Steps of a systematic literature search in non-medical sciences: guide for researchers

This guide provides information about the most relevant steps to consider when planning and conducting a systematic literature search in the sciences. It is specifically designed for the needs in non-medical sciences[1].

Overview

Step 1:	Building a team	Step 7:	Record screening
Step 2:	Research question(s)	Step 8:	Data extraction
Step 3:	Scoping search	Step 9:	Quality assessment / appraisal
Step 4:	Study design decision	Step 10:	Synthesis (data analysis)
Step 5:	Protocol registration	Step 11:	Interpretation
Step 6:	Literature search	Step 12:	Writing and reporting

All twelve steps are also commented in a [Coffee Lecture](#) by Tanya Karrer (fall 2023).

1. Building a team

A systematic review should be conducted by more than one person (e.g., by information specialists, statisticians and writing experts). Working in a team reduces bias and complements subject knowledge with methodical expertise. Step 7, the screening of records, can never been carried out by just one person.

→ Make sure you have your team of colleagues and experts assembled.
→ Allocate enough time for your team to collaborate, particularly for record screening.

2. Research question

Formulate your research question.

→ Be as precise as possible and as broad as necessary based on the aim of the project.
→ There may be several research questions, e.g., if you approach several non-related topics, or if you approach several sub-questions.
→ See video from the Medical Library: [introduction to search concepts](#) (video for health sciences, but useful for other disciplines).
→ For potential question formats, consult the "Research question and protocol" section of the [UB Bern Medical Library Systematic Searching Guide](#) or the [CQUniversity Library's homepage on question frameworks](#).

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[1] For health sciences, the [Medicine and Pharmacy Portal](#) at the University Library Bern provides tailored information and services.

3. Scoping search

Explore your topic.

→ Conduct quick and simple searches, e.g., in Google Scholar.
→ Avoid duplicate work: Check registers for recently published systematic reviews on your topic (OSF and protocols.io: different disciplines, different review types; PROCEED: environmental sector; PROSPERO, Inplasy and Research Registry: health related topics and/or restricted to certain review types).

4. Study design decision

Choose the type of review based on your study's goals. Be aware that it is not always a systematic review that answers best your research question.

→ Get informed about different types of reviews:
   o Consult the "Review Types Decision Tree" in the Glossar zur Systematischen Literaturrecherche, page 30.
   o Descriptions of different review types are also provided by the UB Bern Medical Library Systematic Searching Guide or by whatreviewisrightforyou.knowledgetranslation.net.
→ Consult existing published reviews within your field of interest as a guideline and compare them with your needs and goals.
→ Consider standards and protocols in your field of research that you may have to follow, e.g.:
   o Environmental studies: CEE provides a detailed guideline for authors.
   o Animal and food research: SYREAF provides different protocols.
   o Social sciences: Campell Collaboration provides information.
→ Discuss with supervisors and peers.

5. Protocol writing and registration

Start writing a protocol for your systematic review. Ideally, publish your search protocol on a platform where peers can give feedback (e.g. OSF registration information).

→ It should contain all information necessary to understand and replicate your literature search and the screening process (inclusion/exclusion criteria).
→ Be transparent about your research. Your literature search methods should be clear and reproducible. Inclusion and/or exclusion criteria for the screening process need to be clearly defined.
→ The PRISMA-P extension provides a useful checklist to establish a protocol. There is a protocol template in SciFlow available for Uni Bern researchers working with this online text editor.
→ A general and simple review protocol template that works for different kinds of review types was provided by Sarah Visintini.

→ Check for and follow standards or guidelines in your field of research if there are any (see also section 4). Examples:
- o PRISMA for Ecology and Evolutionary Biology (PRISMA-EcoEvo)
- o ROSES Reporting Standards for environmental systematic reviews (ROSES)

6. Literature search

Find all relevant literature to answer your research question. This task can be divided into several steps:

6.1   Define key concepts

What are the major components addressed by your research question?

→ The "building block strategy" is an effective approach to develop your search.
→ Useful videos:
- o introduction to search concepts (health sciences)
- o performing a Building Blocks Search (natural sciences)
→ Subject librarian(s) in your field can support you to define key concepts.

6.2   Identify relevant databases

There are interdisciplinary and subject-specific databases. Find out which databases are relevant to your research topic and learn about their features for advanced searching (operators, wildcards, truncation, etc.).

