

## RESEARCH ARTICLE



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# Systematic Literature Search Strategies for the Health Sciences

## Abstract

Systematic search of literature is an important skill for researchers to help achieve a comprehensive understanding of the topic of interest. Likewise, clinicians need this skill for them to be updated on the recent evidence in providing relevant health care interventions to their patients. However, many health professionals and health science students rely on the use of limited search engines and few databases without systematically performing search and retrieval of relevant studies. This practice commonly yields inadequate references for a research project or clinical decision-making resulting to an incomplete understanding of the topic at hand. This paper aims to provide an introductory guide for researchers as well as clinicians on the step-by-step process of systematic literature search. It also provides information on the available open-access directories and databases as additional or alternative sources of evidence especially in low-resource institutions. However, careful guidelines must be considered in using open-access sources to maintain the quality of research projects and clinical decisions.

**Key words:** *Systematic literature search, databases, health sciences, open-access sources*

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The development of the internet resulted to an information revolution with rapid practical storage and distribution of available data worldwide (Falagas, Pitsouni, Malietzis, & Pappas, 2008). Voluminous scientific information is readily available online. For every topic of interest in health care, one can easily find related literature. Everyday, more articles are being added to the several millions of published materials in medicine, nursing, pharmacy and other allied health sciences.

Although internet use is continuously increasing worldwide, many academic and research institutions still do not have adequate access to bibliographic databases especially in low- and middle-income countries (LMIC). But with the increasing movement for open-access publishing, alternative and additional sources of scientific information are available. Whether researchers and clinicians rely on subscription-based or open-access sources, the tremendous volume of scientific materials available online makes the identification of the most relevant information difficult.

Effective searching of the literature is considered a core skill for the practice of evidence-based medicine (Doig & Simpson, 2003). For instance, in planning a health education program on dengue or Zika virus, effective literature search can provide recent evidence on the scientific information that can help health sciences students and professionals in the preparation and delivery of educational activities about dengue vaccination or Zika virus complications and management. Similarly, researchers perform literature search to develop and refine their research questions by identifying gaps in the literature. Others use the literature to conduct research synthesis such as systematic review, scoping review, meta-ethnography and realist synthesis to inform health policy and practice.

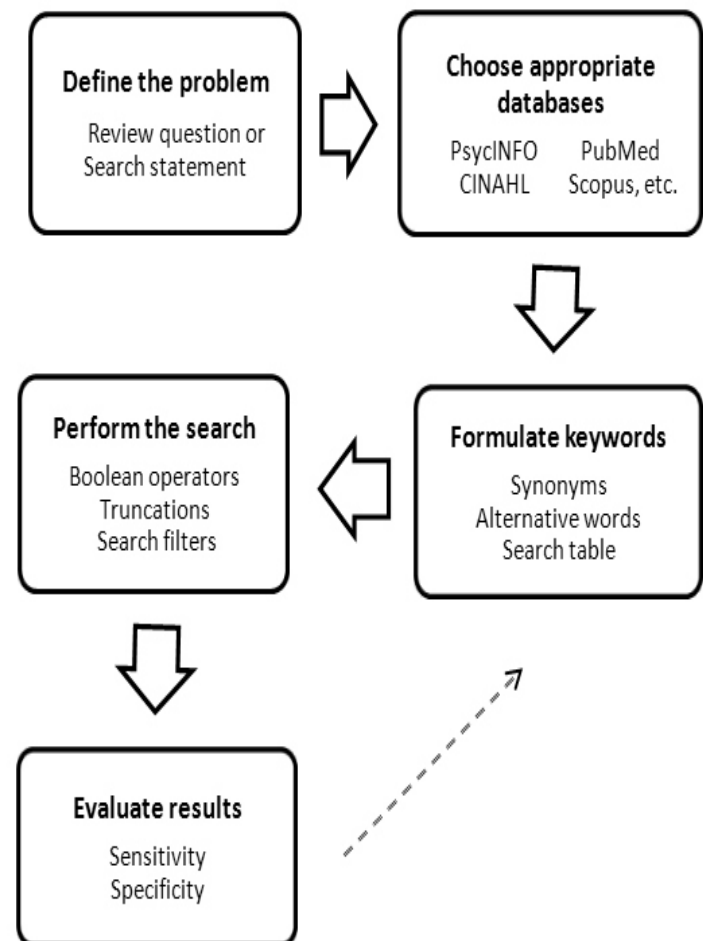
Conducting literature review is always necessary to gain a thorough understanding of the research topic. Many research questions may have been answered and relevant studies may already been available. Clinicians also need to be updated on the current scientific information to help them provide adequate health care to their clients.

