Article

Mapping Two Decades of Research Productivity in the Middle Eastern and Arab Countries: A Comprehensive Bibliometric Analysis

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Abstract: Middle Eastern and Arab countries have been experiencing significant advancements in scientific research and development over the past few decades. Understanding the trends, patterns, and impact of research within this region can provide valuable insights into its scientific landscape, identify areas of strength, and uncover potential areas for improvement. This study presents a comprehensive bibliometric analysis of research productivity in the Middle Eastern and Arab region over a 20-year period. The findings revealed a consistent increase in research productivity, yet mapped significant disparities between countries in scholarly output, excellence, and impact. Adjusting for population size and GDP, Iran displayed the highest publication activity, trailed by Egypt and Turkey. Delving into the distribution of research output across different journal quartiles, the results revealed that this region has a lower percentage of scholarly output published in high-impact journals (both the top 10% and the top 25% categories). Compared to North America and the European Union, the Middle Eastern and Arab region consistently exhibited lower performance in terms of top 10% citations, average citations per publication, and field-weighted citation impact. The field of physical sciences took the lead as the most prevalent subject area in the Middle Eastern and Arab region, comprising about 60.5% of the research emphasis. Conversely, social sciences garnered comparatively less research attention, making up approximately 8.9% of the focus. The region showed strong international collaboration levels (40.5%), yet relatively low national (24.4%) and academic–corporate collaborations (1.5%). The outcomes of this study can facilitate international comparisons and benchmarking, allowing Middle Eastern and Arab countries to position themselves within the global scientific community. There remains a need to prioritize quality over quantity by emphasizing rigorous research practices and collaboration. An ongoing evaluation of research performance using a combination of indicators can help track progress and adjust strategies as needed.

Keywords: bibliometric analysis; Middle Eastern and Arab region; research impact; research productivity; Scopus; SciVal

1. Introduction

The Middle Eastern and Arab countries represent a complex region that spans diverse landscapes, cultures, and histories. Extending from the western Atlantic Ocean to the eastern Arabian Sea, and from the northern Mediterranean Sea to the southern Arabian

Peninsula, this region envelops the countries of Algeria, Bahrain, Comoros, Cyprus, Djibouti, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, Turkey, the United Arab Emirates, and Yemen. These countries exhibit a wide range of development levels and economic structures [1]. While some, such as the United Arab Emirates and Qatar, have experienced rapid economic growth driven by oil wealth and diversification efforts [2], others face socio-economic challenges, including high unemployment rates and income inequality [1]. The gross domestic product (GDP), an important statistic that indicates a country's economic performance and aids in the measurement of its growth and development, varies widely across Arab countries. According to the World Bank [3], the collective GDP of the Arab countries was USD 2.9 trillion in 2021. The largest Arab economy in terms of GDP is Saudi Arabia, with an estimated GDP of approximately USD 833.54 billion in 2021, followed by the United Arab Emirates with a GDP of around USD 415 billion. In contrast, countries such as the Comoros and Djibouti have relatively small economies, with GDPs of about USD 1.29 billion and USD 3.48 billion, respectively [3].

In addition to economic heterogeneity, the Middle Eastern and Arab countries comprise a diverse and geographically expansive region with distinct cultural, social, economic, and political characteristics [4]. This diversity is often reflected in their scientific output, which encompasses a wide range of disciplines, including natural sciences, physical sciences, health sciences, social sciences, and humanities. Overall, Middle Eastern and Arab countries have been experiencing significant expansion in scientific research and development over the past few decades [5]. To encourage and promote the expansion of research, many institutions in the area are dedicated to serve this purpose, such as The Iranian Research Organization for Science and Technology in Iran, The Royal Scientific Society in Jordan, and The National Research Foundation in the United Arab Emirates. While the global landscape of knowledge production continues to evolve, it becomes increasingly important to evaluate the research productivity and scholarly output of these nations.

Research productivity is becoming a crucial indicator of a nation's ability to innovate and respond to challenges, and plays a fundamental role in a country's economic growth, sustainable development, and improvement in the standards of living and quality of life [6]. Understanding the trends, patterns, and impact of research within this region can provide valuable insights into its scientific landscape, identify areas of strength, and uncover potential areas for improvement. Our current knowledge of this subject remains quite constrained. In 2010, a study aimed at depicting research output in West Asia and North Africa unveiled that conflicts and warfare have detrimentally affected research advancement in specific nations, underscoring the necessity for stability and favorable conditions to foster ongoing research growth in the region [7]. Another analogous investigation was carried out, focusing solely on highly cited papers within science, medicine, and technology domains, revealing certain drawbacks concerning the publication of groundbreaking works [8]. Various additional studies showcased promising expansion in research productivity within specific fields, like diabetes [9], toxicology [10], climate change [11], and library and information science [12]. Conversely, other research pointed to lower-quality publications in different domains, such as dengue viruses [13].

Bibliometrics is a quantitative method that utilizes statistical analysis to assess scholarly publications, including journals, articles, authors, and institutions, to measure research productivity and gauge its influence [14]. This study leverages bibliometric techniques to delve into and appraise the status of scientific research in the Middle Eastern and Arab region. The findings of this research study will contribute to a comprehensive understanding of the research productivity, impact, and collaboration patterns within the Middle Eastern and Arab countries. This in turn can help identify research priorities, allocate resources efficiently, and foster collaborative research endeavors in the region.

However, it is essential to acknowledge, as Culcasi [15] astutely points out, that the categorization of the "Middle East" is not universally agreed upon and has been constructed and naturalized within Western geopolitical contexts. This conceptualization

often oversimplifies the diversity and complexities of the region. Therefore, our selection of countries in this study recognizes the challenges inherent in drawing together nations based on both location and ethnicity. The inclusion of Israel, for instance, which has had limited historical connections with its neighbors, highlights the complexity of this endeavor. To provide a more reflective framework for our research goals, we draw upon Culcasi's insights, emphasizing that the Middle East is a region with contested boundaries and meanings [15]. This recognition underscores the need to approach our analysis with a nuanced understanding of the geopolitical and cultural dynamics that shape collaborations within this diverse and multifaceted region. By incorporating these insights, we aim to contribute to a more comprehensive and contextually grounded exploration of research dynamics across the region.

2. Methods

2.1. Data Source

Data for this study were acquired through Scopus/SciVal. Scopus was chosen due to its status as the largest abstract and citation database of peer-reviewed literature, encompassing scientific journals, books, and conference proceedings [16]. Prior to Elsevier's introduction of Scopus in 2004, the Institute for Scientific Information (ISI, now WoS-JCR, part of Clarivate Plc) maintained the sole available bibliographic databases. The citation indexes from ISI, now consolidated under the Web of Science (WoS), were the primary sources of bibliometric data. Despite differing in scope, data volume, and coverage policies, the WoS and Scopus databases exhibit a strong correlation between their outputs (papers) and impacts (citations) [17]. Notably, 13,489 journals (99.11% of Web of Science) are indexed by the Scopus database. Scopus holds an edge by covering more journals than WoS and employs a journal inclusion system based on both quantitative metrics and qualitative expert assessments [18]. Furthermore, Scopus stands as a preferred partner in the rapidly evolving realm of rankings. It contributes data for the influential QS World University Rankings and the Times Higher Education (THE) World University Rankings [16]. Worldwide research institutions, funders, and policymakers rely on Scopus data to augment research performance and tackle research management challenges [16]. SciVal is a bibliometric suite that operates from Scopus data. The data are organized by SciVal into a structured framework that encapsulates various dimensions, including authorship, affiliations, citations, subject categories, and publication years. This granularity of data enables us to delve deeply into the intricate nuances of research dynamics, collaboration patterns, and disciplinary trends. One of the distinctive features of the SciVal data structure is its capacity to accommodate a vast volume of research outputs from an extensive range of international sources. By virtue of its global coverage, SciVal offers a representative snapshot of research contributions from diverse geographical regions, thereby facilitating the cross-border analysis of scholarly activity. Furthermore, SciVal's intricate categorization schema empowers us to dissect research productivity at both macro and micro levels, enabling the identification of trends within specific disciplines as well as the broader scientific landscape.

