabia
19	20	Angham A Abdulkareem	12	47	3.92	4	7	6	2018	Saudi Arabia
20	9	Tarek A Rageh	12	178	14.83	9	15	12	2010	Egypt

Notes: TP = Total number of publications, TC = Total citations, AC = Average Citations, PY\_start = Publications year start.



**Fig. 4.** Authors' Production over Time. The circle size indicates the number of publications, while the shade of color indicates the number of citations per year, and the line indicates the time span.

*syndrome coronavirus (MERS-CoV)* ranked first (TC = 286), which was published in *Infection Journal and* conducted by Yaseen M Arabi who was affiliated with the King Saud bin Abdulaziz University for Health Sciences in Riyadh, Saudi Arabia. This was followed by a study titled *Juvenile Myoclonic Epilepsy: A 5-Year Prospective Study* (TC = 282) which was published in *Epilepsia Journal* and conducted by Panayiotopoulos who was affiliated with St Thomas' Hospital in London, United Kingdom. Daif Abdulkader from the College of Medicine in Riyadh, Saudi Arabia, published a study titled *Cerebral venous thrombosis in adults: A study of 40 cases from Saudi Arabia* (TC = 242) published in *Stroke*.

### 3.7. Keyword analysis

Fig. 6 depicts the three-field plot which represents the relationship between the most frequent keywords, authors, and countries. Each group is represented by a rectangle, with the area of each rectangle proportionate to the value for the most frequently used keywords, and the thickness of the links between keywords, authors, and countries indicates a significant flow of information between

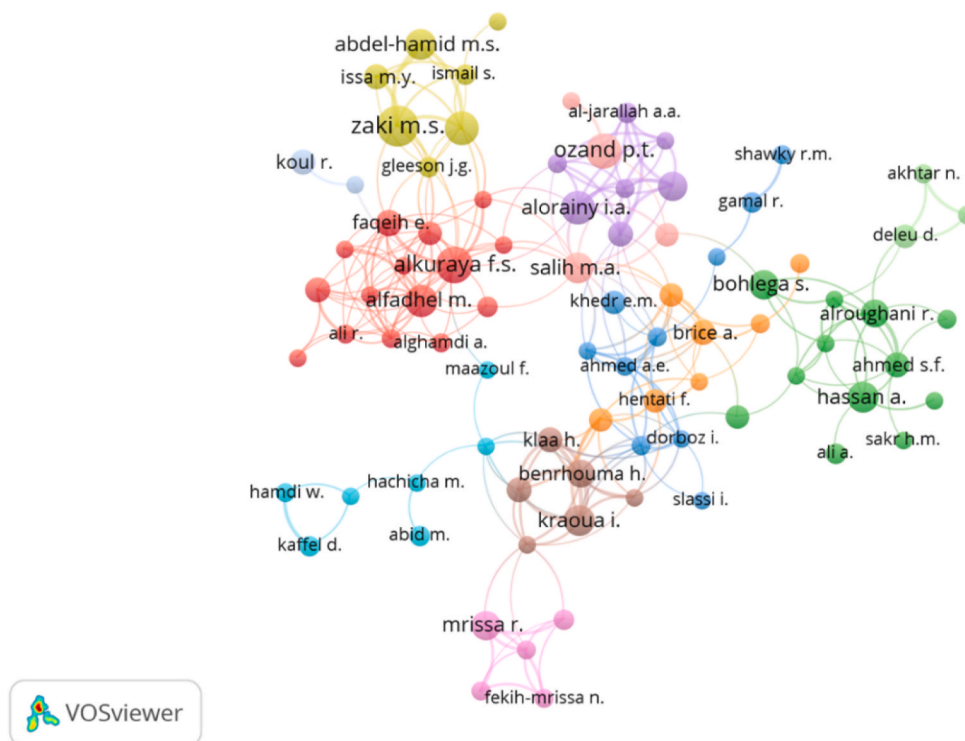


Fig. 5. VOSviewer network of author co-authorship map weighted by the number of publications.

the associated set of values.