→ Check out Appendix A for a description of databases in different subject areas.
→ For additional databases, use the University Library Bern database search.
→ Your subject librarian(s) can support you with additional information about subject-specific databases available at the University of Bern.
→ There is no set rule as to how many databases should be included. As a broad rule, use one or two interdisciplinary databases (e.g., Web of Science, Scopus, PubMed) and at least three subject specific databases[2].
→ Use Google Scholar to find grey literature. The following websites provide additional information on how to search for grey literature:
- o https://opengrey.eu/
- o https://uow.libguides.com/literaturereview/grey-literature
- o https://bristol.libguides.com/sys-reviews-soc-sci/grey-literature
- o https://library.bu.edu/c.php?g=836473&p=5973803

6.3   Compile database search string

Translate your key concepts (see 6.1.) into a database search string.

→ Use Boolean operators, truncation, wildcards and exact phrases to build your search string.
→ Formulate a separate search string for each database; each database offers different search options and operators. See Appendix B for a list of databases and operators.

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[2] See the "Systematic Review Workbook" of the UOW library

→ There are tools that can assist you in translating search strings from one database into another, such as "polyglot".

→ Search techniques (such as operators) are explained, for example, in the Glossar zur Systematischen Literaturrecherche (pages 6 and 42; German), or in this video on advanced search techniques (English).

→ More information on search techniques can be found also on the UB Medical Library website, section "How to search".

→ Your subject librarian(s) can help you translate concepts into a database search string.

→ PRESS (Peer Review of Electronic Search Strategies) provides criteria for reviewing a systematic search: http://dx.doi.org/10.1016/j.jclinepi.2016.01.021

→ If you are using Google Scholar, e.g. for finding grey literature, be aware that these searches cannot be replicated. Use the Publish or Perish Tool for batch download.

6.4   Conduct database search

Perform your search in each database.

→ See Appendix B for a list of databases and operators.
→ Document your searches:
  o List database names, dates, search strings, number of results etc. in a spreadsheet (or similar).
  o Save search histories directly in each database and set alerts for new articles.
  o The PRISMA-S helps reporting details on search strategies.

6.5   Check search output

Check your search output and adapt your search strategy, if needed. You may do so several times before conducting a final search.

6.6   Import records to reference management software

Choose a reference management software (e.g., Endnote, Zotero) and import the records of your final search.

→ Save the records of each database in a separate folder.
→ Write down the total number of results and the numbers of items per database.

6.7   Deduplicate search results

Deduplication removes redundant entries, and thus reduces the number of papers without losing any items.

→ Either perform deduplication in a manual, semi-automated or fully automated way. For more information about these different approaches and deduplication tools, see Appendix C.
→ You do not have to follow a common standard, since there is none. Yet, recommendations for deduplication are given in PRISMA-S. You are free to select your preferred method and tool, but make sure to be transparent and name both in your publication.
→ Register the number of results after deduplication, both in total and per database.

7. Record screening and study selection

Go through all the records. Exclude or include them for your study, based on your criteria. Screening is a crucial and time-consuming step of the review process, so give it enough time.

→ Two persons at minimum (!) are needed to independently perform screening. Bear in mind that conflict cases will arise and need to be solved.
→ The first step of screening is based on title and abstract, the second step on the full text. In case the full text is not accessible via the University of Bern, you can order a copy from the University library.
→ There are other resources to help find full texts:
  o https://unpaywall.org/products/extension
  o https://openaccessbutton.org/
  o https://core.ac.uk/services/discovery
→ Document the screening process in a PRISMA flow diagram. It illustrates the number of records identified, included and excluded, and the reasons for exclusions.
→ For (semi)automated tools that support the screening process, see Appendix D.

8. Data extraction

Extract the data and/or information relevant for your review. The aim and design of your review will determine the template and approach for data extraction[3]. For example, if you are extracting qualitative data, you will want to extract data such as theoretical framework, data collection method, or role of the researcher and their potential bias.

