Video Article

Comparing Bibliometric Analysis Using PubMed, Scopus, and Web of Science Databases

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Abstract

Literature databases (*i.e.*, PubMed, Scopus, and Web of Science) differ in terms of their coverage, focus, and the tool they provide. PubMed focuses mainly on life sciences and biomedical disciplines, whereas Scopus and Web of Science are multidisciplinary. The protocol described in the current study was used to search for publications from Jordanian authors in the years 2013-2017. In this protocol, how to use each database to conduct this type of search is explained in detail. A Scopus search resulted in the highest number of documents (11,444 documents), followed by a Web of Science search (10,943 documents). PubMed resulted in a smaller number of documents due to its narrower scope and coverage (4,363 documents). The results also show a yearly trend in: (1) the number of publications, (2) the disciplines that have the most publications, (3) the countries of collaboration, and (4) the number of open access publications. In contrast, PubMed has a sophisticated keyword optimization service (*i.e.*, Medical Subject Heading, or MeSH), while both Scopus and Web of Science provide search analysis tools that can produce representative figures. Finally, the features of each database are explained in detail and several indices that can be extracted using the search results are provided. This study provides a base for using literature databases for bibliometric analysis.

Video Link

The video component of this article can be found at https://www.jove.com/video/58494/

Introduction

Classically, researchers have used literature databases to perform literature review for their studies[1]. Another use of these literature databases arose at the end of the 19th century, where researchers analyzed the body of literature, a use that has slowly grown since[2]. In the last few decades, digitizing literature and the formation of online literature databases provided an opportunity to researchers to analyze the body of literature and research performance easily and efficiently. An example would be analyzing the research performance for a document[3], a subject[4], a discipline[5], a country[6], or even a region in the world[7]. This type of analysis is known as bibliometric analysis. Heartsill Young defined bibliometric analysis as the use of statistical methods to analyze a body of literature to reveal historical development[8]. In other words, bibliometrics is the quantitative study of published units on the basis of citation and text analysis[9].

Different databases are used to do bibliometric analysis and each database has different characteristics and can provide different services[10]. Currently, the most commonly used literature databases are the Web of Science and Scopus for almost all disciplines, both only available on a subscription basis[11], and PubMed for biomedical and life sciences, a freely available database[10]. There is also Google Scholar, which might be an easy tool to handle, but it should not be used as a bibliometric analysis tool currently due to some deficiencies such as its unclear scope and coverage, its lack of citation analysis tools, and its inclusion of non-peer reviewed non-scientific contents[12,13]. Moreover, Google Scholar lacks the tools for performing advanced search and keyword optimization[14].

Several previous studies have compared the features of the previously mentioned literature databases for literature review purposes[3,5,10,12,13,15,16,17]. However, in this study, the means by which PubMed, Scopus, and Web of Science databases are used to perform a bibliometric analysis will be provided, and the pros and cons for each of them will be compared. Bibliometric analysis can be used to analyze the research output in almost any discipline, so the target audience would be any researcher who intends to analyze publication trends. An example of analyzing a publication trend in Jordan as a country will be presented using each database. Jordan was chosen because doing a bibliometric analysis for a country (in contrast to a subject) is not very straightforward. In addition, Jordan, specifically, is poorly studied in a bibliometric way as it can be both an author name and a country name. We explain how to overcome such a challenge in the search.

Protocol

NOTE: The following are search methods and an example search for each method is provided. Note that the part related specifically to bibliometric analysis is also supplied.