Fig. 7 represents the year of publication and the trending topics in MRI-related research as identified by authors. There were 65 high-frequency keywords, occurring nine times and more, linked into nine distinct clusters. The cluster contains the latest trends. The most frequently occurring keywords were "magnetic resonance imaging" (co-occurrence = 299), "multiple sclerosis" (co-occurrence = 82), "case report" (co-occurrence = 71), "children" (co-occurrence = 50), "epilepsy" (co-occurrence = 43) and "COVID-19" (co-occurrence = 38).

#### 4. Discussion

Our bibliometric and scientometric analysis of medical MRI from 1988 to 2022 explored this field of research in Arab countries. Most publications were original articles published in traditional journals. While the number of publications and citations increased steadily over time. Saudi Arabia, Egypt, and Tunisia were the most active countries in the MRI research. The most prolific author was Maha S Zaki. The most prolific journal was the "Egyptian Journal of Radiology and Nuclear Medicine". The most prolific affiliation was Cairo University. The "multiple sclerosis" and "case report" were the most trending keywords.

We identified a pattern in the growth of MRI research publications. MRI research in the Arab world has been growing exponentially since 2013, with an impressive annual growth rate. This increase is in line with global trends in MRI referrals as it gains more recognition and prominence worldwide [6,7]. This is likely due to improvements in healthcare capabilities and research infrastructure in Arab countries. The publications of Arab countries also received significant attention reflected by the average citation and h-index. These metrics highlight the relevance and quality of MRI research in the region. Due to the 'citation lag' phenomenon, recent publications have not had enough time to accumulate citations.

The study found that most publications were original articles, indicating a strong focus on primary research and generating new knowledge. The number of publications in open-access journals has increased significantly in recent years and exceeds the number of publications published in traditional journals. This might have enhanced their accessibility and thus contributed to improving their impact. This may be due to wider readership and citation opportunities [52,53]. Studies show that open-access publications have higher citation rates than traditional publications [54–56]. However, some fields still value traditional articles, particularly in prestigious journals.

The United States and the United Kingdom were the most common collaborations with Arab countries. in MRI research. This could be due to the fact that these countries are the leading contributors to scientific research [57]. Additionally, they are the most productive of most bibliometric analyses [58–60].

Our results show that Saudi Arabia and Egypt were leading the MRI research in the Arab in terms of the number of publications. A large number of MRI research publications in both countries, especially by their leading institutions (Cairo University, King Faisal