→ Quantitative or qualitative.
→ May include sources (study ID, author ID), outcomes, study design, number of participants, results, etc.
→ Collect data and/or information in Word, Excel, Covidence, or other. You may use a subject specific template, if there is one.
→ The UNC University Library provides useful tips for data extraction[4]:
  o Look for an existing extraction form or tool to help guide you. Use existing systematic reviews on your topic to identify what information to collect.
  o Train the review team on the extraction categories and what type of data would be expected. A manual or guide may help your team establish standards.
  o Pilot the extraction or coding form to ensure data extractors are recording similar data. Revise the extraction form if needed.
  o Discuss any discrepancies in coding occurring throughout the process.
  o Document any changes to the process or the form. Keep track of the decisions the team makes and the reasoning behind them.

9. Quality assessment / appraisal

Carefully assess the quality of the selected studies, find out about their reliability and relevance.

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[3] From: https://guides.lib.unc.edu/systematic-reviews/extract-data

→ Develop explicit appraisal criteria in advance. The criteria can be iteratively refined in a pilot.

→ Assess the included studies by at least two persons to minimize bias.

→ Examples for critical appraisal questions (from the University of Hawaii's HSLIB):

  o Is the study question relevant?
  o Does the study add anything new?
  o What type of research question is being asked?
  o Was the study design appropriate for the research question?
  o Did the study methods address the most important potential sources of bias?
  o Was the study performed according to the original protocol?
  o Does the study test a stated hypothesis?
  o Were the statistical analyses performed correctly?
  o Do the data justify the conclusions?
  o Are there any conflicts of interest?

→ You may use a checklist for critical appraisal. Examples:
  o CEE: https://environmentalevidence.org/cee-critical-appraisal-tool
  o efsa papers:
    https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/sp.efsa.2015.EN-836 and
    https://efsa.onlinelibrary.wiley.com/doi/abs/10.2903/sp.efsa.2023.EN-7787
  o JBI: https://jbi.global/critical-appraisal-tools
  o OSF: https://osf.io/ws824/#!

10. Synthesis (data analysis)

Synthesize the results; if there is a statistical component, conduct the meta-analysis.

→ For more information see, for example, Cochrane Handbook Chapter 9.

11. Interpretation

Interpret your findings: What do the results mean? Are they applicable, generalizable, valid and transferable? What conclusions can you draw?

→ For more information see, for example, Cochrane Handbook Chapter 15.

12. Writing and reporting

Write and report your review.

→ PRISMA 2020 can be used (and adapted) as a basis for reporting systematic reviews, meta-analyses and other types of research. The PRISMA statement contains a checklist of 27 items deemed essential for transparent reporting. There is an extension specific to scoping reviews (PRISMA-ScR).

→ Check early on the target journal's aims, scope and author guidelines.

→ Make use of the UB Bern academic writing courses.

Appendix A: Database descriptions

A selection of resources, in alphabetical order. More databases can be found using the [UB Bern database search tool.](#)

Agris

- Availability: public
- Covered disciplines: agriculture and food
- Covered period: starting 1974
- Search: contains 13,886,594 records - including 4,251 datasets - from 463 data providers; search by data provider, results can be filtered, esp. by content type; allows advanced search by phrase or exact title (place in double quotes)

Business Source Ultimate BSU

- Availability: institutional license (EBSCO)
- Covered disciplines: business (economics to small extent only, use Econlit instead)
- Covered period: starting 1980
- Search: contains around 10.000 economics journals; professional term indexing, advanced search options

EconLit

- Availability: institutional license (EBSCO)
- Covered disciplines: economics, finances (business to small extent only, use Business Source instead)
- Covered period: starting 1969
- Search: contains around 600 economics journals; professional term indexing, advanced search options

ERIC

- Availability: institutional license (Ovid)
- Covered disciplines: (mainly US) literature of education
- Covered period: starting 1965
- Search: professional term indexing, advanced search offers some operators and field search options

FIS Bildung

- Availability: public
- Covered disciplines: all areas of education
- Covered period: starting 1980
- Search: professional term indexing, advanced search offers some operators and field search options

GreenFILE

- Availability: institutional license (EBSCO)
- Covered disciplines: environment and human ecology, biology
- Covered period: starting 1910

- Search: professional term indexing, complex advanced search with operators and field search options, searching hints; search can be refined by publication type and may include Image Quick View Types

APA PsycInfo

- Availability: institutional license (Ovid)
- Covered disciplines: international collection of literature in social sciences
- Covered period: starting 1806
- Search: professional term indexing, advanced search offers some operators and field search options

