Database combinations to retrieve systematic reviews in Overviews of reviews: A methodological study

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Abstract

Background When conducting an Overviews of Reviews on health-related topics it is unclear which combination of bibliographic databases authors should use for searching for systematic reviews. Our goal was to determine which databases indexed the most systematic reviews and identify an optimal database combination for searching systematic reviews.

Methods A set of 86 Overviews of Reviews with 1219 included systematic reviews was extracted from a previous study. Indexing of the systematic reviews was assessed in MEDLINE, CINAHL, DARE, Embase, Epistemonikos, PsycINFO, and TRIP. The mean indexing rate (% of indexed systematic reviews) and corresponding 95% confidence interval were calculated for each database individually, as well as for combinations of MEDLINE with other databases and reference checking.

Results Indexing of systematic reviews was higher in MEDLINE than in any other single database (mean indexing rate 89.7%; 95% confidence interval [89.0–90.3%]). Combined with reference checking, this value increased to 93.7% [93.2–94.2%]. The best combination of two databases plus reference checking consisted of MEDLINE and Epistemonikos (99.2% [99.0–99.3%]). Stratification by Health Technology Assessment reports (97.7% [96.5–98.9%]) vs. Cochrane overviews (100.0%) vs. non-Cochrane overviews (99.3% [99.1–99.4%]) showed that indexing was only slightly lower for Health Technology Assessment reports. However, MEDLINE, Epistemonikos, and reference checking remained the best combination. Among the 10/1219 systematic reviews not identified by this combination, five were published as websites rather than journals, two were indexed in CINAHL and Embase, and one was indexed in the database ERIC.

Conclusions MEDLINE/Epistemonikos, complemented by reference checking, is the best database combination to identify systematic reviews on health-related topics.

Highlights

What is already known

- Overviews of Reviews summarize data from several systematic reviews, thus providing a broad picture of relevant evidence.
- Few empirical studies exist that document all methodological aspects of producing Overviews of Reviews, including the search process for systematic reviews.

What is new

- The present empirical study has shown that 99.2% of systematic reviews are indexed in a combination of the electronic databases MEDLINE via PubMed and Epistemonikos, supplemented by checking reference lists of eligible studies retrieved by these databases.

Potential impact

- A resource-efficient search process for systematic reviews should be based on the free-of-charge electronic databases MEDLINE via PubMed and Epistemonikos, supplemented by reference

checking.

Background

Overviews of Reviews (Overviews) are used to summarize data from several systematic reviews (SRs), thus providing a broader picture of evidence relevant for decision-making [1]. Generally, their aim is to provide a comprehensive assessment of multiple interventions, populations, or outcomes for a defined health problem using SR-level results.

Some methodological components of preparing Overviews are analogous to SRs, such as defining the review question structured into a Population, Intervention, Comparator, Outcomes, and Study types (PICOS) format, setting eligibility criteria, and defining a search strategy, though nuances clearly exist. Other methodological components such as the critical appraisal of included SRs, extraction and analysis of data, and presentation of findings differ more markedly between Overviews and SRs [2-4].

Many specific steps for conducting an overview are not yet based on empirical research [5], and some steps contain few empirical studies which may guide future recommendations including selection of electronic databases to use when searching for SRs.

Current guidance recommends searching the Cochrane Database of Systematic Reviews (CDSR) to locate Cochrane SRs [1, 6], and a structured search process to locate and select non-Cochrane reviews, (e.g. in MEDLINE [7] and Embase [8]). Guidance also recommends searching additional regional and subject-specific databases (e.g. LILACS [9], CINAHL [10], PsycINFO [11]), major repositories of SRs such as DARE (the Database of Abstracts of Reviews of Effects) [12], and the PROSPERO register [1, 2, 13]. In practice, the majority of Overviews in healthcare-related fields published to date searched at least two databases [14, 15], and in addition to reference checking (i.e. looking through the reference list of included studies), and consultation with the relevant Cochrane group [15].

Rathbone et al. have evaluated indexing of a set of 400 SRs of interventions for hypertension in seven electronic databases [16]. They searched for SRs in the Cochrane Library, DARE, Embase, Epistemonikos, MEDLINE, PubMed Health, and TRIP. For each database, sensitivity, precision, numbers missed, and unique records identified were calculated. Embase had the highest sensitivity (169/400, or 69% of SRs) and retrieved the largest number of unique SRs (34/400, or 8.5% of SRs). The authors conclude that searching should not be restricted to one or two major databases, but that all databases should be searched.

In a situation where resources are limited, it remains unclear which combination of electronic resources Overview authors should use for searching for SRs. Therefore, the aims of the present methodological study were: (1) to assess the number and rate of SRs indexed in seven electronic databases: MEDLINE [7], CINAHL [10], DARE [12], Embase [8], Epistemonikos [17], PsycINFO [11], and TRIP [18] from inception to April 2019 without limiting the SR topic; (2) to evaluate whether a single database combined with manual reference checking is sufficient to comprehensively retrieve SRs in the context of preparing Overviews; (3) to identify a combination of databases plus reference checking that may be recommended for searching SRs; and (4) to explore possible contexts (for example, for certain Overview types, or for healthcare interventions compared to other fields of healthcare research) in which the recommendation result of objective #3 produces inadequate retrieval of SRs, defined as lower than 95% retrieval [19].