**Table 7**  
Top 20 most cited publications.

Rank	Title	TC	TC/ Y	NCA	Year	Journal	First Author (ID)	Affiliation
1	Severe neurologic syndrome associated with Middle East respiratory syndrome corona virus (MERS-CoV) [32]	286	31.8	13	2015	Infection	Yaseen M Arabi (7004353546)	King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia
2	Juvenile Myoclonic Epilepsy: A 5-Year Prospective Study [33]	282	9.4	3	1994	Epilepsia	Panayiotopoulos, C. P. (7006902731)	St Thomas' Hospital, London, United Kingdom
3	Cerebral venous thrombosis in adults: A study of 40 cases from Saudi Arabia [34]	242	8.3	7	1995	Stroke	Daif, Abdulkader (35517195100)	College of Medicine, Riyadh, Saudi Arabia
4	Mutations in SPG11 are frequent in autosomal recessive spastic paraplegia with thin corpus callosum, cognitive decline and lower motor neuron degeneration [35]	172	10.8	38	2008	Brain	Stevanin, Giovanni (56385311700)	Université de Bordeaux, Bordeaux, France
5	Mutation of FA2H underlies a complicated form of hereditary spastic paraplegia (SPG35) [36]	160	11.4	15	2010	Human Mutation	Dick, Katherine J. (35607978200)	St George's, University of London, London, United Kingdom
6	Vitamin d deficiency and chronic low back pain in Saudi Arabia [37]	158	7.5	2	2003	Spine	Al Faraj, Saud (6603242151)	Riyadh Military Hospital, Riyadh, Saudi Arabia
7	Kufor Rakeb disease: Autosomal recessive, levodopa-responsive Parkinsonism with pyramidal degeneration, supranuclear gaze palsy, and dementia [38]	156	8.2	5	2005	Movement Disorders	Williams, David R. (3526550040)	Van Cleef Roet Centre for Nervous Diseases, Australia
8	Biotin-responsive basal ganglia disease maps to 2q36.3 and is due to mutations in SLC19A3 [39]	149	7.8	8	2005	American Journal of Human Genetics	Zeng, Wen-Qi (24178782200)	City of Hope National Med Center, Duarte, United States
9	Resolvin E1 (RvE1) attenuates atherosclerotic plaque formation in diet and inflammation-induced atherogenesis [40]	144	16.0	7	2015	Arteriosclerosis, Thrombosis, and Vascular Biology	Hasturk, Hatice (6506490350)	Forsyth Institute, Boston, United States
10	Elevated liver iron concentration is a marker of increased morbidity in patients with I <sup>2</sup> thalassemia intermedia [41]	137	10.5	7	2011	Haematologica	Musallam, Khaled M. (24335608600)	International Network of Hematology, London, United Kingdom
11	Bioactive metabolites from the endophytic fungus Stemphylium globuliferum isolated from Mentha pulegium [42]	131	8.7	14	2009	Journal of Natural Products	Debbab, Abdessamad (26537326000)	Debbab Med, Munich, Germany
12	Prevalence and patterns of neurological involvement in Behcet's disease: A prospective study from Iraq [43]	112	5.3	3	2003	Journal of Neurology Neurosurgery and Psychiatry	Al-Araji, Adnan (6603441226)	Royal Stoke University Hospital, Stoke-on-Trent, United Kingdom
13	Nodding syndrome [44]	98	8.9	13	2013	Emerging Infectious Diseases	Dowell, Scott F. (55628589138)	Centers for Disease Control and Prevention, Atlanta, United States
14	Mycetoma in the Sudan: An Update from the Mycetoma Research Centre, University of Khartoum, Sudan [45]	96	10.7	4	2015	PLoS Neglected Tropical Diseases	Fahal, Ahmed (7003586025)	Khartoum University, Khartoum, Sudan
15	GJA12 mutations in children with recessive hypomyelinating leukoencephalopathy [46]	93	5.2	9	2006	Neurology	Bugiani, M. (7004028193)	Amsterdam UMC - University of Amsterdam, Amsterdam, Netherlands
16	A peroxisomal disorder of severe intellectual disability, epilepsy, and cataracts due to fatty acyl-CoA reductase 1 deficiency [47]	92	9.2	13	2014	American Journal of Human Genetics	Buchert, Rebecca (49461068900)	Eberhard Karls Universität Tübingen, Tübingen, Germany
17	Neurologic involvement in behcet disease: Imaging findings in 16 patients [48]	86	2.2	4	1991	American Journal of Neuroradiology	Banna, M. (7005380853)	King Faisal Specialist Hosp., Riyadh, Saudi Arabia

(continued on next page)

Table 7 (continued)

Rank	Title	TC	TC/Y	NCA	Year	Journal	First Author (ID)	Affiliation
18	Mutations in OSTM1 (grey lethal) define a particularly severe form of autosomal recessive osteopetrosis with neural involvement [49]	85	4.7	14	2006	Journal of Bone and Mineral Research	Pangrazio, Alessandra (6506517909)	Consiglio Nazionale delle Ricerche, Rome, Italy
19	New quinoline alkaloids from <i>Ruta chalepensis</i> [50]	80	3.3	4	2000	Journal of Natural Products	El Sayed, Khalid (35500864400)	University of Louisiana at Monroe, Monroe, United States
20	Alkaloids and polyketides from <i>Penicillium citrinum</i> , an endophyte isolated from the Moroccan plant <i>Ceratonia siliqua</i> [51]	78	7.1	8	2013	Journal of Natural Products	El-Neketi, Mona (55779778700)	Faculty of Pharmacy, Mansoura, Egypt

Notes: TC = Total citations, TC/Y = Total citation per year, NCA= Number of contributing authors.