PSYNDEXplus

- Availability: institutional license (Ovid)
- Covered disciplines: abstracts and references of German-language psychological literature
- Covered period: starting 1885
- Search: professional term indexing, advanced search offers some operators and field search options

PubMed (maintained by the U.S. National Library of Medicine NLM)

- Availability: public
- Covered disciplines: life sciences and biomedical disciplines
- Covered period: starting 1966
- Search: professional term indexing, advanced search offers some operators and field search options
- API: powerful free API available https://www.ncbi.nlm.nih.gov/home/develop/api/ with free libraries in various programming languages

Scopus

- Availability: institutional license (Elsevier)
- Covered disciplines: all disciplines are covered, main focus is on physical, health life and social sciences
- Covered period: starting 1970

SPORTDiscus

- Availability: institutional license (EBSCO)
- Covered disciplines: sports and sports medicine literature
- Covered period: starting 1885
- Search: professional term indexing, advanced search offers some operators and field search option

Web of Science

- Availability: institutional license (Clarivate)
- Covered disciplines: all disciplines are covered, main focus is on science, technology, social sciences, arts and humanities
- Covered period: starting 1900
- Search: citation search options, advanced search: many operators and field search options
- API: only basic API currently available, very limited functionality

Appendix B: Database operators

		general		various		medical	
		Scopus	Web of Science	EBSCOhost (SocINDEX, GreenFILE, EconLit, Business Source, SPORTDiscus)	Ovid (GeoRef, ERIC, PsycInfo, PSYNDEXplus)	PubMed	Examples
Operators	Both terms must appear	AND	AND	AND	AND	AND	
	At least one of the terms must appear	OR	OR	OR	OR	OR	
	The term after it must not appear	AND NOT	NOT	NOT	NOT	NOT	
	Find two words within an "n" distance from each other regardless of their order	W/n	NEAR/n	Nn	ADJn	~n [4]	*Metabolism W/2 Cancer* → result with the words *Metabolism* and *Cancer* within 2 words from each other
	Find a word within an "n" distance prior to the other word (order respected)	Pre/n		Wn	adj [5]		*Metabolism Pre/2 Cancer* → result with the word *Metabolism* preceding *Cancer* by 2 words
Wildcards	Find the words with the specified stem, regardless of the other part of the word, 0 or more characters	*	*	*	* or $ *n or $n (n to restrict number of characters)	*	Will not find different spellings *Color** → finds *Color* or *Colorful* but not *Colourful*

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[4] "search terms"[field:~N]; see:
https://www.nlm.nih.gov/pubs/techbull/nd22/nd22_pubmed_proximity_search_available.html#:~:text=The%20
National%20Library%20of%20Medicine%20is%20pleased%20to,How%20to%20Build%20a%20Proximity%20Sear
ch%20in%20PubMed
[5] https://ospguides.ovid.com/OSPguides/medline.htm#advanced

		Scopus	Web of Science	EBSCOhost (SocINDEX, GreenFILE, EconLit, Business Source, SPORTDiscus)	Ovid (GeoRef, ERIC, PsycInfo, PSYNDEXplus)	PubMed	Examples
Wildcards (cont.)	Find a word with the specified stem and with a maximum of just one more character	? (any single character)	$ (for 0 or 1 character) ? (any single character)	# (for 0 or 1 character) ? (any single character, except at end of word it will be ignored)	? (for 0 or 1 character) # (any single character)		Cell$ or Cell? → results for Cells but not for Cellular Will not find different spellings: Color$ or Color? → will not find Colours
Exact phrase	Find exact phrase in exact order, exact spelling	{ } (stop words, punctuation, spaces, special characters, are searched for) Cannot use wildcards	" " Can use wildcards	" " (stop words and punctuations are ignored, e.g. of, for, in, been, with, etc.) Can use wildcards	" " Can use wildcards	" " Can use wildcards	"color blind*" → finds color blindness but not colour blindness {color blind*} → in Scopus placeholder will be interpreted as part of phrase
	Loose phrase with different spellings of terms within phrase (singular, plural, possessive forms, are considered)	" " (stop words etc. are searched for) Can use wildcards					"color blind*" → in Scopus finds color blindness and colour blindness
Important search fields for systematic search	All fields	ok	ok	ok	ok	ok	
	Topic		ok	Subject		MeSH major topic	
	Article title	ok	ok	ok	ok	ok	
	Abstract	ok	ok	ok	ok	ok	
	Keywords/Thesaurus	Keywords	Keywords	CINAHL/MeSH	Thesaurus	MeSH terms	