2.2. Bibliometrics Retrieved and Analyzed

This study looked into all scholarly output published by individuals affiliated with any of the Middle Eastern and Arab countries. All Arab countries were included (Algeria, Bahrain, Comoros, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates, and Yemen), besides Cyprus, Iran, Israel, and Turkey, which, along with 13 Arab countries (Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, United Arab Emirates, and Yemen) form the Middle Eastern region. Other regions of the world chosen for comparison purposes were the European Union (including the current 27 countries of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy,

Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden) and North America (including Canada and the United States).

The search spanned documents published between 2003 and 2022. All document types (i.e., original primary research, reviews, commentaries, letters, case reports, editorials, abstracts, etc.) were included. Several metrics were used to appraise the status of scientific research in the region, including productivity, impact, and collaboration. Analyzing productivity helps us to understand the volume of research being produced, which is a fundamental indicator of a region's engagement in scholarly activities. By quantifying the number of publications, we gain insights into the scale of research endeavors. Evaluating impact provides a deeper understanding of how research output resonates within the academic community and society at large. Assessing citations, references, and other impact metrics allows us to gauge the extent to which research findings are contributing to advancements in knowledge and practical applications. Examining collaboration sheds light on the extent to which researchers are engaging in international and interdisciplinary partnerships. Collaboration is often a driving force behind innovation and the exchange of ideas, making it a valuable dimension to analyze. The combination of these dimensions enriches our analysis by offering a holistic view of research performance. Table 1 describes all the used indicators along with their operational definitions.

Table 1. Operational definitions of study variables.

Dimension	Indicator	Definition
Production	Number of scholarly outputs by country	Number of scholarly outputs produced by a country. The country(ies) for a given output to be determined by examining the address(es) of the author(s) in that output. When authors of the same scholarly output are from different countries, full credit is to be given to each country. This was retrieved using the filter by "Country" option in SciVal Scopus.
	Number of scholarly outputs relative to country population	Publication activity was adjusted for all the countries categorized by population size and gross domestic product (GDP) retrieved from the online databases of the World Bank. An adjustment index (AI) was calculated following previous research using the following formula: AI = [total number of scholarly outputs for the country/GDP per capita of the country] $\times$ 1000, where GDP per capita = GDP/population of the country.
	Number of scholarly outputs by institution	This refers to the number of scholarly outputs produced by an institution. The institution(s) for a given output is/are determined by referring to the institutional affiliation(s) of the author(s) as listed in that study. This was retrieved using the filter by "institution" option in SciVal Scopus.
Impact	Research excellence	The percentage of scholarly outputs published in journals whose CiteScore was ranked in the top quartile. This was retrieved using the filter by "Journal quartile" option in SciVal Scopus.
	Top 10% citation	The percentage of a researcher's scholarly outputs that fall within the top 10% of highly cited papers.
	Citations per publication	The average number of citations a researcher's scholarly outputs have received.
	Field-weighted citation impact	A normalized measure of the impact or influence of a specific scholarly output, journal, or author within a particular field of study. It considers the citation patterns within a specific subject area, adjusting for differences in citation behavior across disciplines. This was retrieved using the filter by "Cited" option in SciVal Scopus.

Table 1. *Cont.*

Dimension	Indicator	Definition
Collaboration	International collaboration	The extent to which an entity's scholarly output has international authorship.
	National collaboration	The extent to which an entity's scholarly output involves partnerships with other entities located within the same country.
	Academic–corporate collaboration	The extent to which an entity's scholarly output is co-authored across the academic and corporate, or industrial, sectors.