1. PubMed

1. Choose Advanced Search from PubMed homepage (www.ncbi.nlm.nih.gov/pubmed).
2. Enter the desired search term in the search field. Choose the search terms from the medical subject heading (MeSH) database. The following example details how to assess research in "cancer".
    1. Open the MeSH database: https://www.ncbi.nlm.nih.gov/mesh.
    2. Enter the word "cancer" in the search field.
    3. Ensure that the results show the word "neoplasms" at the top of the search, where it notes that using the word "neoplasms" is more suitable, as "neoplasms" is the word used to index relevant topics.
    4. Further check other terms listed under the term "neoplasms" by clicking on it. The results will show other terms used to describe similar topics (*e.g.,* tumor), and will also list other subcategories (subheadings) under the term neoplasm.
    5. Use the drop-down lists in the Builder section to specify the field of the article that PubMed will search for the term in. Note that the following search fields are available: all fields, title, abstract, authors, affiliation, conflict of interest, language, journal, publisher, publication type, grant number, ISBN, and MeSH terms.
    6. Add as many fields as needed and choose the relation between these fields (AND, OR, or NOT). See Table 1 for further details.
3. Click Search.
4. Refine the search results further in the results using different filters available as detailed in Table 2. Note that from now on, the final search done will be saved in the history of the Advanced Search, which was accessed in the first step. This means that the search can be paused at this step and resumed later.
5. Ensure that each new search is saved in the Advanced Search history screen where it will be assigned a number (*e.g.*, #2). Use this number in the search field above to subtract searched queries (*e.g.,* "#1 NOT #2" to subtract results in search #2 from results of search #1).
6. Export the results to further analyze them.
    1. Use the FLink tool (https://www.ncbi.nlm.nih.gov/Structure/flink/flink.cgi) to export the results in a comma separated values (CSV) format, and choose PubMed from the Please choose a database to start drop-down list.
    2. Choose Input From Entrez History from the input screen, and an advanced PubMed search history will appear at the drop-down list.
    3. Choose the search performed in the previous steps at the PubMed advanced search and click Submit.
    4. View the resulting report since it provides the option of exporting the search results in a CSV format file.
7. Perform the following steps to analyze Jordanian research output during a 5-year period between 1/1/2013 and 31/12/2017 using PubMed.
    1. Open the Advanced search form in the document search form at the PubMed website (www.ncbi.nlm.nih.gov/pubmed).
    2. Use Jordan as the search term and specify Affiliation as the search field. Note that PubMed interprets affiliation as all information related to the author (*i.e.,* author's name, address, affiliation), so exclude any document authored by an author named "Jordan" in which the affiliation country is not Jordan. Follow the steps below to avoid including such irrelevant results.
    3. Type Jordan in another field and choose the field type Author.
    4. Choose the operator NOT as the relation between the two fields and click on Search.
    5. Specify Publication Dates from 1/1/2013 to 31/12/2017 in the results window, and choose Journal Article and Review from Article Types.
    6. Open FLink (https://www.ncbi.nlm.nih.gov/Structure/flink/flink.cgi), and choose PubMed as the database.
    7. Choose Input From Entrez History from the input screen, and choose the search from the drop-down list.
    8. Click Download CSV.
    NOTE: **Figure 1** details the PubMed search report with annotation for each section of the report.

2. Scopus

1. Register in order to access the full search capabilities of the Scopus database. Check if the local institution is already registered and has access to the database since academic institutions are usually registered in Scopus.
2. Go to the website (www.scopus.com) and by default, Scopus opens the document search form screen.
3. Enter the search term desired in the search field available.
4. Specify the fields in the article to be searched for. Note that the following search fields are available: all fields, title, abstract, keywords, authors, affiliations, funding information, language, references, conference, ISSN, CODEN, DOI, ORCID, and CAS number.
5. Add other fields to search for and indicate the relation between the newly added field and the other field already entered (AND, OR, or AND NOT). See (Table 1) for further details.
6. Use the Limit option to limit the search based on the options provided by Scopus, as detailed in Table 2.After executing the search, save the search and continue later if needed.
    1. In this case, set an alert using the option Set alert, where an email will be sent when an article satisfying the searching criteria is added.
7. Refine the search results further from the results directly by choosing from the options provided by Scopus (Table 2), where Scopus shows the number of documents included for each option.
8. Choose to either analyze the results directly on the Scopus website (click Analyze Search Results), or to export the results in either zip or CSV formats after completing the search criteria.

9. Perform the following steps to analyze Jordanian research output during a 5-year period between 1/1/2013 and 31/12/2017 using Scopus.
    1. Go to the website (www.scopus.com) and by default, Scopus opens the document search form screen.
    2. Type Jordan as the searching term in the document search form.
    3. Specify Affiliation Country as the search field.
    4. Limit the search duration from 2013 to 2017. Note that from 2013 means from 1/1/2013, and to 2017 means to 31/12/2017.
    5. Limit the document type to Article or Review, and then click Search.
    NOTE: **Figure 2** details the Scopus search report with annotation for each section of the report.

3. Web of Science

1. Register in order to access the full search capabilities of the Web of Science database. Check if the local institution is already registered and has access to the database as academic institutions are usually registered in Web of Science.
2. Go to the Web of Science home page (www.webofknowledge.com). The website opens the basic search and includes the Web of Science Core Collection as the selected database for search.
3. Search for the fields as detailed in Table 2.
4. Add another field (if needed) to connect both fields by either AND, OR, or NOT. See Table 1.
5. Define the duration that is searched down to 1945. After completing the search, the results are saved in the history and can be returned to at any time. If needed, set an alert if any new document is added to the search report.
6. Sort the results according to either data, times cited, usage counts, or to other categories from the drop-down list provided.
7. Refine the search results further from the results directly by choosing from the options provided by Web of Science (Table 2), where Web of Science shows the number of documents included for each option.
8. View the results and analyze them via a tree map or bar graph. Note that there is a table showing the count in each category.
9. Download the results. Note that unlike Scopus and PubMed, Web of Science only allows the downloading of 5,000 records at a time (*e.g.,* a 10,000 result search is downloaded in two batches, the first batch for the first 5,000 records, and a second batch for the next 5,000 records).
10. Perform the following steps to analyze Jordanian research output during a 5-year period between 1/1/2013 and 31/12/2017 using Web of Science.
    1. Type Jordan in the search field and specify Address as the search field.
    2. Identify the duration of search between 2013 and 2017 and click Search.
    3. Restrict the search using Article and Review filters.
    4. Choose to analyze the results that are saved in Search History now or later.
    5. Choose to analyze the results in the form of tables or visual tree map and bars.
    NOTE: **Figure 3** details the Web of Science search report with annotation for each section of the report.

