

# Table of Contents

[1. Introduction 3](#_Toc13235159)

[2. What is a systematic review? 3](#_Toc13235160)

[3. Methodological considerations for systematic reviews 3](#_Toc13235161)

[4. Scoping reviews and searches 4](#_Toc13235162)

[5. Creating a review protocol 5](#_Toc13235163)

[5.1. Question formulation frameworks 5](#_Toc13235164)

[5.2. Developing inclusion and exclusion criteria 6](#_Toc13235165)

[5.3. Sources of information 7](#_Toc13235166)

[5.3.1. Bibliographic databases 7](#_Toc13235167)

[5.3.2. Reference and citation searching 7](#_Toc13235168)

[5.3.3. Hand searching 7](#_Toc13235169)

[5.3.4. Trial data 8](#_Toc13235170)

[5.3.5. Grey literature 8](#_Toc13235171)

[5.3.6. Reducing bias in a review 8](#_Toc13235172)

[6. Developing a search strategy 9](#_Toc13235173)

[6.1. Searching using elements from question formulation frameworks 9](#_Toc13235174)

[6.2. Text mining 9](#_Toc13235175)

[6.3. Pearl growing 9](#_Toc13235176)

[6.4. Search filters 10](#_Toc13235177)

[6.5. Testing a search strategy 10](#_Toc13235178)

[7. Documenting the search process 11](#_Toc13235179)

[8. Systematic review software 12](#_Toc13235180)

[9. Further resources 12](#_Toc13235181)

[10. References 12](#_Toc13235182)

[11. Credits 15](#_Toc13235183)

# Introduction

This guide is intended to provide an overview of some of the methodological and practical considerations required when undertaking the search component of a systematic review. The guide signposts to resources to aid the process of undertaking a systematic review and enhance a review’s quality and reporting standards. The guide should, therefore, not be seen as extensive nor a handbook.

This resource is not necessarily intended to be read in a linear fashion. As an example, if your search skills require development then you may wish to review the resources in the ‘Developing a search strategy’ section prior to undertaking a scoping search.

# What is a systematic review?

The Cochrane Handbook for Systematic Reviews of Interventions notes the following key characteristics of a systematic review:

* “a clearly stated set of objectives with pre-defined eligibility criteria for studies;
* an explicit, reproducible methodology;
* a systematic search that attempts to identify all studies that would meet the eligibility criteria;
* an assessment of the validity of the findings of the included studies, for example through the assessment of risk of bias; and
* a systematic presentation, and synthesis, of the characteristics and findings of the included studies (1).”

Prior to commencing a review, researchers should familiarise themselves with the various guides to undertaking a systematic review, such as the [Cochrane Handbook for Systematic Reviews of Interventions](https://training.cochrane.org/handbook/current), the [CRD’s guidance for undertaking reviews in health care](https://www.york.ac.uk/crd/guidance/), the [Joanna Briggs Institute Reviewer's Manual](https://wiki.jbi.global/display/MANUAL/JBI%2BManual%2Bfor%2BEvidence%2BSynthesis) and [Searching for studies: a guide to information retrieval for Campbell systematic reviews](https://doi.org/10.4073/cmg.2016.1).

# Methodological considerations for systematic reviews

Researchers should consider both the human and time resource implications of undertaking a review. In order to minimise bias and error, systematic reviews require a minimum of two reviewers throughout the review process (1, 2). Researchers should also note that systematic reviews take between six months to two years to complete (3).

There are other review types available if you are unable to comply with the methodological rigour required by a systematic review, see for example a typology of 14 review types and their associated methodologies (4). Single authors or those unable to commit to the resource requirements of a systematic review may wish to consider a rapid or systematised review. Both rapid and systematised reviews may be undertaken by a single author. Rapid reviews typically take between one and six months to complete (5).

To avoid research waste and a dilution of the quality of systematic reviews as a review type, a review should not be published as systematic if it cannot comply with the required methodology. The publication of non-systematic reviews and poorly conducted reviews is an increasingly occurring problem (6) risking research waste and potentially harmful results.

# Scoping reviews and searches

Scoping reviews are a useful tool when planning the systematic review topic and the scope of a review. A scoping review helps synthesise what may be a heterogeneous field of research in emerging research areas, and understand the breadth of a topic in established fields of research with an abundance of research (7). Scoping reviews can be published in their own right, aiding the review team and other researchers in identifying important review questions. Furthermore, a scoping review will ensure that the chosen research topic and question is unique among systematic reviews. A unique and clearly defined review question is a critical component of a systematic review and considerable amount of resource is wasted if a protocol is written and a search strategy is created, only to find a similar systematic review in the search results.