This paper aims to provide introductory information on the systematic search of the medical and allied health literature to help inform research projects as well as clinical practice. This paper specifically intends to present a general step-by-step guide in literature searching and provide some information on the additional or alternative sources of articles– the use of open access publications. Researchers interested in literature search in specific databases should refer to other articles (e.g. Doig & Simpson, 2003; Ebbert, Dupras, & Erwin, 2003; Schrimsher & Kendrach, 2006). This paper does not cover selection and appraisal of literature.

## A step-by-step literature search

This section presents our experiences in the systematic literature search and substantiated it with the available related literature (e.g. Bartels, 2013; McGrath, Brown, & Samra, 2012; Timmins & McCabe, 2005). The following steps are suggested in conducting systematic search of the literature for research projects and clinical decision-making. Figure 1 below shows the steps in the systematic search of literature.

Figure 1: Diagram of the systematic literature search



Specify what you need to search. A more specific review question or search statement will generate the most relevant literature. For instance, rather than asking, 'what are the interventions for diabetes?', narrow it down to, 'what are the most effective preventive interventions for type II diabetes?'. This will allow the searcher to retrieve studies on strategies specific to preventive approaches rather than studies that include a range of promotive, preventive and curative interventions. Adding the word 'effective' would also allow the searcher to generate studies

on interventions that produced only good outcomes rather than including interventions that are both effective and ineffective. However, in some instances a relatively broader review question (or search statement) is necessary when the purpose is to look for breadth of evidence on a research topic and/or when the topic is relatively new and fewer articles are available.

The extent of literature search always depends on the purpose. If one would like to review the literature to help decide on the effectiveness of dengue vaccine, you may search on the most recent studies or a meta-analysis on the effectiveness of dengue vaccination. Sometimes identifying the most cited article would help for similar purpose. Identifying seminal studies related to the topic may also be necessary in providing historical or contextual background information.

On the other hand, if the purpose is to perform research synthesis, searching the literature may require a more comprehensive number of studies to be included in the synthesis. A number of databases maybe identified to provide substantial information on this purpose. For literature reviews such as scoping reviews and systematic reviews, Stern, Jordan, and McArthur (2014) suggest that review questions can be formulated using PICO (Population, Intervention, Comparison and Outcome) for quantitative reviews, and PICo (Population, phenomenon of Interest and Context) for qualitative reviews.

### Step 2: Choose the appropriate database

Bibliographic databases are organized digital collection of references to published literature such as journals, articles, books, conference reports, graphics and multimedia that can be searched through the internet.

There are several hundreds of databases available but it is difficult to select the most appropriate for specific search topic. The selection of databases depends on the areas of interest in the health sciences. For behavioural sciences, PsycINFO might be an important database to start with. For nursing and allied health, CINAHL is one of the most popular databases. Scopus is one of the largest abstract and citation databases with peer-reviewed literature that could provide adequate number of studies with a wide range of topics in the health sciences. For studies in biomedicine, medicine and pharmacy, PubMed and Embase are good sources of relevant articles (Wilkins, Gillies, & Davies, 2005).

Lawrence and Laflamme (2008), however, warn that using only one or two databases may not enable the searcher to access adequate essential information related to the review

question. Other authors suggest to conduct exhaustive search of the study topic to achieve breadth and depth. Identification of all possible literature databases is usually necessary to determine the most influential and relevant information. Researchers can also avoid repetitions in addressing previously answered research questions.

The extent of search will always depend on the purpose of the searcher, e.g. scoping review over systematic reviews, where the latter always necessitate retrieving practically all related articles unlike with the scoping review where it may only require the most relevant studies to be included.

### Step 3: Formulate the keyword search strategy

Keywords are significant words or phrases identified by the authors of a particular publication that represent the gist of the paper. The keyword is the main tool in retrieving relevant studies. The selection of the appropriate keywords should be targeted. Using less appropriate keywords will yield volumes of unrelated publications, thus causing problems in the selection and appraisal of studies and may lead to frustration on the side of the searcher.

In using keyword search strategy, we can formulate keywords based on the research question or search statement developed in step 1. Identifying synonyms or alternative words of these keywords may also be helpful. For instance, the keyword 'obesity' is synonymous with overweight; the keywords 'public participation' is synonymous with 'public involvement' or 'consumer participation'. On the other hand, the alternative phrases for "health planning" are "priority setting" or "public consultation". To identify alternative words, it is important that a searcher has done background readings about the topic. The searcher should take time to scan articles, especially the seminal papers on the specific topic, if available. We should also take note that many databases have limits to the number of keywords to be used for searching that may affect the extent of the yielded results. For instance, Scopus limits up to 30 words, Web of Science up to 15 words, while PubMed has no limit (Falagas et al., 2008).