Representative Results

Results from PubMed search

A total of 4,363 documents were retrieved based on the search conducted in this study. Free full text was available for 1,767 documents (40.5%). In 2013, a total of 532 documents were published, 663 documents in 2014, 811 documents in 2015, 952 documents in 2016, and 1,405 documents in 2017.

The results reveal that 1,008 (23.8%) documents discussed issues related to cancer, while only 53 (1.2%) documents discussed AIDS related topics. The results also show that 150 (3.5%) documents were published in dentistry related journals, while 275 (6.5%) documents were published in nursing journals.

Results from Scopus search

A total of 11,444 documents resulted from the search conducted in the current study, including 10,974 (95.9%) articles and 470 (4.1%) reviews. Only 652 (5.7%) of the documents were open access.

Figure 4 shows the yearly trend in Jordanian publications during the 5-year interval. According to the country of collaboration in the Scopus search (**Figure 5**), the United States of America (USA) is the most common country Jordanian researchers collaborate with (1,553 publications), followed by Saudi Arabia with 1,176 publications, and United Kingdom with 723 publications.

Figure 6 details the 10 most common disciplines Jordanians have published in. Based on the Scopus search, medicine is the most common discipline published in (2,441 publications), followed by engineering (1,837 publications), and social sciences (1,468 publications). The University of Jordan has contributed to 3,346 (29.3%) publications of the total five year publications, followed by Jordan University of Science and Technology with 2,396 publications (21.0%), and Hashemite University by 1,347 publications (11.8%).

Results from Web of Science search

A total of 10,943 documents were published in Jordan. 87 are highly cited papers and 14 are considered to be hot papers. The results show that 2,879 documents were Open Access, 2,547 documents were Gold open access, 170 documents were Green published, and 162 documents were Green accepted (manuscript deposited in repositories upon acceptance before publication).

Figure 7 shows the yearly trend in Jordanian publications during the 5-year interval. **Figure 8** details the country of collaboration. According to the Web of Science search, the USA is the most common country Jordanians collaborate with (929 publications), followed by France with 860 publications, and Austria with 429 publications. **Figure 9** details the 10 most common disciplines Jordanians published in. According to the Web of Science search, engineering is the most common discipline published in (1,315 publications), followed by mathematics (1,263 publications), and computer sciences (828 publications).

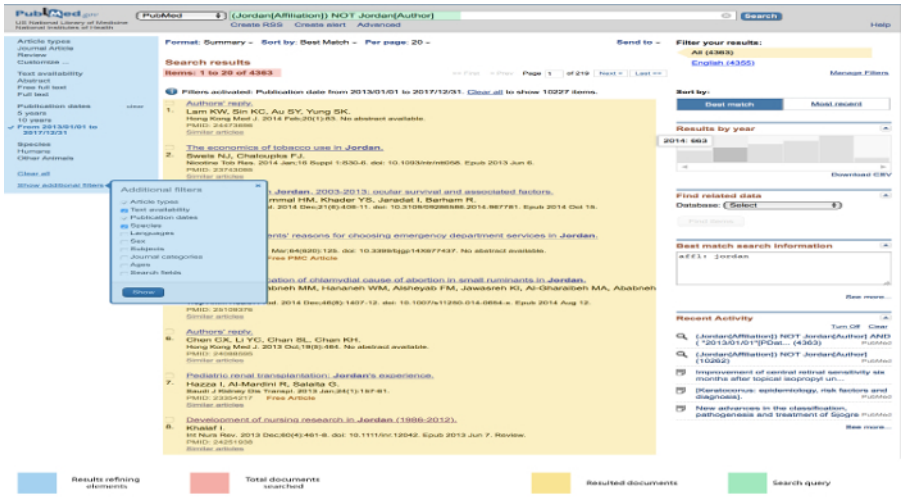

Figure 1: The report for the PubMed search with color annotation for each section in the report. Please click here to view a larger version of this figure.