3. Results

3.1. Scholarly Output by Middle Eastern and Arab Countries

Our search identified a total of 3,303,079 scholarly outputs by Middle Eastern and Arab countries between the years of 2003 and 2022. Comparatively, the European Union recorded 13,799,739 scholarly outputs while North America recorded 14,791,083 scholarly outputs during the same period. The top publishing countries in terms of the number of total scholarly outputs were Iran (804,289), Turkey (783,062), Israel (404,976), Saudi Arabia (345,802), and Egypt (327,649). After adjusting for population size and gross domestic product (GDP), publication activity remained the highest in Iran (160,925), followed by Egypt (108,923), Turkey (74,231), Tunisia (28,636), and Morocco (27,614). Supplementary Table S1 presents the number of scholarly outputs produced by each country from 2003 to 2022, as well as publication activity relative to population size and GDP for the same period. Figure 1 illustrates the trends in publication activity relative to population size and GDP from 2003 to 2021 across Middle Eastern and Arab countries. Figure 2a portrays the crude scholarly outputs for the Middle Eastern and Arab region collectively, compared to the European Union and North America. Figure 2b portrays the same scholarly output relative to population size and GDP for each region. Of note, due to the unavailability of GDP data for the year 2022, we made adjustments based on scholarly output data up to the year 2021.
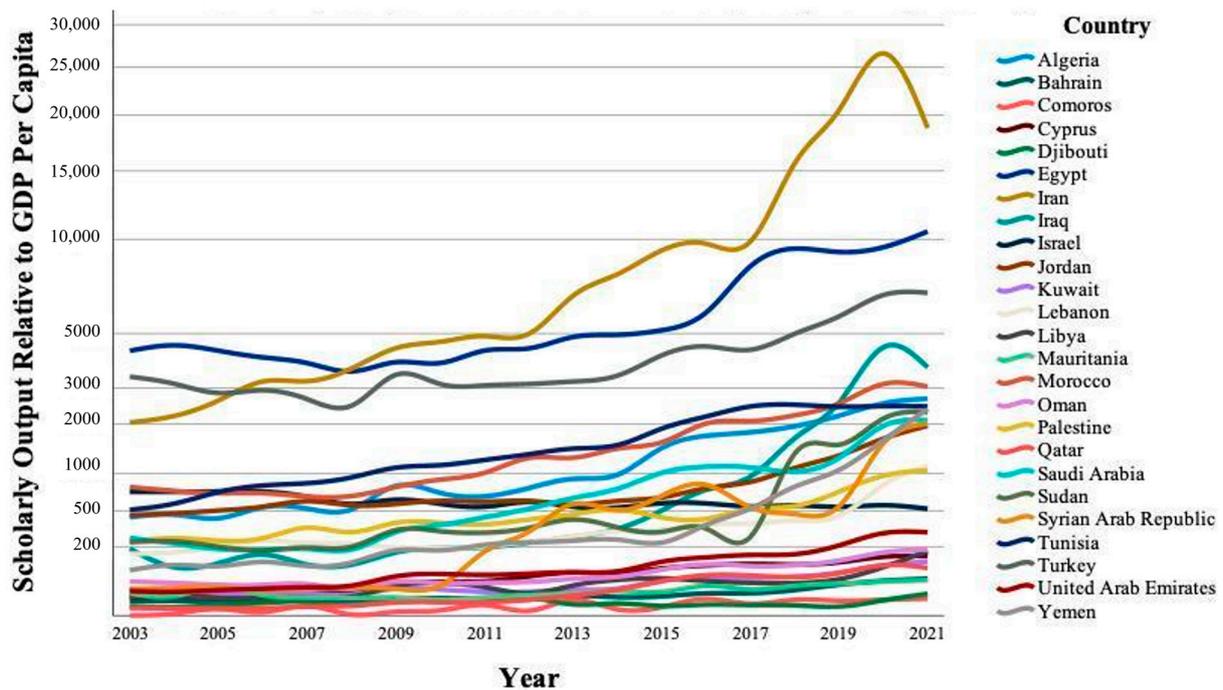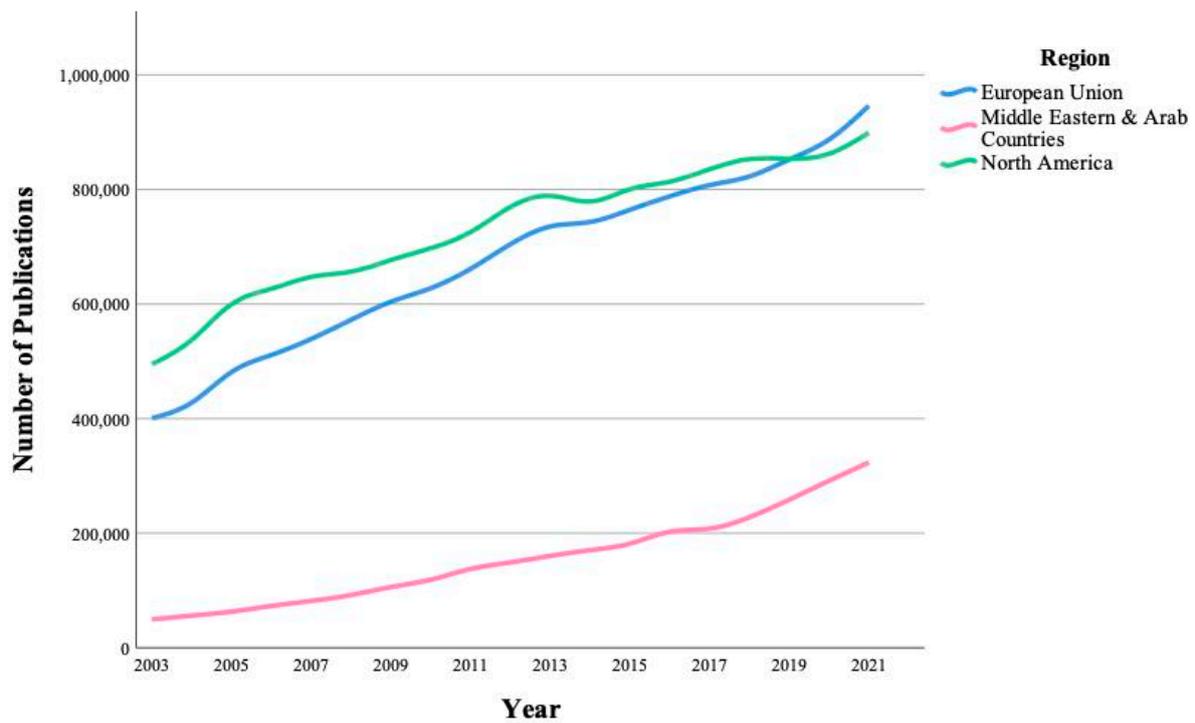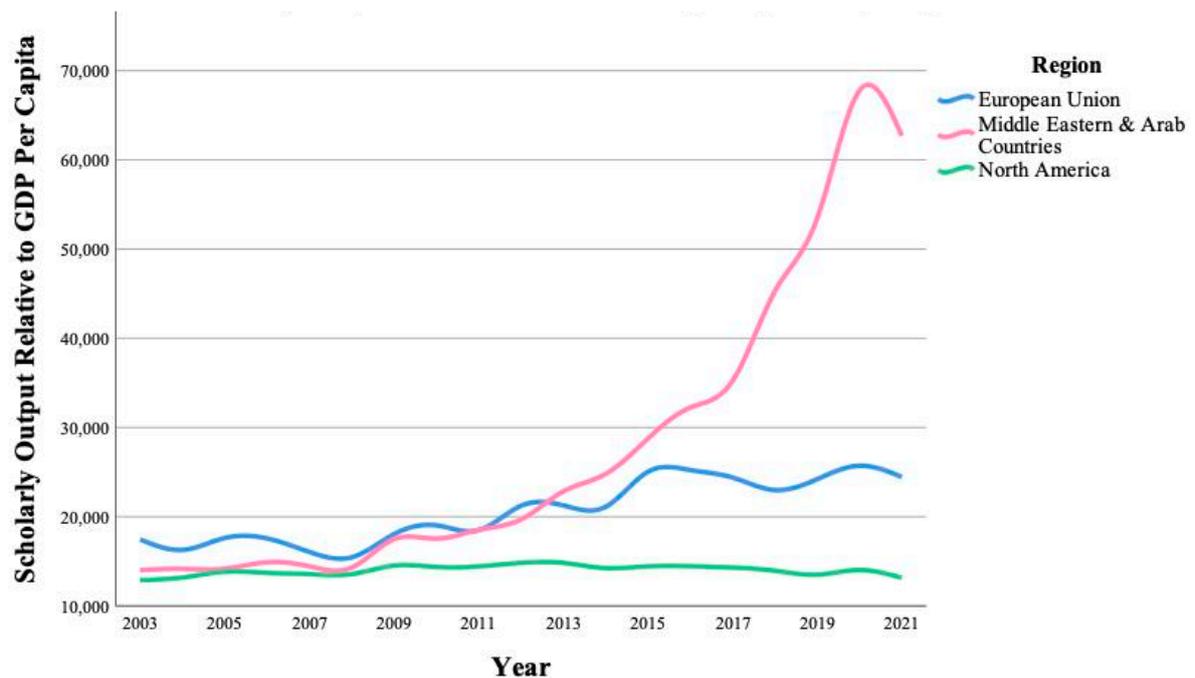

Figure 1. Scholarly outputs relative to GDP per capita by year by country.

(**a**)

(**b**)

Figure 2. (**a**) Scholarly outputs by year by region. (**b**) Scholarly output relative to GDP per capita by year by region.

By analyzing the publication activity trends across Middle Eastern and Arab countries from 2003 to 2021, particularly in relation to the European Union and North America, an intriguing pattern emerges when accounting for GDP and population size adjustments. The crude numbers of scholarly outputs clearly suggest a lower research output in the region. However, the adjustments for GDP and population size reveal a different narrative. The

region's relatively lower GDP, especially when compared to Europe and North America, seems to have influenced the initial perception of lower research productivity. Upon adjusting for GDP, the region exhibited a notably higher research productivity than their raw publication counts might suggest. This is particularly exemplified by Iran, where the GDP decreased over the years and the research output increased, leading to a significantly higher performance after adjustment. Similarly, countries like Egypt and Morocco showed stable GDP over the same period but an increase in scholarly outputs. However, in contrast, Europe and North America exhibited a synchronized rise in both GDP and research productivity, resulting in a relatively lower ranking when compared to the Middle East and Arab region. This scenario is a reminder that quantitative indicators alone can sometimes mask the intricate dynamics at play within the research ecosystem.