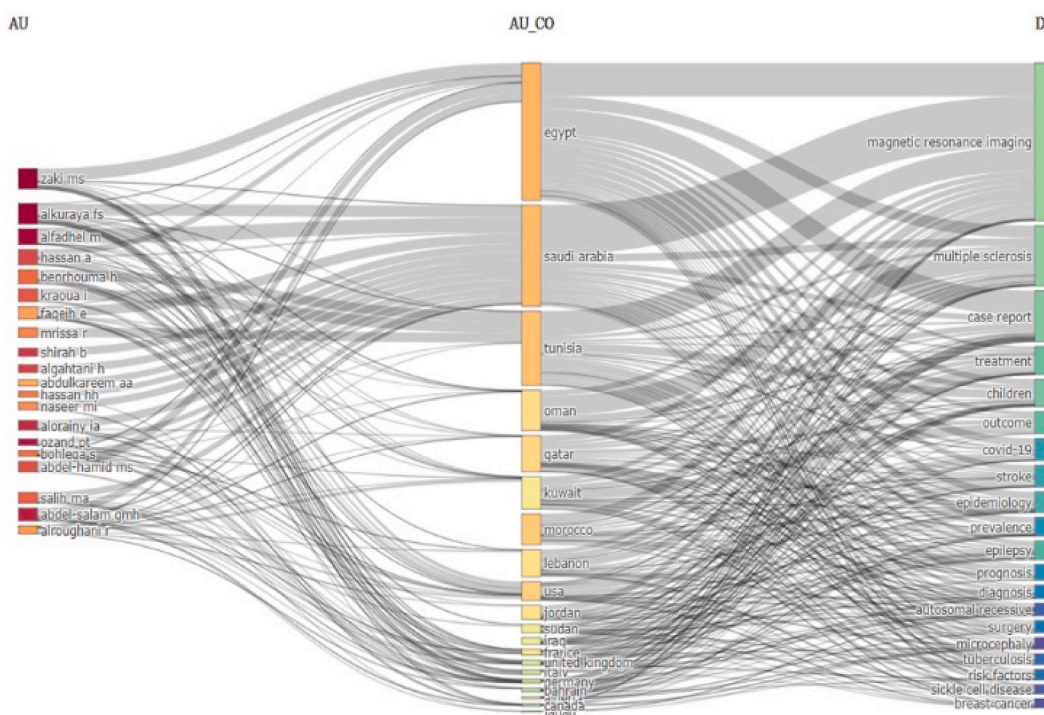
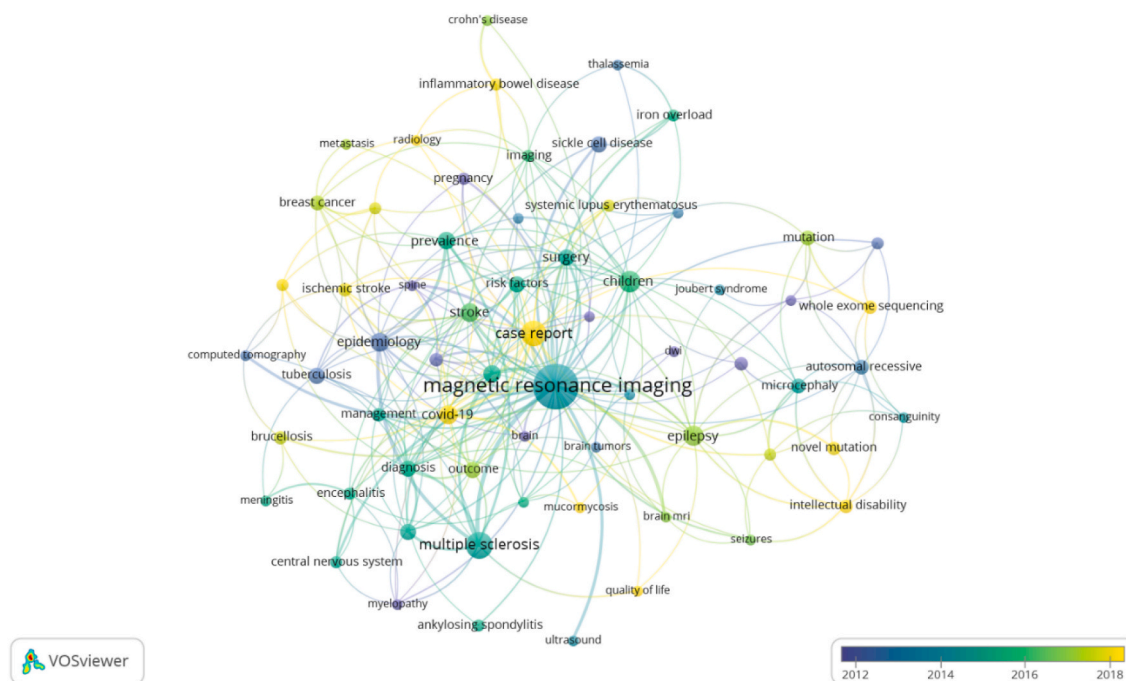