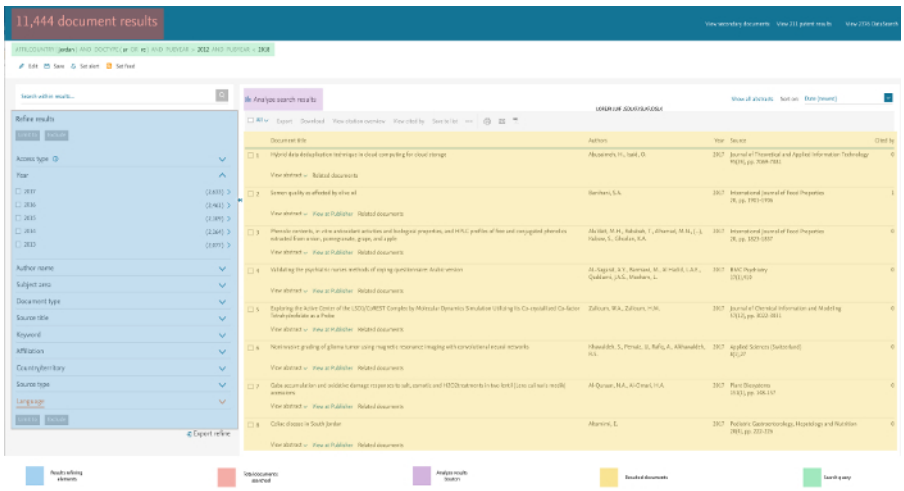

Figure 2: The report for the Scopus search with color annotation for each section in the report. Please click here to view a larger version of this figure.