3.2. Research Excellence and Impact

Supplementary Table S2 presents data on research excellence measured by the percentage of scholarly outputs published in top-ranked Scopus journals for various countries. Figure 3 illustrates the percentages categorized by country and by region. The results show that some countries have notably high percentages of scholarly outputs in Q1 of Scopus journals. Israel has 53.82% of its scholarly output being published in Q1 journals. Similarly, Cyprus (41.48%), Saudi Arabia (41%), Qatar (45.73%), and Djibouti (44.09%) have a large proportion of scholarly outputs in top-tier Q1 journals. Several countries exhibit a relatively balanced distribution across different journal tiers, implying that they have a diverse publishing portfolio in terms of journal rankings. For instance, Algeria, Jordan, Libya, and Morocco demonstrate relatively similar percentages across the Q1, Q2, and Q3 categories. However, a few countries have a higher proportion of their scholarly outputs in lower-ranked journals, such as Iraq with 27.76% of its scholarly output classified under the Q4 tier. Overall, the Middle Eastern and Arab countries have a lower percentage of scholarly output published in the highest impact journals (both the top 10% and the top 25% categories) compared to the European Union and North America. This indicates a relative difference in research quality and visibility in the most prestigious academic scholarly outputs between these regions.

We also looked into the top 10% citation (which shows how well a researcher's work performs compared to their peers in terms of citation impact) and average citations per publication (which provides an overall measure of the impact of a researcher's work) (Table 2). Further, field-weighted citation impact (FWCI) was analyzed as a measure of the impact or influence of a specific article, journal, or author within a particular field of study. Figure 4 presents the FWCI for each county. It is evident that the Middle Eastern and Arab countries have the lowest impact metrics among the three regions.

In our analysis of research productivity and impact indicators, it is essential to acknowledge that not all scholarly outputs are citable in the traditional sense. While metrics such as the top 10% citation rate, average citations per publication, and FWCI offer valuable insights into the impact of researchers' work, they may not provide a complete picture. To ensure a more comprehensive and objective assessment, we systematically collected and examined the percentages of scholarly outputs that often garner citations, primarily focusing on articles and reviews attributed to each country and region (Table 3). This is crucial for providing readers with the ability to accurately gauge the impact of research across diverse countries and regions, preventing any inadvertent distortion of the overall picture.
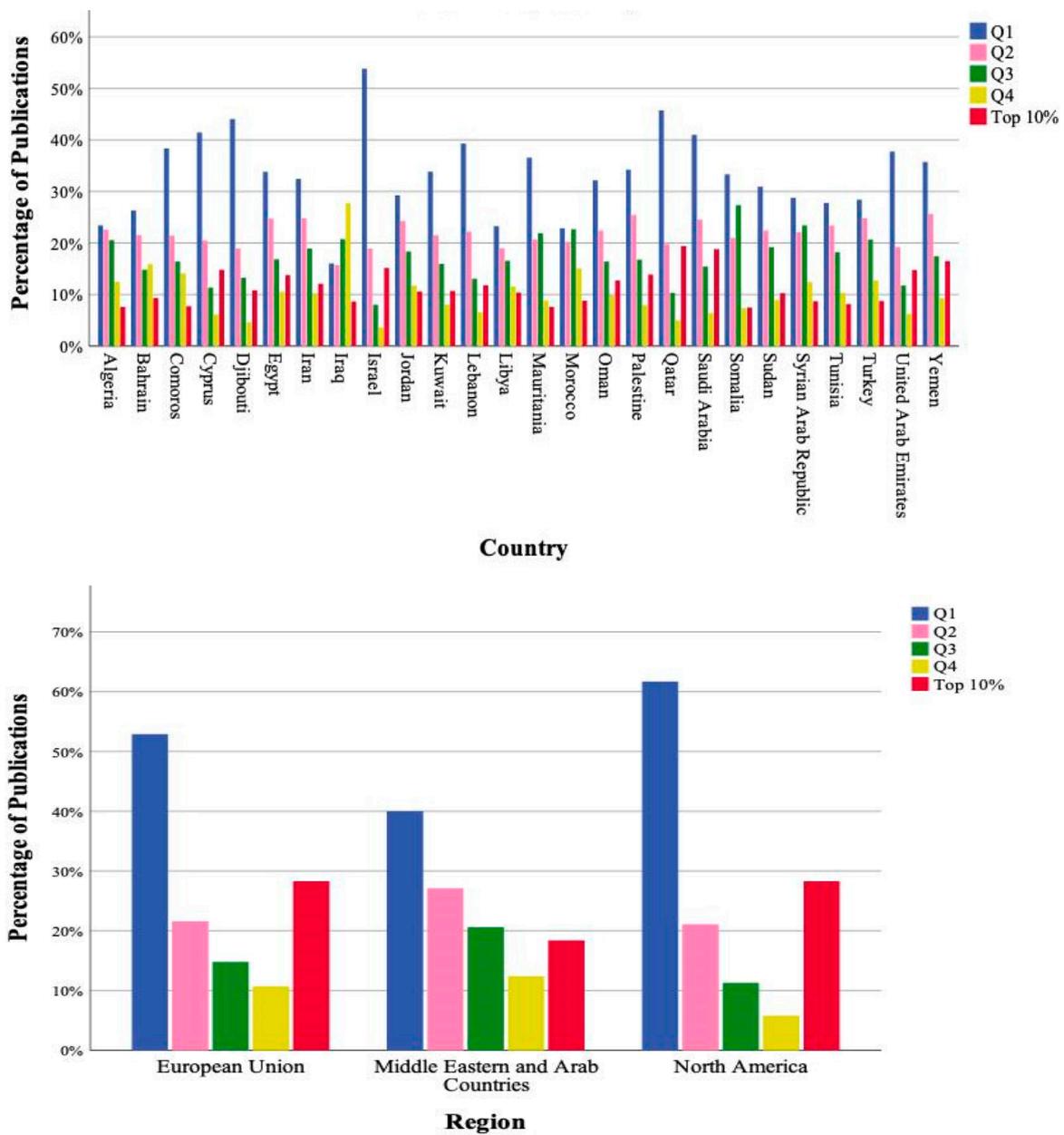
Figure 3. Percentage of scholarly outputs in Scopus Q1, Q2, Q3, Q4, and top 10% journals by country and by region.

Table 2. Top 10% citation and citations per publication for each region.