At the very least, researchers should undertake broad searches on their proposed review topic, using an appropriate range of synonyms and acronyms, in the following systematic review repositories:

* [PROSPERO](https://www.crd.york.ac.uk/PROSPERO/): an international prospective register of systematic reviews.
	+ Registering a systematic review is voluntary (although highly recommended) so the database only represents a small percentage of published reviews.
* [Cochrane Database of Systematic Reviews (CDSR)](https://www.cochranelibrary.com/advanced-search): an online search interface for the journal of the same name.
	+ Contains only Cochrane reviews, protocols and editorials and supplements.
* [Joanna Briggs Institute (JBI) Database of Systematic Reviews and Implementation Reports](https://journals.lww.com/jbisrir/pages/advancedsearch.aspx): an online search interface for the journal of the same name.
	+ As with CDSR the database only includes JBI reviews, protocols and editorials. Also contains implementation reports.
* [Epistemonikos](https://www.epistemonikos.org/): “the largest source of systematic reviews relevant to health-decision making”, Epistemonikos scans multiple databases to search for systematic reviews, which are then added to their own database of reviews.
* Subject databases
	+ An appropriate range of [subject-specific databases](https://www.gla.ac.uk/myglasgow/library/specificsearch/databasesbysubject/) should be searched with results filtered for systematic reviews. Note that automated ‘tick-box’ filters (see Figure 1) are not reliable and, where possible, [validated search filters](https://sites.google.com/a/york.ac.uk/issg-search-filters-resource/home/systematic-reviews) should be used to more accurately identify systematic reviews from a results set.



Figure 1: Example of limits available on the Ovid interface.

By their nature, systematic reviews must be explicit and reproducible. Published reviews must therefore state their exact methods; these should include a list of databases used, including the interfaces on which the databases were searched, and the search strategies used on each database. All this information can inform the methods of a new systematic review.

# Creating a review protocol

Once a review topic has been decided and the review question(s) established, the research group should formulate a protocol using the internationally recognised [PRISMA-P reporting guidelines](http://prisma-statement.org/Default.aspx) (8, 9). As with any protocol, the PRISMA-P reporting guidelines act as a planning and review document that should be referred to as the research progresses. If a protocol is published, research waste is minimised and reporting bias is minimised. Following a protocol does not necessarily mean that a rigorous systematic review ensues and other reporting standards should also be used (10), such as [AMSTAR](https://amstar.ca/) (11). In addition, familiarity with critical appraisal tools to assess the quality of systematic reviews will aid the synthesis stages of a review and how one reads and appraises other reviews and their included studies.

## Question formulation frameworks

Following the identification of a suitable research question, the question should be transposed into a question formulation framework. A question formulation framework informs the search strategy and inclusion and exclusion criteria. A validated framework should be used wherever possible.

[A user guide to some of the more frequently used frameworks](https://edshare.gla.ac.uk/38/), PICO, SPICE, SPIDER and ECLIPSE, is available on EdShare. Many other frameworks are available. Indeed, one rapid review identified 38 different frameworks for formulating questions (12). Research is available to aid understanding of what type of systematic review should be conducted and the relevant framework for the question type (13).

## Developing inclusion and exclusion criteria

Whilst a question formulation framework is a useful device in considering the construction of a search strategy, a framework can be more useful in developing inclusion and exclusion criteria. A detailed guide to setting eligibility criteria for including studies in a review can be found in the [MECIR Manual](https://community.cochrane.org/mecir-manual/standards-conduct-new-cochrane-intervention-reviews-c1-75/developing-protocol-review-c1-23/setting-eligibility-criteria-including-studies-review-c5-13) (14).

The search component of a systematic review rarely uses each element of the framework as a template for the search strategy as the search would be far too specific (the more elements added to a search, the more precise the search with fewer results retrieved).

At this point, it is useful to consider the limitations of bibliographic databases (in which the search is conducted). As the name would suggest, bibliographic databases contain only the bibliographic details of a research output, such as the title, abstract, journal name, the volume and issue in which the output appears and the author names and affiliations. As such, a search strategy is never performed across the fulltext of a research output (from title to conclusion). One therefore needs to consider what information is contained in an abstract. Outcomes may be a stated element in a PICO framework but would be inappropriate to add to a search as outcomes are rarely discussed in an abstract. Adding outcomes to a search would therefore retrieve a very small percentage of potentially relevant material available on a subject. Outcomes tend to be better added as inclusion criteria to be used when screening fulltext records.