Appendix C: Deduplication methods and tools

Information on different ways of removing duplicate records is provided by the ISMP library's information specialists on ILIAS: https://ilias.unibe.ch/goto_ilias3_unibe_cat_2297227.html

Manual deduplication

A useful approach on manual deduplication can be found here. It is based on recommendations from the University Library of Leeds and requires EndNote as literature management software. A similar method is the «Bramer method» (papers listed in ILIAS; video tutorials on YouTube), also based on EndNote. Please note that manual deduplication is time-consuming and needs training.

(Semi)Automated deduplication

For small to medium datasets, we recommend SR-Accelerator. It is currently free and allows importing and exporting literature lists in the most common formats (xml, RIS, bibtex). It provides various deduplication options by grouping references from unlikely to highly likely duplicates. Depending on how much time you want to invest, you can then select to manually review the likely duplicates in different groups before removing them from the literature list.

It may be sufficient to use the inbuilt deduplication function in your literature management program; tools supported by UB Bern are Zotero, EndNote, Citavi. Please note that Mendeley currently does not offer a deduplication function. In addition, be aware that the deduplication method applied by these programs may not be transparent.

The new tool «Deduklick» is a valuable option if you have large datasets. It is a highly reliable, fast and transparent tool with great accuracy. The result includes a deduplicated literature list, but also a documentation of all duplicates. Deduklick is a fee-based tool, i.e., you buy single or bundles of deduplication jobs. A free version is available for test-use. The method and approach of Deduklick is published here: https://pubmed.ncbi.nlm.nih.gov/35978441/

Various additional tools can be used for (semi)automated deduplication of literature lists. All of them will work well on condition that all items in the literature list be complete and in the same format. Nevertheless, be aware that deduplication errors may occur, e.g., if the list of authors is incomplete or the publication title is misspelled.

A quick check of the results for obvious deduplication errors is useful in all cases.

Additional tool:

ASySD tool for deduplication: https://camarades.shinyapps.io/ASySD/

Appendix D: Screening tools

This list gives an overview about free and subscription-based online tools that help with the screening process. Please note: the list is not exhaustive.

Questions to answer before choosing a tool:

- Which guidance or standard will the team use to conduct and report the SR?
- How large is the team? How many people will need to access the tool?
- Are there tools they have already identified to use in addition?
- What reference management software (e.g., Endnote) will be used?
- For meta-analyses: Is there a specific software used for the meta-analysis?

If possible, choose a tool with a support contact to troubleshoot any issues identified along the way.

Free Tools

- Rayyan is web-based. One can invite others to collaborate on the review. Supports the whole screening process.
  https://rayyan.qcri.org/welcome
- Cadima is a web-based tool and supports the screening process and provides detailed documentation for reporting.
  https://www.cadima.info/index.php
- Abstrackr is only for screening, created by Brown University.
  http://abstrackr.cebm.brown.edu/account/login
- Screenatron: Recommended, e.g., for psychology.
  https://sr-accelerator.com/#/screenatron

Fee-based Tools

- PICO Portal has a free version (1 project) and paid version.
  https://picoportal.org/
- Covidence is user friendly, helps with screening, data extraction, and creates a PRISMA flowchart once authors have completed the project. Two reviewers at maximum can vote per record. Allowing for a 3rd person to decide on conflicts among studies.
  Supports the whole screening process.
  https://www.covidence.org/
- DistillerSR assists with screening, quality assessment, etc.
  https://www.evidencepartners.com/
- SWIFT-Active Screener supports the screening process for multiple reviewers.
  https://www.sciome.com/swift-activescreener/
- EPPI-Reviewer is an application for all types of literature review, including systematic reviews, meta-analyses, 'narrative' reviews and meta-ethnographies. It is suitable for small or large-scale reviews.
  http://eppi.ioe.ac.uk/cms/Default.aspx?alias=eppi.ioe.ac.uk/cms/er4

More information

The Systematic Review Toolbox is an online search catalog for tools supporting systematic review processes.