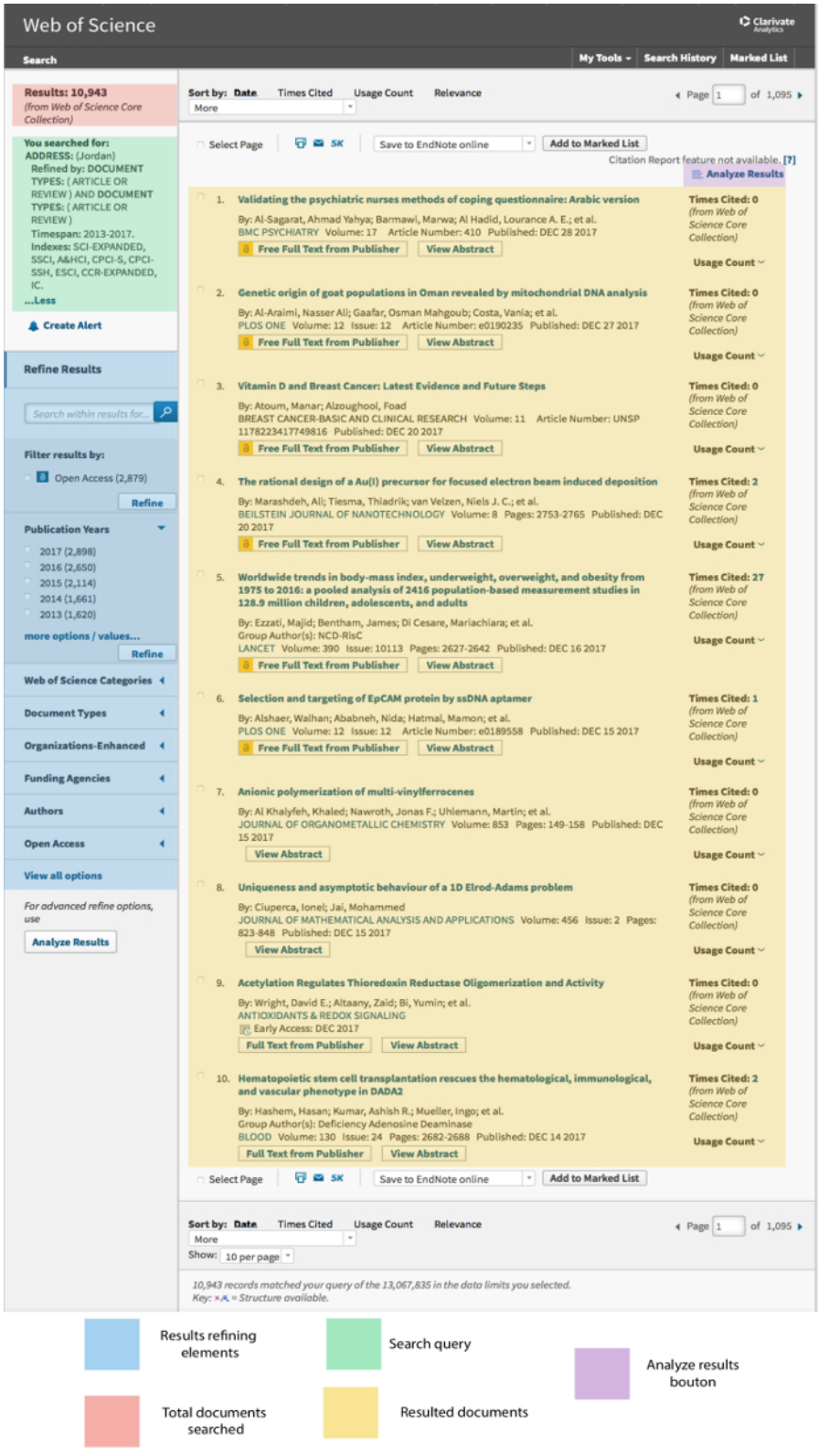

Figure 3: The report for the Web of Science search with color annotation for each section in the report. Please click here to view a larger version of this figure.

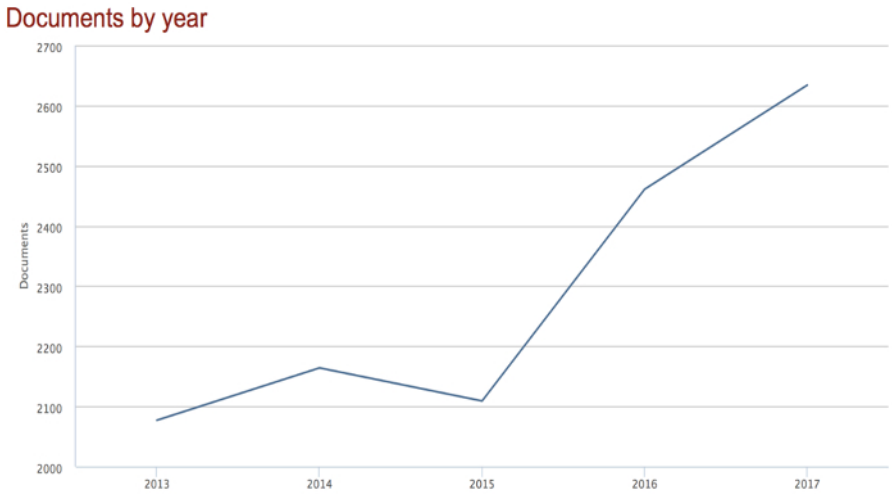

Figure 4: The yearly trend in publications in Jordan during the 5-years period, as extracted from Scopus. Please click here to view a larger version of this figure.

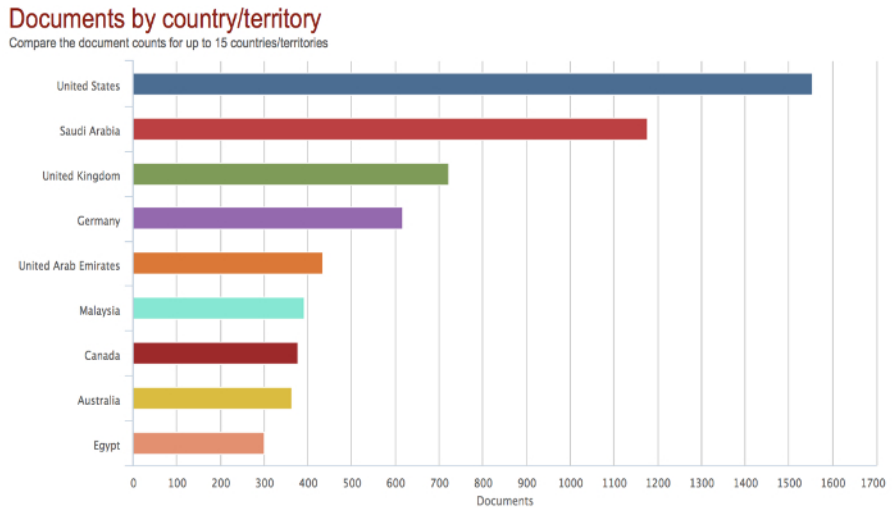

Figure 5: The countries Jordanians tend to author publications with, as extracted from Scopus. Please click here to view a larger version of this figure.