Fig. 6. The three-field plot “Sanky plot”. The relationship between keywords, authors, and countries was found in MRI field research. AU= Authors, AU-CO= Authors country, DE = Authors keywords.

Specialist Hospital, And Research Center). These research institutions likely have well-established MRI research programs and resources, which attract researchers and facilitate collaboration [61]. Additionally, Saudi Arabia and Egypt have a relatively large population, 36 million and 111 million in 2022, respectively [62]. Saudi Arabia invested extensively in the needed resources for medical and scientific research over the years. Saudi Arabia has also rapidly become a major player in scientific research, as research and development (R&D) is one of the main pillars of the Saudi Vision 2030, with the specific goal of having at least five Saudi universities among the top 200 in the world by 2030 [63,64].

In contrast, despite the large number of MRI publications from Arab countries, none appear among the list of the most productive or impactful countries in global bibliometric analyses of MRI research [65,66]. There are several recommendations for future researchers to enhance the productivity and impact of MRI research in Arab countries to reach the global figure. It is recommended to encourage and support researchers to publish in high-impact journals to increase the citation potential of their work, foster interdisciplinary collaboration to address complex research questions, and promote knowledge exchange, emphasizing the importance of open-access publishing to ensure broader accessibility and visibility of MRI research, establish research networks and platforms for researchers in Arab countries to share knowledge, collaborate, and facilitate research partnerships, encourage funding agencies and MRI research institutions in Arab countries adopt benchmarking practices and performance metrics to measure, evaluate, and improve their research productivity and impact.



**Fig. 7.** The Most Frequent Keywords (Trend Topic), Co-occurrence of author's keyword.

Authorship patterns offer a peek into collaboration dynamics. Multi-authored publications may contribute to the apparent occurrence of collaboration between countries. Further interdisciplinary work is needed to address the complexity of issues challenged that necessitate varied expertise. While single-authored publications could be indicative of focused niche research domains or perhaps areas where collaboration is less prevalent or not interdisciplinary [67].

Between 2004 and 2010, there was an observed increase in the occurrence of keywords related to specific diseases and medical disorders, including "autosomal recessive inheritance," "tuberculosis," and "cerebral palsy." Notably, there was a small emphasis on neurological conditions within this trend. In the next years, up to 2014, there is an observable trend towards encompassing a wider range of medical topics. The presence of keywords such as "mental retardation," "epilepsy surgery," and "ataxia" suggests a sustained emphasis on neurological matters. However, the inclusion of new keywords like "osteomyelitis," "Alzheimer's disease," and "dystonia" indicates an expansion of research topics. Additionally, the utilization of terms such as "NMR" and "MR spectroscopy" indicates an inclination towards more technologically driven research.