Bartels (2013) suggests that instead of rushing into a search by typing the words that come to mind, it is worthwhile to create a search table. The example below is a search table for a search strategy on the research question, "what strategies are effective in reducing teen-age pregnancy?" The most important terms in this review question are: "strategy", "effective", "reduce" and "teen-age pregnancy". To be able to

capture relevant studies, identify synonyms or alternative words for each term as shown in Table 1.

Moreover, the PubMed database stores both Medline and non-Medline databases for medical literature, and uses a more sophisticated controlled vocabulary called MeSH terms (Medical Subject Headings). These terms are identified and classified by highly skilled information technicians or indexer that would allow the searcher to cull for citation in an increasingly refined topic (McKeever, Nguyen, Peterson, Gomez-Perez, & Braunschweig, 2015).

#### Step 4. Perform the search

Performing the actual literature search may vary from one database to the other. Though there are commonalities in the search strategies across databases, it is essential to be familiar with the specific search functionalities for each database. The following are among the general strategies that may guide searchers to retrieve relevant citations.

##### *Working with Boolean operators and truncation*

In performing the search, there are two important strategies in limiting or broadening the search. The first is the use of Boolean operators. These operators are simple words used as conjunction to include or exclude keywords that would allow a more focused and productive search. The words OR, AND, and NOT are common Boolean operators. They must be written in all caps.

The use of the operator OR broadens the search, as it will allow retrieval of publications that contains either of the keywords used. Using the keywords 'health policy' OR 'health planning', will generate all articles containing either of these phrases. However, if we use 'health policy' AND 'health planning', the searcher puts limit to the search as it will only generate articles that contain both of these two phrases. Using NOT will tell the search engine to exclude articles that contain the keywords identified.

The second strategy is the use of truncation. It allows the search to capture both British and American spelling. If the searcher types the word 'edema', it will not capture studies with the British spelling of 'oedema'. Similarly, using the word 'organization' will not capture the word spelled as 'organisation'. By using an asterisk (\*), e.g. \*dema, organi\*ation, the searcher

**Table 1:** *Sample search table*

Strategy	Effective	Reduce	Teen-age pregnancy
Intervention	Successful	Minimize	Adolescent Pregnancy
Program	Outcome	Decrease	Early-age pregnancy
Activity	Result	Lessen	

allows the search engine to generate studies that contain words with various spellings. Moreover, if the search intends to cull all terms with the prefix of a particular word such as the word 'nurse', truncation can be used at the end, like nurs\*. It will capture plurals or alternate suffixes such as nurses, nursing and nursery.

##### *Using quotation marks or parenthesis*

To cull studies with specific phrases such as 'health care practices', the use of quotation marks will limit the search only for articles that contains these words in particular order. It will not include 'health', 'care' and 'practices' that are written separately. Other databases use parenthesis instead of quotation marks.

##### *Using search filters*

The use of search filters also makes the search more specific. The choice of search filters always depends on the purpose of the search. Below are some examples of search filters.

**Publication dates.** If the purpose of the search is to understand the social determinants of health in relation to the prevalence of tuberculosis, the searcher may indicate the year "2007 to present" in the search filter box. Using search filter to limit publications dates should always be justified. For this example, this is the period where many articles on the social determinants of health begun to be published after the report of the WHO's Commission on the Social Determinants of Health.

**Publication types.** If the intent of the search is to identify the best neurological assessment tool in the clinical assessment of adults and children, searchers may opt to include research articles that are primary studies from peer-reviewed journals only and exclude papers that are book reviews, commentary and conference papers. If the aim of the search is to draw historical evolution of primary health care in LMIC, the search may include a range of publication types such as research articles, editorials, conference papers and book chapters, in order to capture broad contextual and historical information.

**Subject area.** If the area of interest is on pharmaceutical intervention for psychiatric disorder, search terms may include subject areas such as psychiatry, pharmacology, neuroscience, and biomedicine but may exclude subjects on social science or population health.

**Language.** If the search aims to include two languages in searching for certain research projects and if there are available resources for the translation of the citation to be generated, the searcher should include only the identified languages rather than deselecting other languages. It might be more practical to select the two languages as search filters rather deselecting the others because there are so many languages included in every database. For instance, PubMed database includes 57 languages, Scopus uses 31 languages and Web of Science has 45 languages (Falagas et al., 2008).