Similarly, numerical data is generally not relevant in a search strategy. Take age as an example. The population element of a PICO might specify an age range of 16-18-year olds but, in an abstract, authors more usually use general terminology, such as ‘adolescents’ or ‘teenagers’. Equally, authors may define an age range of 13-18-year olds; potentially relevant to the research question, but one would only know by reading the research output in fulltext and seeing whether the required data could be extracted at that point. In both instances, the search strategy should include a wide-range of synonyms to describe the population group, but the specific 16-18-year old range should be added as inclusion or exclusion criteria.

There are many more instances where elements of a framework are better used in inclusion or exclusion criteria; conditions or interventions are often referred to in either general or specific terms. A systematic review search must therefore consider all variations of how authors may describe framework elements. Assistance from a librarian or information specialist can be valuable in translating a research question and framework into a suitable search strategy.

## Sources of information

### Bibliographic databases

Database selection is highly dependent on the review topic and researchers may have to look outside their immediate field of expertise if the review topic has an educational or social science element, for example. The Cochrane Handbook for Systematic Reviews of Interventions (1) considers Medline, Embase and CENTRAL to be most important for the identification of trials, but this is only one research methodology and perspective. [A list of databases supplied by the University of Glasgow Library](https://www.gla.ac.uk/myglasgow/library/specificsearch/databasesbysubject/) can be found on the Library webpages.

The journals in which pre-identified relevant literature are found can give an indication of databases to conduct a search. Pre-identified relevant literature can come from a scoping search or through the review team’s subject knowledge. The websites of journals often contain a section on ‘abstracting and indexing’, see the [Health Libraries Journal homepage](https://onlinelibrary.wiley.com/page/journal/14711842/homepage/productinformation.html) as an example; this lists the bibliographic databases in which the journal can be found and can be used to inform the search strategy.

### Reference and citation searching

Reference searching is a useful method of ensuring relevant research is not omitted from the selection process and checking the validity of the search strategy. Upon completion of the final stage of the PRISMA flow diagram (15), where the search has been performed and records screened, a loop is added to the flow diagram where included studies have their references checked for duplication against the list of records retrieved in the initial, pre-screened search. Any new records not retrieved in the search are subject to screening against the same review criteria. If new records are identified the search may be too specific and may need to be reviewed. It is therefore important to test a search strategy thoroughly against pre-identified relevant literature to avoid wasted resource.

An additional step is to also search for citations to literature included in the review. Citations can be found in [Google Scholar](http://scholar.google.com/), [Scopus](https://eleanor.lib.gla.ac.uk/search~S6/y?search=scopus&SORT=D) and [Web of Science](https://eleanor.lib.gla.ac.uk/search~S6?/yweb+of+science/yweb+of+science/1%2C2%2C2%2CB/eresource&FF=yweb+of+science+core+collection&1%2C1%2C) among others.

### Hand searching

Often, important, relevant information is missed through database searching as a result of a search strategy being too specific, research outputs not being indexed with terms that allow for efficient identification, or outputs, such as conference proceedings, not being indexed in bibliographic databases. Handsearching involves identifying relevant journals and conferences and manually looking through the contents of relevant issues; this can be conducted by browsing printed or electronic formats.

Conference proceedings can be found in repositories such as [ProceedingsFirst](https://eleanor.lib.gla.ac.uk/search~S6/y?search=proceedingsfirst&SORT=D), [Scopus](https://eleanor.lib.gla.ac.uk/search~S6/y?search=scopus&SORT=D) and [Web of Science](https://eleanor.lib.gla.ac.uk/search~S6?/yweb+of+science/yweb+of+science/1%2C2%2C2%2CB/eresource&FF=yweb+of+science+core+collection&1%2C1%2C), as well as named conference websites.

### Trial data

Many clinical trials are never formally published. To completely understand the effect of an intervention, trial registries should be searched for concluded, on-going and prospective trials. The main trial registries are: [ISRCTN registry](http://www.isrctn.com/), [European Union Clinical Trials Register](https://www.clinicaltrialsregister.eu/ctr-search/search), [UK NIHR trial register](https://bepartofresearch.nihr.ac.uk/), [US NIH trial register](https://www.clinicaltrials.gov) and [Australian New Zealand Clinical Trials Registry](http://www.anzctr.org.au/). Many other registries exist and lists of [international registries](https://www.who.int/ictrp/network/en/) and [US registries](https://www.nih.gov/health-information/nih-clinical-research-trials-you/list-registries) are available. Researchers may need to contact trial authors to obtain trial data or additional information on the trials.