From 2014 onwards, there was a noticeable increase in the frequency of keywords associated with broader medical conditions, and technological and methodological approaches to medical science. For instance, "multiple sclerosis" appeared frequently, alongside keywords such as "diagnosis", "prognosis", and "treatment". During this period, there was an observable increase in the occurrence of keywords associated with disorders that were specific to certain regions or prevalent worldwide, such as "diabetes mellitus", "hypertension", "obesity", and "breast cancer" From 2020 onwards, there has been a noticeable rise in the use of the terms "covid-19" and "sars-cov-2," indicating a shift in the worldwide medical research agenda in response to the pandemic. Furthermore, the utilization of terms such as "whole exome sequencing" and "molecular docking" indicates a growing interest in advanced diagnostic and research methodologies.

This analysis also identified several gaps based on trending topic analysis (co-occurrence keywords analysis). Other important trending topics were not comparably conducted in Arab countries. These topics may include faster scanning times, higher resolution images, improved accessibility, and the incorporation of AI and machine learning. Addressing these gaps is crucial for enhancing the quality of MRI research and its applications regionally, and for making significant contributions to the global field of medical imaging. Collaborative efforts among academic institutions, healthcare providers, and MRI manufacturers, as well as interdisciplinary collaboration between physicists, radiologists, and engineers, are essential for advancements in these areas.

## 5. Limitations

The findings of this bibliometric analysis are based on a single database. Although Scopus covers a wide range of publications in various fields, future research may also consider other databases for comprehensive understanding while maintaining the same level of publication quality. Despite efforts to only select relevant documents according to the pre-defined criteria, there is a possibility that a few articles may not be entirely relevant to the topic.

## 6. Conclusion

This bibliometric analysis uncovered a strong growth in research characteristics, collaboration patterns, and trends of the MRI research in Arab countries between 1988 and 2022. The rise of open-access journals and international collaborations highlights the increasing accessibility and interconnectedness of the academic community in this field. Based on the research topics and keywords analysis, it seems that the research community is, to some degree, responsive to emerging health concerns, such as COVID-19, as well as common conditions like multiple sclerosis and epilepsy. However, many emerging topics were not apparently evolving in this analysis. To stay at the forefront of addressing contemporary and future health issues, future research in Arab countries could benefit from a predictive analysis of emerging trends and challenges in MRI research.

Future research should focus on some priorities to address the evolving challenges and opportunities in MRI research. These priorities may include effectively harnessing the potential of international collaborations to address global health challenges, exploring innovative methodologies to enhance the impact and applicability of research findings, and utilizing technological advancements to push the boundaries of current MRI capabilities.

## Funding

The author(s) received no specific funding for this work.

## Ethical approval

As this research is a bibliometric study, it does not involve primary data collection from human or animal subjects. Instead, it relies on analyzing existing literature and published data, which are publicly available and do not require ethical approval. The study adheres to standard practices of bibliometric analysis, ensuring the responsible use of data and respecting intellectual property rights. Hence, ethical approval was not deemed necessary for this type of study.

## Data availability

Data will be made available on request.

## CRediT authorship contribution statement

**Bilal Attallah Albadayneh:** Writing – review & editing, Visualization, Validation, Supervision, Project administration. **Ahmad Alrawashdeh:** Writing – review & editing, Visualization, Validation, Investigation. **Naser Obeidat:** Writing – review & editing, Visualization, Investigation. **Arwa M. Al-Dekah:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ahmad Waleed Zghool:** Writing – review & editing, Validation, Investigation. **Mostafa Abdelrahman:** Writing – review & editing, Validation, Investigation, Data curation.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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