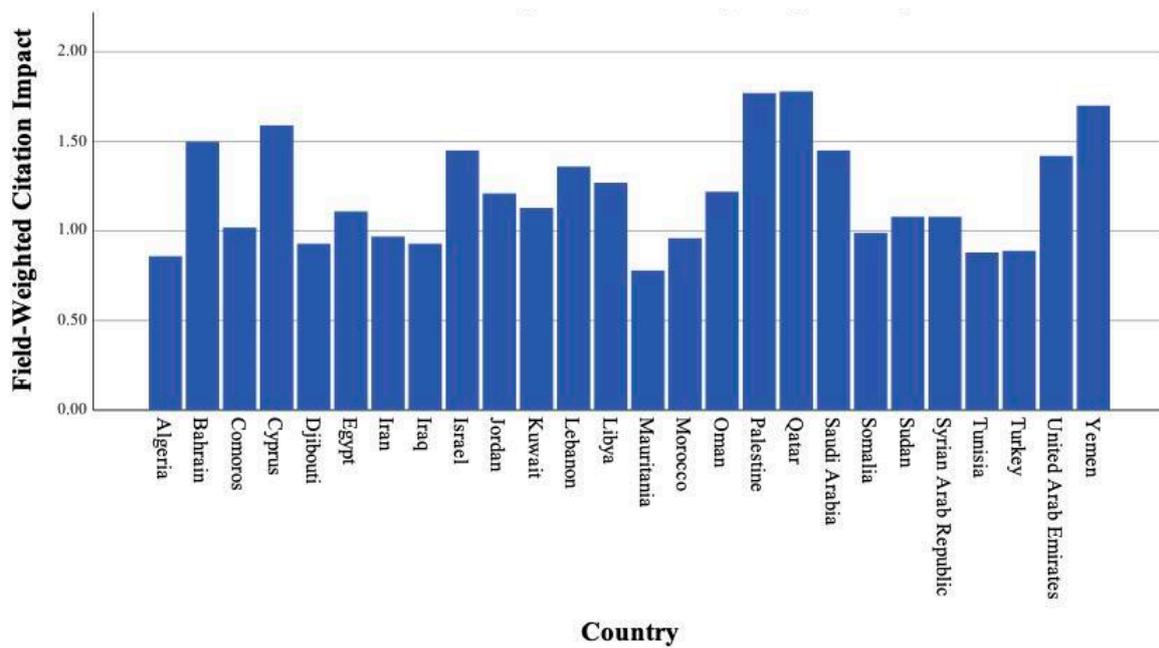| Region	Scholarly Output	Top 10% Citation	Citations per Publication	FWCI
Middle Eastern and Arab Countries	3,303,079	11.3%	16.1	1.02
European Union	13,799,739	12.5%	21.7	1.19
North America	14,791,083	15.3%	28.2	1.39

Figure 4. The field-weighted citation impact for each country.

Table 3. Percentage of articles and reviews in total scholarly outputs by country and region.

Country	Articles	Reviews
Algeria	71.0%	1.9%
Bahrain	67.5%	6.1%
Comoros	82.4%	5.9%
Cyprus	63.5%	5.9%
Djibouti	82.0%	3.5%
Egypt	81.5%	3.8%
Iran	82.9%	4.3%
Iraq	75.5%	2.6%
Israel	68.9%	6.5%
Jordan	80.3%	4.2%
Kuwait	71.1%	4.3%
Lebanon	65.3%	8.2%
Libya	63.6%	4.3%
Mauritania	83.2%	2.6%
Morocco	69.6%	2.9%
Oman	69.4%	5.8%
Palestine	79.1%	4.3%
Qatar	64.8%	8.2%
Saudi Arabia	79.7%	5.3%
Somalia	82.5%	4.2%
Sudan	77.1%	5.4%
Syrian Arab Republic	81.3%	5.0%
Tunisia	69.8%	2.7%
Turkey	78.9%	3.4%
United Arab Emirates	61.9%	5.8%
Yemen	83.1%	4.9%
Middle Eastern and Arab countries	76.4%	4.3%
European Union	65.4%	6.8%
North America	62.1%	7.8%

3.3. Top Research Subjects

In order to explore the most prevalent research subject areas in the total scholarly outputs produced by the Middle Eastern and Arab countries, we chose All Science Journal

Classification (ASJC) in Scopus. Supplementary Table S3 shows the complete ASJC for each country. In terms of agricultural and biological sciences, Iran stands out with the highest number of scholarly outputs (72,411), followed by Turkey (63,452) and Egypt (33,501). However, when assessed primarily on the grounds of scientific impact defined by field-weighted citation impact, Cyprus (1.49), Djibouti (1.58), and Saudi Arabia (1.74) took the lead, implying that their research work exerted more significant influence compared to others in this field. For the chemistry research field output, Iran was also on top, with (106,449) scholarly outputs followed by Turkey (60,349) and Saudi Arabia (50,883). Moreover, Turkey (73,556), Iran (86,950), and Saudi Arabia (54,154) showed notable productivity in the computer science research field, although according to field-weighted citation impact, Qatar took the lead (2.13), followed by Yemen (1.83). In the field of environmental sciences, Iran comes first in scholarly outputs, while Saudi Arabia holds the highest field-weighted citation impact. Iran also excels in mathematics research with significant numbers of published works. Yemen and Qatar emerge as leaders in this category with high field-weighted citation impacts, indicating their impactful research contribution. Iran again tops the charts within engineering, biochemistry, genetics, molecular biology, immunology, microbiology, pharmacology, toxicology, and pharmaceutics domains. Meanwhile, Turkey and Egypt follow closely behind with substantial research output. When measured according to medicine research output, Turkey secured the top position in scholarly outputs (reaching 288,186) followed closely by Iran (190,369) and Saudi Arabia (69,214). The field-weighted citation impact values are the highest for Libya (4.27), Palestine (3.09), and Yemen (3.98). These countries have a relatively smaller research output but show a strong influence in terms of citation impact. In the fields of business, management, accounting, economics, econometrics, finance, and social sciences, Turkey leads the pack. However, field-weighted citation impact scores shift the lead toward Lebanon and Qatar. Moving toward psychology studies, Israel shows significant emphasis on studying human behavior, which has resulted in a leading score of 19,512, but the field-weighted citation impact shows that the United Arab Emirates has the most impact in this field.