Methods

Study design

A methodological study was conducted to analyse how SRs were indexed in selected electronic resources. We did not write a protocol for this study.

Search methods

A set of Overviews, including Health Technology Assessment (HTA) reports, Cochrane Overviews, and non-Cochrane Overviews, was obtained as described in detail in a preceding publication [20]. Briefly, MEDLINE via PubMed, Embase via Embase.com [21], CINAHL via EBSCOhost [10], PEDro [22], CDSR, DARE, CENTRAL, CMR, HTA, and NHS-EED via the Cochrane library, and the websites of 127 HTA agencies were searched from inception to May 2012. Search terms were text words related to Overviews and SRs and the search algorithms can be found in Pieper et al. 2014 [20]. The search was limited to Overviews published in English or German between 2009 and 2011.

Eligibility criteria

Overviews were defined as systematic reviews for which the unit of searching, inclusion and data analysis is the systematic review rather than the primary study [1]. Thus, we included all overviews that had searched explicitly and systematically for SRs in at least one electronic database, included at least one SR (overviews including both SRs and primary studies were eligible if the evidence synthesis relied at least in part on SRs, e.g., by combining primary studies and SRs in the evidence synthesis), and critically appraised all included SRs and additional primary studies. A HTA report was defined as “a method of evidence synthesis that considers evidence regarding clinical effectiveness, safety, cost-

effectiveness and, when broadly applied, includes social, ethical, and legal aspects of the use of health technologies" [23].

Inclusion criteria:

- Searched for SRs in at least one electronic database;
- Included at least one SR in their evidence synthesis;
- Critically appraised included SRs and primary studies; and
- Full text publication was available.

Exclusion criteria:

- Overviews with a methodological focus; and
- Published in a language other than English or German.

The set of included Overviews will be henceforth called the "basis set".

Description of electronic databases selected in this study

Seven databases were selected to assess indexing of systematic reviews as described in the section "data collection", below, namely MEDLINE, CINAHL, DARE, Embase, Epistemonikos, PsycINFO, and TRIP. Each of these databases will be described here: MEDLINE is a bibliographic database published by the U.S. National Library of Medicine, with coverage of the biomedicine and health literature published from 1966 to present [24]. It is accessible free of charge [21]. CINAHL, the Cumulative Index to Nursing and Allied Health Literature, is accessible by subscription [10]. Its coverage is specific to nursing, biomedicine, health sciences librarianship, alternative medicine, and allied health topics [11]. DARE was published by the UK's NHS Centre for Reviews and Dissemination until 2015 but is no longer being updated. It contains summaries of SRs which meet strict quality criteria [12]. Embase, provided by Elsevier, covers biomedical literature from 1947 to the present day, and requires a subscription [21]. Epistemonikos is a non-profit database specific for SRs which includes machine- and hand-filtered evidence from a broad range of relevant sources (currently CDSR, PubMed, Embase, CINAHL, PsycINFO, LILACS, DARE, The Campbell Collaboration online library, JBI Database of Systematic Reviews and Implementation Reports, EPPI-Centre Evidence Library) [25, 26]. Epistemonikos also includes records from other databases, such as DARE and HTA, which were previously scraped, but are no longer updated. Updates of algorithms in February and April 2019 have led to an expansion in the dataset by more than a factor of 1.5. PsycINFO is a database produced by the American Psychological Association [11]. It is devoted to peer-reviewed literature in behavioural science and mental health. TRIP is a search engine which widely collects references from sources of SRs (including Cochrane Library and DARE), guidelines, regulatory agencies (FDA, EMA, NICE,

IQWIG), HTA databases, NHS EED, literature databases (PubMed), journals, as well as PROSPERO and clinical trial registries [27].

Data collection

From the full text of each included Overview, the following data were extracted into MS Excel (2016): citation, publication title, number of databases searched, name of each database searched, searched in social science/economics databases (yes/no; i.e. EconLit, HEED, NHS EED, IBSS, Social Sciences Citation Index, Social SciSearch, the Campbell Collaboration Database, Social Sciences Abstracts, Social Services Abstracts, Applied Social Science Index and Abstracts, Social Service Information Gateway), searching additional sources ('other sources' yes/no; i.e. reference lists of included studies, queries to experts, Google, Google Scholar, internal departmental files, hand-searching or electronically searching journals), clinical trial or study registries (e.g. clinicaltiral.gov, PROSPERO), publishers' databases (e.g. Springer, ScienceDirect, Thieme, Wolters Kluwer), HTA agencies' websites (e.g. https://www.iqwig.de, https://www.dimdi.de, http://www.msac.gov.au), number of SRs included, Overview type (Cochrane overview, HTA report, or other), intervention/non-intervention Overview, and mental health- or psychology-related topic (yes/no).