#### *Three-step search strategy*

For all types of reviews, The Joanna Briggs Institute (2015) suggests to perform a three-step search strategy. The first step is an initial search in at least two databases to identify the commonly used keywords for the topic of interest. The second step is to use all the identified keywords (using the search table) in the entire database search. The third step involves manually checking the reference list of the selected articles or contacting authors for relevant articles.

#### *Manual searching*

The inability to yield some studies could be associated with the quality of search strategies. There are two possible ways to address this limitation. First, a study by Horsley, Dingwall, and Sampson (2011), found that checking the references cited by the articles generated from the keyword search was found to supplement the number of search output. However, the time and resources allotted in manually searching for additional studies was not clearly accounted in this study. The second approach is to contact authors and/or experts in the field or organizations who could suggest relevant articles to the search topic or question (Hopewell, Clarke, Lefebvre, & Scherer, 2007). Although these strategies maybe time consuming, results may not be available soon, and may require additional resources in performing the search, it can still help minimize the risk of selection bias of literature.

#### **Step 5: Evaluate the result and revise search strategy, if needed**

There are several ways to evaluate the result of the search. After performing the first step of searching from at least two

databases, the results of this initial search can provide a sense of the quality of the search strategy. A good search yields relevant articles that answer the review question or search statement. Reading the title and abstract of the generated result could provide an idea if the searcher culled the most relevant articles. If many unrelated articles were yielded, it is better to check the search terms and determine which of these terms might have contributed to the broad search result. Checking the reference list of the relevant articles could also help determine if the searcher generated all relevant articles. If the reference lists show a number of relevant articles not included in the search output, revision of the search strategy is necessary and a manual search is highly recommended (McGrath et al., 2012). Evaluating the use of search filters may also be necessary.

The important factors to consider in evaluating the search outcome are sensitivity and specificity (Cleary, Hunt, and Horsfall (2009). Sensitivity refers to the retrieval of all relevant articles. If sensitivity has low precision, it may result to the searcher sorting through huge number of the irrelevant studies. On the other hand, specificity is the retrieval of fewer articles of high quality and minimal number of inappropriate articles. The downside of specificity is the possibility of omitting some relevant articles. Walters, Wilczynski, and Haynes (2006) suggest to trade-off high specificity and high sensitivity depending on the searcher's needs.

#### **Documenting the search strategy**

Documenting the search strategy would provide evidence on the quality and possible limitations of the search. A well-documented search process will show how the findings of the research were achieved. This adds credibility to the research process especially if the project is a systematic review of a particular intervention. In documenting search strategies, Kable, Pich, and Maslin-Prothero (2012) describe 12 points to consider. Although these steps extend beyond systematic search per se, these points will be helpful in documenting the entire literature review process. The points to consider in documenting include: (1) provide a purpose statement to describe the question addressed in the literature search, (2) document databases or search engines used and specify if other sources were also accessed, (3) specify the search filters applied and justify its use, (4) list the inclusion and exclusion criteria, (5) list the search terms used and identify the concepts of interest, (6) document the search results for each search engine/database including numbers of articles retrieved, (7) assessed the retrieved articles for relevance, (8) document a summary table of included article, (9) provide statement of included articles, (10) conduct quality appraisal of retrieved articles, (11) critical review of literature and, (12) check reference list for accuracy.

Cleary et al. (2009) further suggest documenting the process of the search through a flow diagram showing the steps from the beginning of the search up to the inclusion of articles for review. This provides a clearer visual view of the steps undertaken in the search process.

### **Finding additional and alternative sources: open-access directories and databases**

One of the common barriers of access to published documents is the lack of subscription to databases. Individuals or institutions who have limited resources may opt to subscribe to 3-5 databases out of the several hundreds of databases. The increasing movement of publishers for 'open-access' addresses this problem of accessibility. The Budapest Open Access Initiative (BOAI, 2002), defines open access as;

... the free availability of scientific publications on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself...

This section provides some descriptions of open access sources to support health science research and clinical decision-making.

Google scholar is considered as the most common and readily accessible search engine that stores and manages millions of articles. It covers a great range of topical areas and appears to be strongest in the sciences, particularly medicine, and secondarily in the social sciences (Vine, 2006). Though it provides quick access and initial information, Google Scholar is not ready as a professional searching tool for tasks where structured retrieval methodology is necessary (Boeker, Vach, & Motschall, 2013). It lacks sufficient and advanced search features, lacks transparency of the database content, and has uneven coverage of the database (Vine, 2006).