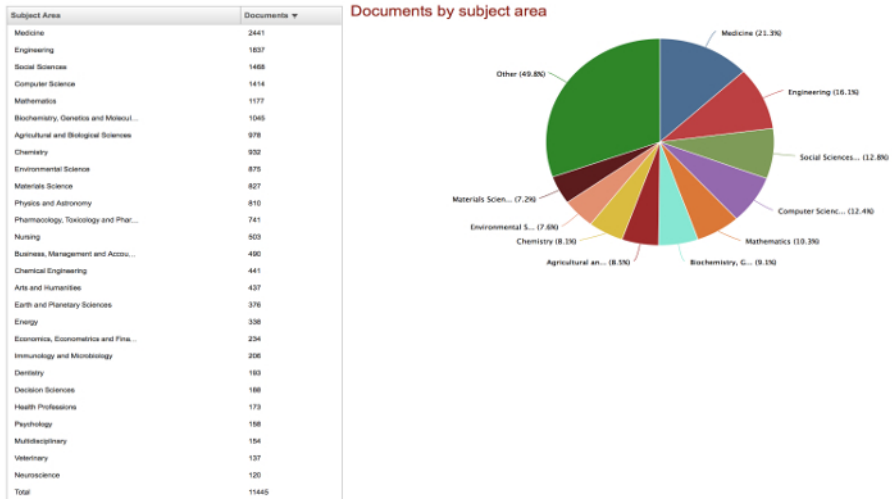

Figure 6: The disciplines Jordanian publications are generally about, as extracted from Scopus. Please click here to view a larger version of this figure.

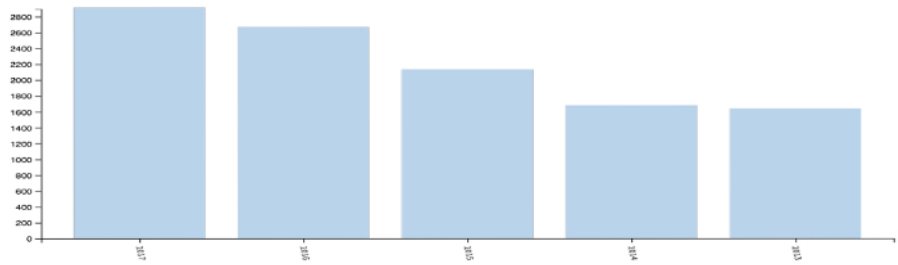

Figure 7: A bar chart showing the yearly publication trend in the years 2013-2017 in Jordan, as extracted from Web of Science. Please click here to view a larger version of this figure.

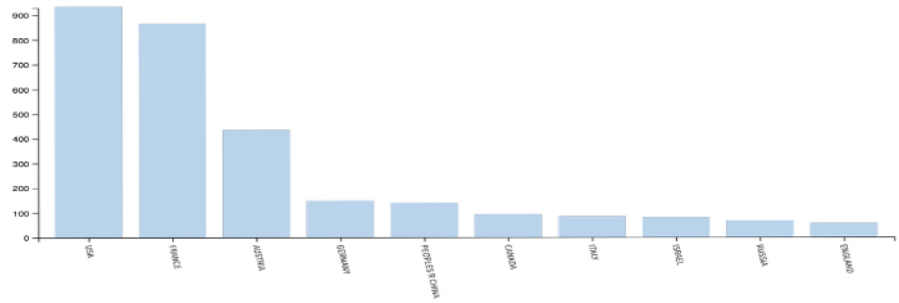

Figure 8: A bar chart showing the countries Jordanians tend to collaborate with in the years 2013-2017, as extracted from Web of Science. Please click here to view a larger version of this figure.

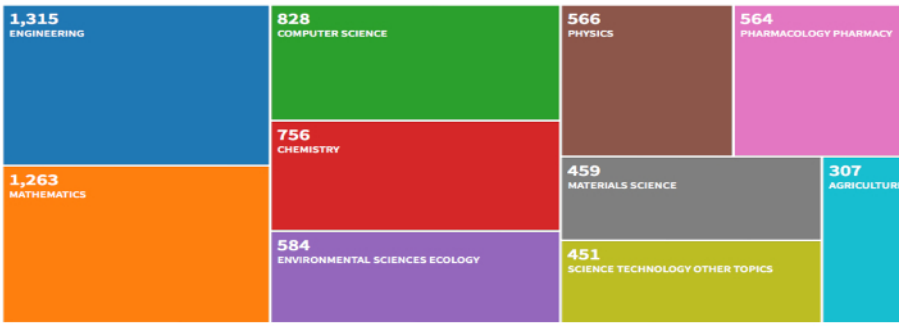

Figure 9: A tree map showing the 10 disciplines which most Jordanian publish in during the years 2013-2017, as extracted from Web of Science. Please click here to view a larger version of this figure.