We also utilized other subject area categories and classifications in Scopus, which included four categories: physical sciences, health sciences, social sciences, and life sciences. Supplementary Table S4 presents the number of scholarly outputs in each of the four Scopus's subject areas for each country. Figure 5 showcases the percentage of scholarly outputs across each of Scopus's subject domains for every country and region. The field of physical sciences took the lead as the most prevalent subject area in the Middel Eastern and Arab region, comprising about 60.5% of the research emphasis. Conversely, social sciences garnered comparatively less research attention, making up approximately 8.9% of the focus.
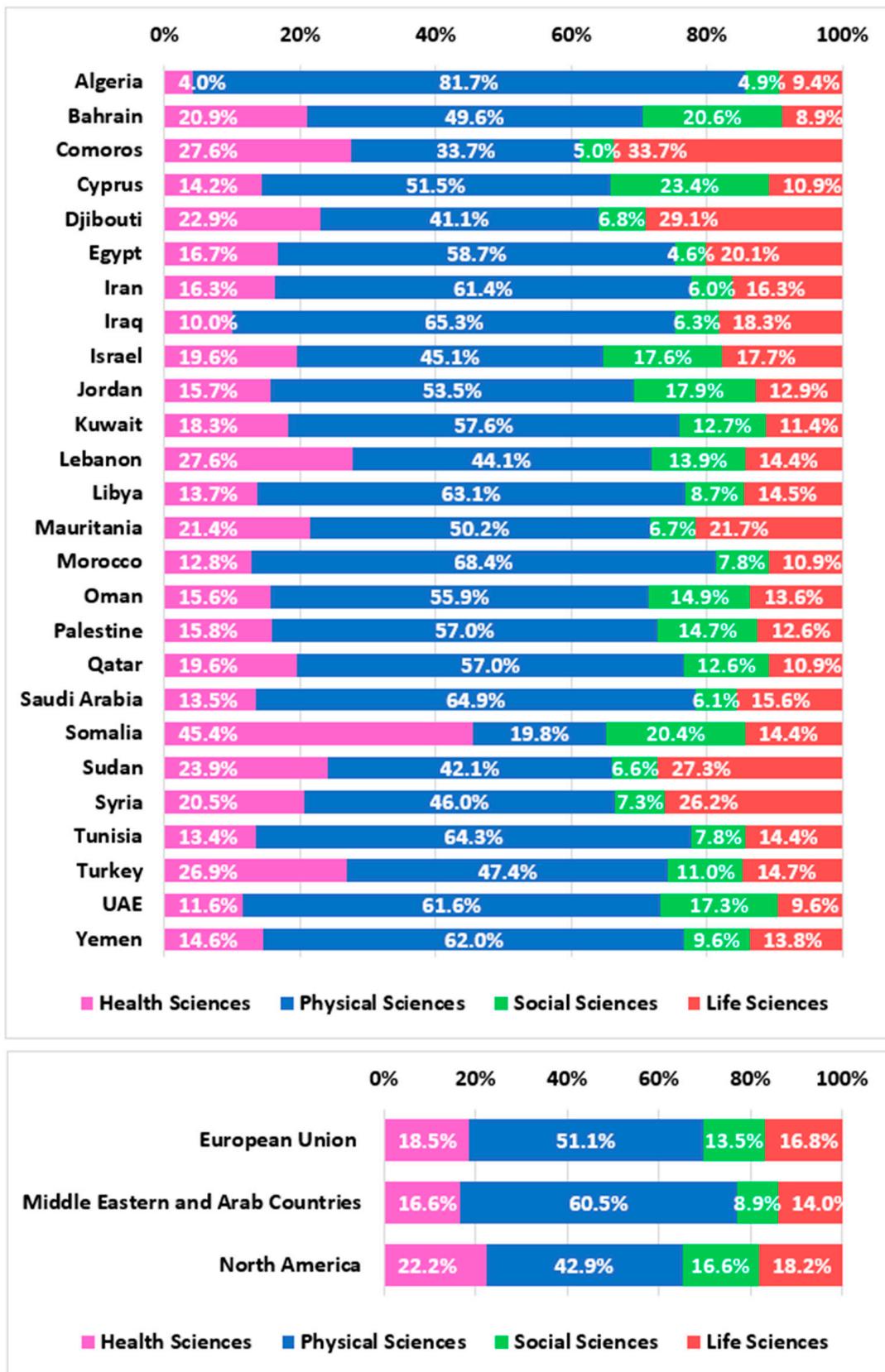
Figure 5. The percentage of scholarly outputs across each of Scopus's subject domains for every country and region.

3.4. Highest Publishing Institutions

Table 4 displays the highest publishing institution in each country in the Middle Eastern and Arab region. Several countries showcase significant research productivity, including Iran (Islamic Azad University), Saudi Arabia (King Saud University), and Egypt (Cairo University), with scholarly outputs of 139,188; 72,727; and 58,709, respectively. On the lower end of the scholarly output are Université des Comores in Comoros with 74 scholarly outputs, Centre d'étude et de recherche de Djibouti in Djibouti with a total of 102 scholarly outputs, and Somalia National University in Somalia with only 44 scholarly outputs, reflecting their smaller academic infrastructure.

Table 4. The highest publishing institution in each country in the Middle Eastern and Arab region.
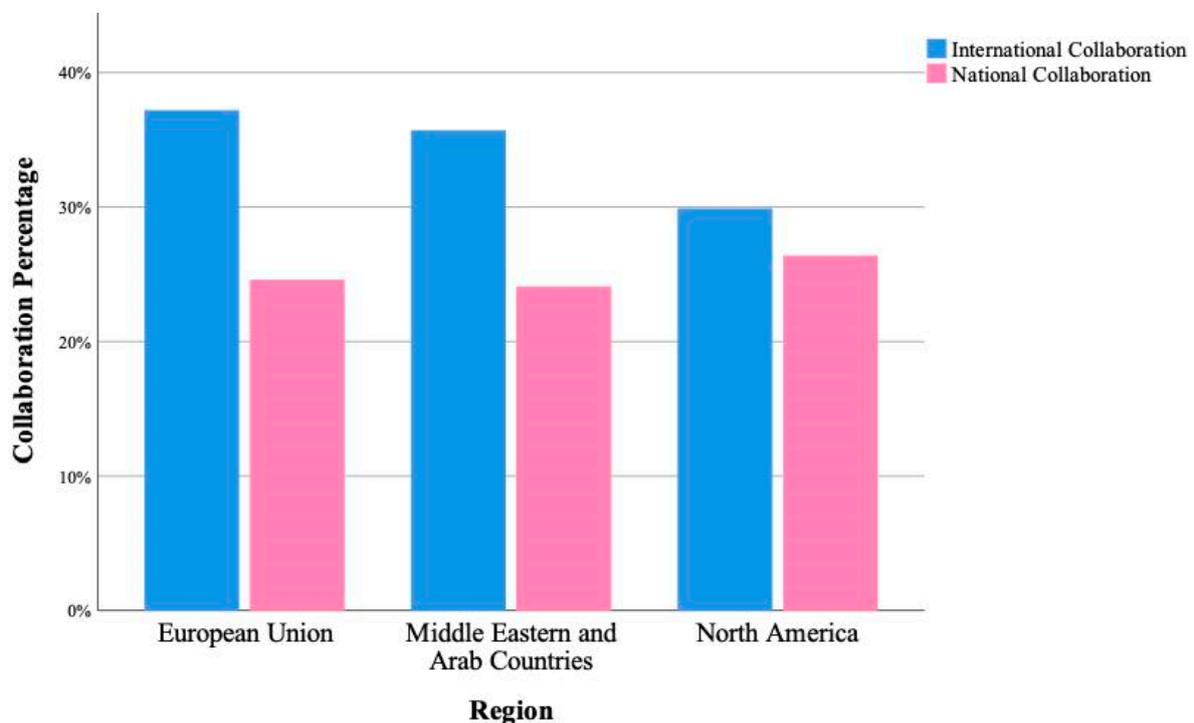
Country	Highest Publishing Institution	Crude Number of Scholarly Outputs
Iran	Islamic Azad University	139,188
Israel	Tel Aviv University	102,295
Saudi Arabia	King Saud University	72,727
Egypt	Cairo University	58,709
Turkey	Hacettepe University	41,138
Tunisia	Université de Tunis El Manar	35,634
Morocco	Mohammed V University in Rabat	23,116
Qatar	Qatar University	21,598
Lebanon	American University of Beirut	19,986
Iraq	University of Baghdad	17,926
Jordan	University of Jordan	17,025
United Arab Emirates	Khalifa University of Science and Technology	16,963
Cyprus	University of Cyprus	16,309
Oman	Sultan Qaboos University	15,800
Kuwait	Kuwait University	15,053
Algeria	University of Science and Technology Houari Boumediene	12,784
Sudan	University of Khartoum	5517
Bahrain	University of Bahrain	4445
Palestine	An-Najah National University	3656
Syrian Arab Republic	Damascus University	3038
Yemen	Sanaa University	2403
Libya	University of Tripoli	1812
Mauritania	University of Nouakchott	403
Djibouti	Centre d'étude et de recherche de Djibouti	102
Comoros	Université des Comores	74
Somalia	Somali National University	44

3.5. Research Collaboration

Table 5 shows international collaboration, national collaboration, and academic–corporate collaboration within each country in the Middle Eastern and Arab region. Additionally, Figure 6 displays the region-wise breakdown of percentages for international collaboration and national collaboration. Several countries, such as Comoros, Djibouti, Mauritania, Sudan, and Yemen exhibit a high level of cooperation with other countries with over 70% collaboration rates. On the other hand, some countries maintain low international collaboration, for instance, Algeria, Iran, Iraq, Morocco, and Turkey have relatively lower rates of international collaboration, ranging from 25% to 50%. Most countries have academic–corporate collaboration rates between 1% and 4%, while some countries like Djibouti, Iran, Iraq, Morocco, and Tunisia reveal minimal academic–corporate collaboration with percentages below 1%.