There are various open-access directories and databases. Some of these include the Directory of Open Access Journals (DOAJ), Open Access Theses and Dissertations (OATD), WHO Library and Information networks for knowledge database (WHOLIS) and the Institutional Repository for Information Sharing (IRIS), and PubMed.

### **DOAJ**

The Directory of Open Access Journals aims for the visibility and ease of use of all high quality, peer-reviewed open access journals, periodicals and articles' metadata. Researchers and clinicians can search for open access articles at the DOAJ's website (<http://doaj.org>) through the quick search box or start with the advance search. There are about 8,829 indexed journals in this directory and includes around 1.98 million articles. However, DOAJ remains an incomplete source for biomedical research papers in general and perhaps other areas of the health sciences. Liljekvist, Andresen, Pommergaard, and Rosenberg (2015) found that DOAJ list about 86.7% of all open access journals in biomedicine. However, the number of journals indexed in the DOAJ may change as current journals may become inactive overtime and new members could be included.

### **OATD**

Thesis and dissertations are increasingly available freely online. Authors choose to publish online to gain wider audience. OATD is a collection of over 2.4 million electronic theses and dissertations (ETDs) that are accessible online. Full text of all papers live on the original hosting site, usually the repository of the university that granted the degree. However, these are not always full-text and access to full-text is limited and bounded by the policies of the universities owning the repository. Some websites could be useful for accessing thesis and dissertations are: <https://oatd.org>, [pqdtopen.proquest.com](http://pqdtopen.proquest.com) and <http://www.openthesis.org>.

### **WHOLIS and IRIS**

The World Health Organization maintains databases that are openly available in various areas of public health such as disease surveillance, health systems, environmental health, primary healthcare, patient safety, among others. These databases include full text of WHO publications such as the Bulletin of the World Health Organization from 1997 to the present and Weekly Epidemiological Record from 1996 to the present. However, documents in these databases are only limited to WHO publications. These databases can be accessed from: <http://www.who.int/library/databases/en/index.html> and [who.int/iris/](http://www.who.int/iris/)

### **PubMed**

PubMed ([www.PubMed.com](http://www.PubMed.com)) is a biomedical and life sciences database with more than 5600 journals and greater than

22 million total citations (Lindsey & Olin, 2013). When PubMed searching is compared with the other databases, PubMed tends to generate more specific citations for the intended topic because it uses MeSH searching and hierarchy. Many of the journals indexed in PubMed are available free of charge. This database is also considered to provide the most up-to-date clinical information for practice and research as it is updated daily.

### Other possible sources of open-access articles

Thelwall and Kousha (2015) suggest two academic social networking sites (ASNS) that are potential sources of relevant articles. ResearchGate.net and Academia.edu are used by academics to disseminate their work by listing or uploading their work that may provide additional access points for literature searchers. Other reference sharing sites with social networking functionality are also possible source of researches such as Mendeley.com, BibSonomy.org, Zotero.org, and CiteULike.org.

### The question of quality of open-access publications

There is a debate that open-access journals publish low quality articles. The perception is that, if open access journals require fees from the authors rather than the subscribers, there is a possibility that these journals accept low quality papers for more collection of fees (Leopold, 2014) to sustain its operation. However, Björk and Solomon (2012) found that the share of gold open access publishing (assigns the cost of publishing to the author) for the overall volume of peer-reviewed journals publishing is rapidly increasing and argue that there is no reason not to choose to published in the OA journals. But researchers need to be vigilant of the increasing number of questionable or 'predatory' open-access journals (Shen & Björk, 2015). There is a need to check carefully the quality standards of the OA journals being considered aside from appraising the quality of the articles retrieved. Jeffrey Beall (2015), a well-known critique of predatory open-access publishing, defines a list of criteria in identifying predatory publishers and journals, and provides a list that are regularly updated at his blog, scholarlyoa.com.

### Conclusion

Systematic search of literature for the purpose of research or clinical decision-making requires time. The relevance of the generated articles depends on the quality of the planning process for the actual performance of the search. Systematic literature search, with the properly developed search strategies, allows the searchers to retrieve the appropriate materials and answer the research question or search statement. The problems on accessibility of researchers and clinicians in low and

middle-income countries to journal subscriptions could be addressed partially by maximizing the rapidly increasing number of open-access publications that may provide additional or alternative sources of scientific information. Searchers, however, need to evaluate these open-access sources and identify its potential limitations. •

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*“It is GOOD to cherish your yesterdays; It is BETTER to dream your tomorrows;  
but it is BEST to live your today's! Remember to hold fast to your dreams,  
for if your dreams die, then your life is like a bird with broken wings that cannot fly.”*

*- Donald Pillai*