### Grey literature

Grey literature refers to publications that are not formally published. Examples could include policy documents, theses and dissertations, third-sector publications, and standards and guidelines.

Researchers are recommended to consult [Grey Matters: a practical tool for searching health-related grey literature](https://www.cadth.ca/resources/finding-evidence/grey-matters) developed by the Canadian Agency for Drugs and Technologies in Health (CADTH), and [Finding Grey Literature Evidence and Assessing for Outcome and Analysis Reporting Biases When Comparing Medical Interventions: AHRQ and the Effective Health Care Program](https://effectivehealthcare.ahrq.gov/topics/methods-guidance-reporting-bias/methods/) by the Agency for Healthcare Research and Quality (AHRQ).

Grey literature repositories such as [Open Grey](http://www.opengrey.eu/), [NTIS](https://ntrl.ntis.gov/NTRL/), [APO](https://apo.org.au/), the [NICE Evidence search](https://www.evidence.nhs.uk/) and [TRIP](https://www.tripdatabase.com/) should be searched in addition to subject-specific websites. The websites of specialist research organisations and professional bodies should also be consulted.

### Reducing bias in a review

#### Publication bias

Using sources other than bibliographic databases reduces the publication bias of a review. Non-significant or null results are often not formally published, and some conference or other forms of research never reach full publication or are published in outlets not indexed in bibliographic databases. Using the sources listed above will reduce the publication bias of a review.

#### Geographic coverage

Whilst most bibliographic databases have broad coverage of international journals, Embase (16) has a greater proportion of European journals compared to MEDLINE (17). Overwhelmingly, bibliographic databases tend to index journals published in English. As such, [regional and global indexes](https://www.globalindexmedicus.net/) should be searched to retrieve a greater proportion of research representative of international research and populations.

#### Language

Whilst limiting a search to English language may be a necessary step in a systematic review with a lack of resources (18), reviews with language restrictions and reviews that did not report contacting study authors have lower overall credibility (19).

# Developing a search strategy

## Searching using elements from question formulation frameworks

Most bibliographic databases can be searched using controlled vocabulary (also called subject headings, indexing terms or thesauri). Controlled vocabulary provides an additional layer of information on which to retrieve information in addition to text words (commonly titles and abstracts). Do not conflate indexing terms or text words with keywords, which are often a list of author-assigned words used to describe their articles.

Using controlled vocabulary increases the sensitivity of a search strategy and is a mandatory element of a systematic review search. Each element of the question formulation framework should, wherever possible, include both controlled vocabulary and text words.

A guide to [developing literature search strategies](https://edshare.gla.ac.uk/76/) using a question formulation framework is available on EdShare. This search strategies guide is complemented with [how-to videos](https://edshare.gla.ac.uk/278) for the key interfaces commonly used in medical, veterinary and life sciences research.

## Text mining

Regardless of how familiar a researcher is with their chosen research topic, tools such as [PubReMiner](https://hgserver2.amc.nl/cgi-bin/miner/miner2.cgi) are valuable in revealing different synonyms and acronyms that authors use to describe the topic and the controlled vocabulary used by indexers. For systematic review purposes, PubReMiner searches PubMed with the chosen query and retrieves a frequency table of terms used in the title and abstracts and MeSH terms (the controlled vocabulary used on Medline records within PubMed).

## Pearl growing

Pearl growing is a sampling technique where the titles, abstracts and controlled vocabulary from search results are scrutinised to find synonyms, acronyms and other relevant controlled vocabulary terms. Around 15-20 results, chosen at random, is normally a suitable sample. Any new information is added to the search strategy and the process repeated until saturation is reached. Combined with text mining techniques, pearl growing is an effective method of ensuring a valid and sensitive search strategy (20).

Peal growing can also be used to exclude text words and controlled vocabulary retrieving high numbers of irrelevant results. In the sample of selected results, identify common text word or vocabulary terms commonly retrieving irrelevant results. These terms can be removed from the search strategy as long as their removal does not cause the loss of relevant results.

A [guide to using pearl growing](https://doi.org/10.1080/13682820600742190) in a systematic review is available (20).

## Search filters

Predefined search filters offered in databases should not be used as they are not sensitive enough for the requirements of a systematic review. Instead, methodological search filters should be used. A range of search filters by study design are available from the [InterTASC Information Specialists’ Sub-Group website](https://sites.google.com/a/york.ac.uk/issg-search-filters-resource/home); these filters have been tested and validated. Guidance on how to critically appraise search filters is available on the InterTASC website.

