**TITLE**

Comparing Bibliometric Analysis using PubMed, Scopus, and Web of Science databases

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**SHORT ABSTRACT**

Literature databases are commonly used to assess publications in a certain subject, discipline, country, or region of the world, a practice known as bibliometric analysis. The current protocol details how to use PubMed, Scopus, and Web of Science databases to do bibliometric analysis.

**LONG 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.

**INTRODUCTION**

Classically, researchers have used literature databases to perform literature review for their studies1. 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 since2. 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 document3, a subject4, a discipline5, a country6, or even a region in the world7. 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 development8. In other words, bibliometrics is the quantitative study of published units on the basis of citation and text analysis9.

Different databases are used to do bibliometric analysis and each database has different characteristics and can provide different services10. Currently, the most commonly used literature databases are the Web of Science and Scopus for almost all disciplines, both only available on a subscription basis11, and PubMed for biomedical and life sciences, a freely available database10. 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 contents12,13. Moreover, Google Scholar lacks the tools for performing advanced search and keyword optimization14.

Several previous studies have compared the features of the previously mentioned literature databases for literature review purposes3,5,10,12,13,15-17. 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](http://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.

1. **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](http://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](http://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.

1. **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](http://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 1767 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 1008 (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 AND TABLE LEGENDS:**

**Figure 1: The report for the PubMed search with color annotation for each section in the report.**

**Figure 2: The report for the Scopus search with color annotation for each section in the report.**

**Figure 3: The report for the Web of Science search with color annotation for each section in the report.**

**Figure 4: The yearly trend in publications in Jordan during the 5-years period, as extracted from Scopus.**

**Figure 5: The countries Jordanians tend to author publications with, as extracted from Scopus.**

**Figure 6: The disciplines Jordanian publications are generally about, as extracted from Scopus.**

**Figure 7: A bar chart showing the yearly publication trend in the years 2013-2017 in Jordan, as extracted from Web of Science.**

**Figure 8: A bar chart showing the countries Jordanians tend to collaborate with in the years 2013-2017, as extracted from Web of Science.**

**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.**

**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. ✖=not present.

**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.

**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 database10,22-24.

**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 in18. In addition, two other databases for books and conferences are also included19. Scopus is generally easy to use and has a database that covers more journals than the other two services20, 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 related24,25:

* 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 subscription-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 database26.
* 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 database26.
* 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 Nations27, 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 dictionary28. 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 journals28. 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.

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**DISCLOSURES**

All authors disclose no potential conflicts of interest.

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