Operator function	PubMed	Scopus	Web of Science	Example
Both terms must appear	AND	AND	AND	
At least one of the terms must appear	OR	OR	OR	
The term after it must not appear	NOT	AND NOT	NOT	
You want to find two words within an "n" distance from each other regardless of their order	X	W/n	NEAR/n	Jordan W/2 Cancer → finding a result with the words "Jordan" and "Cancer" within 2 words from each other
You want to find a word within an "n" distance prior to the other word (order respected)	X	Pre/n	X	Jordan Pre/2 Cancer → finding a result with the words "Jordan" is preceding "Cancer" by 2 words
You want to find the words with the specified stem, regardless of the other part of the word	X	* or ?	*	Jordan* or Jordan? → will return also the results for "Jordanian"
You want to find a word with the specified stem and with a maximum of just one more letter after it	X	X	$ or ?	Jordan$ or Jordan? → will give results for "Jordans" but not for "Jordanian"
Searches for the exact phrase within the quotation marks, will respect the meaning of any operators mentioned within the quotations	X	""	""	"Cancer in Jordan?" → will search for "cancer in Jordan" or "cancer in Jordans"
Searches for the exact phrase within the quotation marks, without respecting the meaning of any operators mentioned within the quotations	X	{}	X	{Cancer in Jordan?} → will search for "cancer in Jordan?" only, that is it will interpret the question mark as a question mark

Table 1: Operators to perform the specified functions for each database. Operators in PubMed must be in upper case, unlike those for Scopus and Web of Science. X=not present.

Outcome measures	PubMed	Scopus	Web of Science
Documents each year	√	√	√
Publications in specific Journal	√	√	√
Publications per author	√	√	√
Institutional affiliation	√	√	√
Country of authors	√	√	√
Number of open access publications (Golden OA)	√	√	√
Number of open access publications (Green OA)	X	X	√
Publications per each document type	√	√	√
Subject area	√	√	√
Publications in specific publishers	√	X	X
Publications for specific MeSH terms	√	X	√
Web of Science categories	X	X	√
Funding agency	X	X	√
Publications on specific gender	√	X	X
Publications on specific age group	√	X	X
Publications by a unique PubMed ID	√	X	√
Publications managed by specific editor	X	X	√
Highly cited papers: Papers in top 1% in each subject area in terms of highest citations in the last 10 years.	X	X	√
Hot papers in the field: Papers that have been highly cited in the latest two months compared to the norm (average citations in peer papers).	X	X	√

Table 2: Outcome measures and search filters that are available for each literature database. Researchers may refer to each database's instructions for further details on using each filter.

	PubMed	Scopus	Web of Science
Covered disciplines	**Life sciences and biomedical disciplines**	**All disciplines**	**All disciplines**
Focus	**Life sciences and biomedical disciplines**	**Physical, health, life, and social sciences**	**Science, technology, social sciences, arts and humanities.**
Covered period	**1966**	**1970**	**1900***
Free/Paid	**Free**	**Paid**	**Paid**
Ownership	**National Institute of Health**	**Elsevier**	**Clarivate**
Professional term indexing	**Yes**	**No**	**No**
Associated data search	**No**	**No**	**Yes**
Old data coverage	**No**	**No**	**Yes**
Figure production	**No**	**Yes**	**Yes**
Open access assessment	**Gold open access**	**Gold open access**	**Green and gold open access**
Friendly interface	**+**	**++**	**+++**
Availability of operators	**+**	**+++**	**++**
* Coverage depend on institutional subscription			

Table 3: Comparing the characteristics of PubMed, Scopus, and Web of Science. Information in this table is based on this study's data and the information provided by each database[10,22,23,24].

Discussion

In this study, the steps through which PubMed, Scopus, and Web of Science databases are used to perform a bibliometric analysis were provided. It was indicated that the friendliest and the easiest tool to use for bibliometric analysis services is Web of Science; however, its drawback is that its services are not available for free. PubMed is devoted for biomedical sciences and is affiliated with several other National Library of Medicine (NLM) tools that can help to optimize analysis of biomedical subjects. Medical Subject Heading (MeSH) is a professional indexing tool, where upon adding a new article to PubMed database, the article will be searched by experts for the main topics it discusses, and a list of MeSH will be assigned for each article. On the other hand, its main drawback is that it requires good knowledge on how to use it. Searching the Web of Science core collection will yield all articles that are published in journals indexed in the Science Citation Index Expanded (SCIE), the Social Science Citation Index (SSCI), the Arts and Humanities Citation Index (AHCI), and the newly added Emerging Source Citation Index (ESCI), where authors can choose the database within Web of Science to search in[18]. In addition, two other databases for books and conferences are also included[19]. Scopus is generally easy to use and has a database that covers more journals than the other two services[20], but it is still a paid service. **Table 3** further details and compares the characteristics of PubMed, Scopus, and Web of Science.