## Testing a search strategy

Once a first draft of a search strategy has been developed, the results should be tested to ensure that they retrieve relevant material. To test the results, search for the titles of pre-identified relevant literature and combine the title list with the final line of the strategy search. An example is illustrated below:

1. [Final line of search strategy]
2. Title of relevant paper 1
3. Title of relevant paper 2
4. Title of relevant paper 3 [The more relevant papers identified, the more reliable any testing]
5. Combined list of relevant papers, i.e. 2 OR 3 OR 4
6. Combine the final line of the search strategy with the list of papers, i.e. 1 AND 5

If a relevant paper is not found in the database, the database might not index the journal in which the paper appears. Ensure that across the list of databases at least one database indexes the journal in question.

If a relevant paper is not found when combined with the search strategy, the strategy might be too specific and might need to be edited to increase the sensitivity. Look at how the paper is described in the title and abstract and the indexing terms – can the search be edited to include the paper without making the search strategy too sensitive to make the review unfeasible?

It may not be possible to include every pre-identified paper in a search; the paper may be poorly indexed or, to include the paper, the search may have to become so sensitive that the review becomes unfeasible. The balance between sensitivity and specificity lies with the review team. Do bear in mind that decisions taken during a search strategy affect the quality of the review and may have to be justified at peer review. Maintaining a record of the decision-making process is essential and informs the methods section of the review and aids the defence of the methods at peer review.

Internal peer review of the search strategy using the [PRESS guidelines](https://doi.org/10.1016/j.jclinepi.2016.01.021) (21) is highly recommended.

# Documenting the search process

As illustrated, good record keeping is an important process in the development of a systematic review search strategy and the subsequent review process. Good record keeping will help a review team to comply with the [PRISMA reporting process and the flow diagram](http://prisma-statement.org/).

In order for a systematic review to be replicable, search strategies and the PRISMA flow diagram should be included as appendices or supplementary data. If the publication outlet does not support supplementary data, systematic review search strategies can be deposited in [Enlighten: Research Data](http://researchdata.gla.ac.uk/) where they will receive a DOI that can be linked to in the corresponding publication.

Search strategies should be reported as follows:

Source: [Name of database in full]

Interface / URL: [Interface on which the database was queried]

Database coverage dates: [If not immediately obvious, coverage dates can often be found on the websites of interface providers]

Search date:

Retrieved records:

Search strategy: [A line by line copy of the search strategy, including the number of results retrieved per line]

Repeat for each database and source searched. Full details on reporting items for systematic review searches can be found in the [PRISMA-S extension](http://prisma-statement.org/Extensions/Searching).

Appendix B of the [NICE guideline on Vitamin D supplementation](https://www.nice.org.uk/guidance/ph56/evidence/evidence-review-1-431762365) offers an excellent illustration on how search strategies should be recorded (22).

# Systematic review software

EndNote is used for the management and coding of references at the University of Glasgow. Step-by-step guidance on using EndNote for a systematic review is available (23, 24). Further guidance on [coding references and merging EndNote libraries](https://medicine.exeter.ac.uk/media/universityofexeter/medicalschool/research/pentag/documents/EAHIL_poster_v5.pdf) when collaborating on reviews is available. Note that efficiencies with de-duplicating results from EndNote can be made by [importing references from databases in a specific order](https://blogs.lshtm.ac.uk/library/2018/12/07/removing-duplicates-from-an-endnote-library/).

Other software for managing systematic reviews is available. The website Systematic Review Toolbox (25) maintains a list of software, some paid for, some free. For a list of tools that can be used throughout the whole systematic review process select the underlying approach to ‘Whole Process’ and tick the ‘Any’ features box before searching.

# Further resources

* [Introduction to systematic reviews: lecture recording and slides](https://edshare.gla.ac.uk/135)
	+ Introductory lecture for Doctorate in Clinical Psychology students. The content is relevant to all fields of research.
* [Systematic review workshop and journal club: recording, slides, exercises and handouts](https://edshare.gla.ac.uk/1048)
	+ Systematic review workshop and journal club that follows the introductory lecture for Doctorate in Clinical Psychology students. The content is relevant to all fields of research.
* [Literature search and review in MVLS](https://edshare.gla.ac.uk/78/)
	+ A collection of literature review resources, including some of those linked to in this guide.
* [A range of textbooks and guides are available via the University Library](https://glasgow.summon.serialssolutions.com/#!/search)

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#  Credits

#### Author credit

Paul Cannon, Information Services, University of Glasgow

#### Peer-reviewers

Tracey McKee, Library Network, NHS Greater Glasgow and Clyde

Valerie Wells, MRC/CSO Social and Public Health Sciences Unit, University of Glasgow

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