Table 5. International collaboration, national collaboration, and academic–corporate collaboration within each country.

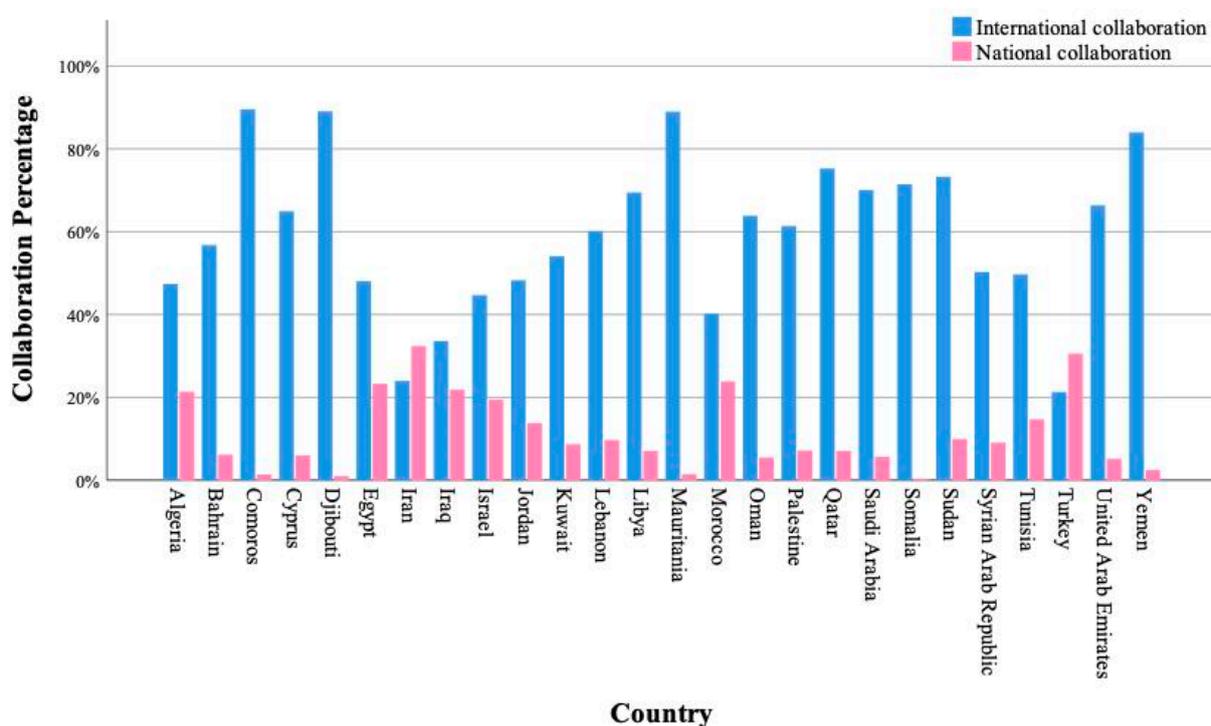| Country	International Collaboration	National Collaboration	Academic–Corporate Collaboration
Algeria	47.4%	21.4%	1.1%
Bahrain	56.8%	6.2%	1.9%
Comoros	89.6%	1.4%	0.9%
Cyprus	65%	6%	3.8%
Djibouti	89.1%	1%	0.7%
Egypt	48.1%	23.3%	1.4%
Iran	24%	32.4%	0.7%
Iraq	33.6%	21.9%	0.6%
Israel	44.7%	19.5%	4.3%
Jordan	48.3%	13.8%	1.4%
Kuwait	54.1%	8.7%	2.6%
Lebanon	60.2%	9.7%	2.8%
Libya	69.5%	7.1%	2.3%
Mauritania	89%	1.5%	1.1%
Morocco	40.2%	23.9%	0.8%
Oman	63.9%	5.5%	2.4%
Palestine	61.4%	7.2%	1.3%
Qatar	75.3%	7.1%	3.9%
Saudi Arabia	70.1%	5.7%	2.4%
Somalia	71.5%	0.4%	1.7%
Sudan	73.3%	10%	1.6%
Syrian Arab Republic	50.3%	9.1%	1.1%
Tunisia	49.7%	14.7%	0.9%
Turkey	21.3%	30.6%	1.2%
United Arab Emirates	66.4%	5.2%	3.6%
Yemen	84%	2.5%	1%

Figure 6. *Cont*.

Figure 6. Percentages of international and national collaboration by region and country.

The European Union has the highest percentage of international collaboration at 37.2%, followed closely by Middle Eastern and Arab countries at 35.7%, and then North America at 29.9%. As per the national collaboration, North America has the highest percentage at 26.4%, followed by the European Union at 24.6%, and then Middle Eastern and Arab countries at 24.1%.

4. Discussion

A robust research ecosystem is vital for driving socioeconomic development. Understanding the volume and impact of research within the Arab and Middle East region helps identify the contributions of scientific advancements to societal and economic growth. It enables policymakers to align research priorities with national development goals and promotes the utilization of research outcomes for addressing local challenges and improving the quality of life.

Our results suggest that Iran, Egypt, Turkey, Tunisia, and Morocco are actively engaged in research activities and have made significant contributions to the scientific outputs in the Arab and Middle East region. With an adjusted publication activity, Iran maintains the highest research output relative to population size and GDP. Egypt and Turkey follow closely, which demonstrates a significant research output relative to its population and economic size. However, it is important to note that the number of scholarly outputs does not necessarily reflect the quality or impact of research conducted at these institutions. Other factors, such as citation rates, collaborations, and subject areas, also play a role in assessing research excellence.

Of note, between 2003 and 2022, Middle Eastern and Arab countries collectively authored 3,303,079 scholarly outputs. In contrast, the European Union produced a significantly higher volume of 13,799,739 scholarly outputs, while North America outpaced both with an impressive 14,791,083 number of scholarly outputs during the same period. The European Union has a long-standing tradition of scientific excellence and is known for its significant contributions across various disciplines. The large number of scholarly outputs can be considered as a direct reflection of the strength of research institutions, funding support, and collaborative efforts within the European Union. Seemingly, the robust

research presence for North America is a product for its developed research ecosystem with renowned universities, research institutions, and funding agencies. Comparing these numbers make it evident that the Middle Eastern and Arab region lag significantly behind the developed world in terms of scholarly outputs. Factors related to limited research funding, inadequate infrastructure, political instability, and regional conflicts can certainly result in fewer research opportunities and resources available for scientists and scholars. Additionally, language barriers may also play a role in the lower scholarly outputs from the Middle Eastern and Arab region. English is the dominant language in scientific publishing, and researchers from non-English speaking countries may face additional challenges in disseminating their research in international journals.