As shown in the results, each of Scopus and Web of Science database search provided different disciplines as the most common disciplines Jordanians publish in. The reasons behind these discrepancies were examined by analyzing the research area (discipline) classification for each database. It was found that Scopus search yielded 27 research areas, where publications are classified into one or more of them. On the other hand, Web of Science search yielded 140 research areas. However, Web of Science publications are classified into only one of them (no publication is classified into more than one research area). For example, the single research area "Medicine" in Scopus corresponds with 27 research areas in Web of Science, which are (numbers correspond to the contribution of each research area in the total 10,936 publications which resulted from Web of Science search):

Internal medicine (2.5%), neurology (2.2%), oncology (2.2%), surgery (1.4%), endocrinology (1.1%), pediatrics (1.1%), psychiatry (1%), experimental medicine (1%), cardiovascular system (0.9%), infectious diseases (0.9%), radiology (0.9%), orthopedics (0.7%), obstetrics and gynecology (0.7%), immunology (0.6%), rehabilitation (0.6%), hematology (0.6%), urology (0.5%), respiratory (0.4%), ophthalmology (0.3%), gastroenterology (0.3%), complementary medicine (0.3%), dermatology (0.2%), morphology (0.2%), rheumatology (0.2%), anesthesiology (0.2%), emergency medicine (0.1%), allergy (0.1%).

As explained earlier in the protocol, researchers may download search results in a CSV or XLSX format, where several tools are available to further analyze and map the results. These tools apply the concept of science mapping or bibliometric mapping, which is a spatial representation of how disciplines, fields, documents, or authors are related[24,25]:

- The Sci2 Tool (https://sci2.cns.iu.edu/user/index.php): A freely available tool to perform analysis on data extracted from Scopus, Web of Science, or even PubMed.
- BibExcel (http://homepage.univie.ac.at/juan.gorraiz/bibexcel/): A freely available tool that manages and builds maps for data extracted from different bibliometric software.
- CiteSpace (http://cluster.cis.drexel.edu/~cchen/citespace/): A freely available tool for visualizing and analyzing trends and patterns in scientific literature.
- UCINET (https://sites.google.com/site/ucinetsoftware/home): A s ubscription-based tool for the analysis of social network data and drawing visualized maps.
- Pajek (http://mrvar.fdv.uni-lj.si/pajek/): A freely available tool for the analysis and visualization of large networks.
- Leydesdorff' s Software (https://www.leydesdorff.net/software.htm): A freely available tool to analze output from bibliometric databases and to draw mappings of the results.

- Network Workbench Tool (http://nwb.cns.iu.edu): A freely available tool that provides specific algorithms to deal with publications data to construct and analyze bibliometric networks and maps.
- VintagePoint (https://www.thevantagepoint.com): A subscription-based tool to analyze and science map large volumes of structured text to discover patterns and relationships
- VOSviewer (http://www.vosviewer.com/download): A freely available tool specifically designed to construct and visualize bibliometric maps, paying special attention to the graphical representation of such maps.

In addition, researchers can use data obtained from the three databases (Pubmed, Scopus and Web of Science) and calculate several other valuable indices using data from other sources, including World Bank and the Organization for Economic Co-operation and Development (OECD). As yearly publications and the author's country of affiliation are available as outcome measurements in the three databases, the following indices can thus be measured:

- Population index
- Number of publications per million inhabitants, where populations can be obtained from World Bank database[26].
- Publications per gross domestic product (GDP)
- Number of publications per billion-dollar GDP, where GDP can be obtained from “World Development Indicators” from World Bank database[26].
- Annual scientific growth rate (Research productivity)
- (Publications in the year (n) – Publications in the year (n-1))/ Publications in the year (n-1)
- Publications per region

As the world is divided into 9 regions according to United Nations Statistical Year Book by the United Nations[27], these divisions are based on geographical, scientific, and economical considerations. These regions are: Western Europe, Eastern Europe, the United States of America (USA), Canada, Latin America and the Caribbean, Africa, Japan, Asia (excluding Japan), and Oceania.

Researchers aiming to do bibliometric analysis using the aforementioned databases should be aware of their limitations; journal coverage by Scopus and Web of Science in almost all disciplines does not reach half of the journals in Ulrich's periodicals dictionary[28]. This means that although Scopus and Web of Science indexed journals are based on quality, they do not cover all journals in any discipline. Moreover, non-English language journals are under-represented, as the focus of these databases are English-language journals[28]. One of the limitations one can encounter during the analysis is the unavailability of complete information about an article (*e.g.*, missing author's country of affiliation), which might lead to some sort of error in the results. This can be avoided by performing a manual search for the author. However, this issue was not discussed in the analysis conducted in this study since previous studies have estimated the missing information caused by this issue to be insignificant (less than 5%)[6].

Disclosures

All authors disclose no potential conflicts of interest.

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