We looked into the distribution of research output across different journal quartiles (Q1, Q2, Q3, Q4) and the top 10% of scholarly output for various countries. The results revealed that the percentages across quartiles differ for each country, suggesting variations in research excellence and impact. Some countries, like Cyprus and Qatar, have higher percentages in Q1, while countries like Iraq and Libya have higher percentages in Q4, indicating a higher share of research output in lower-ranked journals. The percentage of research output in the top 10% represents a subset of highly influential and impactful scholarly outputs. Countries like Qatar, Saudi Arabia, and the United Arab Emirates exhibit higher percentages in the top 10%, suggesting a notable presence of highly influential research. However, these observations should be interpreted in the context of each country's research landscape, disciplinary strengths, and the specific indicators used to measure research excellence. Further, it should be noted that operationalizing research excellence through the percentage of articles published in journals whose CiteScore was ranked in the top quartile has its own limitation, especially when the number for scholarly outputs is low, potentially yielding false positive results.

Both North America and the European Union seemed to consistently outperform the Middle Eastern and Arab region in terms of top 10% citations, average citations per publication, and FWCI. These indicators collectively underscore that research from the Middle Eastern and Arab countries exhibit a comparatively lower impact. Researchers in this region are encouraged to boost their research impact besides quantity. Collaborative efforts, networking, and engagement with international researchers and institutions could help increase visibility and citations. Fostering research environments that promote interdisciplinary collaborations and encourage participation in global research networks, conferences, and publication outlets are also promising strategies to enhance the reach and impact of research outputs. It remains important to recognize that research impact is multifaceted and depends on various factors, including research quality, collaboration, interdisciplinary efforts, publication strategies, and engagement with the global research community [19]. The recommendations should be tailored to the specific context and goals of each region. Furthermore, ongoing evaluation of research performance using a combination of indicators can help track progress and adjust strategies as needed.

Our data also revealed that certain subject areas received more research attention in certain countries. In particular, physical sciences were the most prevalent subject area across various Middle Eastern and Arab countries, indicating a notable emphasis on research and academic activity in fields related to chemistry, computer science, environmental sciences, physics, and engineering. This emphasis on physical sciences could be attributed to several factors. Many Middle Eastern and Arab countries have a rich history in science and mathematics, dating back to ancient civilizations like Mesopotamia and the Islamic Golden Age. This historical legacy might have contributed to the continued focus on physical sciences. In addition, many of these countries have invested significantly in establishing strong educational institutions, particularly in the fields of science and engineering. Physical sciences also often involve collaborative research projects with international partners, leading to increased scholarly outputs in this field due to the exchange of knowledge and resources. However, it is important to note that while physical sciences appear to be prevalent, this does not necessarily imply that other fields are less important. Different countries might

have different strengths and areas of focus based on their resources, expertise, and societal needs. Additionally, the interpretation should consider the quality and impact of the research, not just the quantity of scholarly outputs.

The domain of social sciences appears to have garnered relatively lower research attention within the context of Middle Eastern and Arab countries. However, it is imperative to shed light on a crucial aspect that could potentially influence this observation. The data we have employed for analysis primarily draws from research studies published in Scopus journals, which predominantly encompasses research published in English. A significant proportion of social sciences studies, integral to addressing region-specific sociopolitical, cultural, and community-related issues, are published in the Arabic language. This situation underscores a nuanced interplay between language, academic databases, and research priorities. While the database's language criterion accentuates the prominence of English-language scholarly outputs, it inadvertently underrepresents the extensive body of localized social sciences research conducted and published in Arabic. Recognizing this dynamic presents an opportunity to foster a more comprehensive and accurate understanding of research trends and priorities within the region. It prompts us to consider a broader spectrum of data sources, including those featuring Arabic-language research scholarly outputs, to ensure that the vibrant landscape of social sciences in Middle Eastern and Arab countries is authentically portrayed. In this pursuit, a balanced approach that appreciates both localized relevance and global visibility will enable a more holistic assessment of the research endeavors in these regions.

The study revealed varying international research collaboration rates, ranging from as low as 21.3% (Turkey) to as high as 89.6% (Comoros). These numbers indicate the extent to which researchers from these countries engage in collaborative research with international partners. Besides Comoros, Djibouti (89.6%), Mauritania (89%), and Yemen (84%) also stood with the highest international collaboration rates. These numbers suggest a strong inclination toward international research collaborations, which can lead to knowledge exchange, shared resources, and diverse perspectives in scientific endeavors. However, these high percentages of international research collaborations in low-resource countries may indicate that a significant number of these studies were conducted by foreign international principal investigators. Low international collaboration rates that are seen across several countries, such as Turkey (21.3%), Iran (24%), and Iraq (33.6%) might be influenced by various factors such as geopolitical circumstances, research priorities, funding constraints, or language barriers. The inclusion of international collaboration rates for other regions like the European Union (37.2%) and North America (29.9%) provides a broader context for international collaboration. It indicates that collaboration rates vary not only within the Arab and Middle East region, but also globally. It is important to note that these percentages provide a snapshot of international collaboration rates, and the interpretation may vary based on the specific circumstances of each country. Factors such as regional dynamics, cultural connections, language preferences, funding opportunities, and research priorities can influence the collaboration rates observed.

5. Limitations

Our study is not without its limitations and challenges. Firstly, we recognize that our research is conducted within the complex and diverse landscape of the Middle Eastern and Arab region. Despite our rigorous efforts to mitigate potential biases, the inherent heterogeneity among the countries in our dataset remains a crucial consideration. Smaller nations may naturally exhibit higher rates of external collaboration compared to their larger and more diverse counterparts. This limitation underscores the essential need for a nuanced interpretation of our findings, as they may not fully encapsulate the entire spectrum of variations among countries characterized by differing sizes, economic structures, and historical contexts. Researchers with specific interests in particular countries or sub-regions within the Middle East and Arab world should take into account additional contextual factors when analyzing the findings. Secondly, the attribution of scholarly outputs repre-

sents another dimension that demands thoughtful consideration. Collaborative research, particularly when conducted across international borders, often involves authors with diverse backgrounds and affiliations. This frequently results in a shared authorship model, which can introduce complexities in ascribing individual contributions. We acknowledge that our methodology, which equally attributes publication credit to all authors, may not fully capture the nuanced roles played by each collaborator. To address this challenge, it is important for future research to explore alternative attribution models that weigh contributions more accurately. Additionally, investigating collaboration strength, journal prestige, and other contextual variables are recommended avenues for enriching our understanding of scholarly collaboration dynamics within the region. Lastly, publication bias stemming from the reliance on one database could influence the comprehensiveness of our findings. Despite these limitations, we believe that our study contributes valuable insights into the broader patterns of research within the region and provides a foundation for future research to explore the complexities of research dynamics at a more granular level.

6. Conclusions

Accounting for each country's economic performance, this study identified the top publishing countries, institutions, and subject areas within the region. It also recognized countries with a strong presence in top-tier journals and those with a higher proportion of scholarly outputs in lower-ranked journals and acknowledged the need to improve international and academic–industry collaborations and impact. By analyzing bibliometric data, it becomes possible to assess the research performance of Arab and Middle Eastern countries, identify areas of strength, and track progress over time. This information is valuable for policymakers, funding agencies, and institutions seeking to allocate resources effectively and promote research excellence. Our work may also enhance the visibility and dissemination of research from the Arab and Middle East region. An increased visibility and recognition of research output contribute to the global reputation and competitiveness of the region's researchers and institutions. Recognizing the multifaceted nature of research impact, contingent upon factors like research quality, collaboration, interdisciplinary efforts, publication strategies, and global engagement, underscores the need for tailored approaches to enhance research impact in the Middle Eastern and Arab region. These strategies should be sensitively attuned to the region's unique contextual intricacies and emerging prospects.

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