For each Overview, the included SRs were extracted and tagged with the Overview from which they originated. HTA reports are usually structured into sections entitled clinical effectiveness, safety, cost-effectiveness, social, ethical, or legal. For HTAs, we only included SRs from the clinical effectiveness section of the report.

A stepwise process was followed to identify whether an SR was indexed in an electronic database, found by reference checking, or indexed in a database combination:

1. From the sample of SRs extracted from the overviews, we determined which of seven databases each SR was indexed in, namely MEDLINE, CINAHL, DARE, Embase, Epistemonikos, PsycINFO, or TRIP. These included and indexed SRs will be henceforth called the "indexed SRs".
2. We then determined which database contained the largest overall number of indexed SRs. This database was identified as the 'reference database'. We set the reference database to MEDLINE as it had the highest indexing rate. The included SRs indexed in MEDLINE will be henceforth called the "MEDLINE-indexed SRs".
3. A list of all SRs not indexed in MEDLINE was compiled. These SRs are called the 'MEDLINE-non-indexed SRs'.
4. For each 'non-indexed SR' obtained in step C, we then manually checked the reference lists of the 'MEDLINE-indexed SRs' that were cited in the same Overview as the 'non-indexed SR'. The aim was to see if each SR not indexed in MEDLINE could have been identified by reference checking of SRs identified in MEDLINE on the same topic. The SRs found in the reference lists/bibliographies are henceforth called "biblio SRs"

Finally, for SRs not found either in MEDLINE (the reference database) or by reference checking ('other SRs'), we explored whether they could be retrieved in the six databases from step A, to allow calculating a combined mean indexing rate (see statistical analysis). This was done to evaluate whether searching more than one database would expand the study pool.

Statistical analysis

For each Overview, we calculated:

1. the mean indexing rates (% of included SRs) and corresponding 95% confidence interval (95% CI) separately for each database.
2. the mean indexing rate for the reference database (as defined above) combined with reference checking (as described above).
3. the mean indexing rates for combinations of the reference database, reference checking, and each of the other six databases.

The Overview-level indexing rates obtained in statistical analysis steps A to C were then aggregated for the entire dataset by calculating weighted mean indexing rates and corresponding 95% confidence intervals (95% CI). Weighting was based on the number of SRs included in each Overview.

Stratification

The goals of stratification were to generate hypotheses on contexts where the results-based recommendations would apply, and to identify situations when further searches may be necessary, by: (1) investigating whether searching large numbers of databases offers added value, (2) gauging the magnitude of effect when using sources other than standard literature databases, (3) examining whether different Overview types require searching different electronic resources, (4) exploring differences in indexing between healthcare interventions and other fields of healthcare research, and (5) evaluating the role of specialist databases when such databases exist in the area of the Overview topic, using PsycINFO as an example.

To answer the above objectives (1) to (5), respectively, exploratory analyses were performed for the following strata: (1) number of databases searched (1-3 / ≥4), (2) other sources searched (yes / no), (3) Overview type (Cochrane overview, HTA report, or non-Cochrane overview), (4) intervention/non-intervention Overviews, and (5) mental health- or psychology-related topic (yes/no).

Stratification analysis was performed only for strata containing ≥3 Overviews for analysis. For each stratification analysis, the weighted mean indexing rate with 95% CI was calculated for combinations of the reference database and reference checking with each of the other databases. For analyses with two strata, the weighted difference in means and corresponding *p*-value were calculated using a two-

sample weighted t-test (Welch) computed in R version 3.5.1 (2018-07-02) using the R package 'weights' [28, 29]. *p*-Values $<10^{-10}$ were rounded to 0.

Qualitative analysis of missed SRs

All SRs not indexed in a combination of the reference database, reference checking, and the best additional database were qualitatively analysed. Features investigated were the topics of these SRs, whether they were located on websites, indexed in the other five databases that were investigated in this study, listed in a publisher's database (e.g. ScienceDirect, Wiley Online Library, Springerlink, De Gruyter), or in Google Scholar.

Results

Overviews included in the study

The literature search yielded a basis set of 86 Overviews [30-115], of which 73 had been identified in electronic databases and 13 on HTA websites [20]. The characteristics of the included Overviews are summarised in Table 1, and detailed in Table S1 [see Additional file 1].

Table 1. Summary characteristics of N=86 included Overviews.

	Median	**IQR**	**Range**
Databases searched	6	4–8	1–25
SRs included per Overview	8	5–17	1–103
	n	**% (of 86 Overviews)**	
Type:			
Cochrane overview	3	3%	
HTA report	14	16%	
non-Cochrane overview	69	80%	
	n	**% (of 1219 SRs)**	
Databases:			
MEDLINE/PubMed†	82	95%	
Embase	61	71%	
DARE or Cochrane Library *	59	69%	
CINAHL	36	42%	
PsycINFO	30	35%	
HTA databases (any)	20	23%	
TRIP	3	3%	
Epistemonikos	0	0%	
Any other social science/economics database	18	21%	
Other sources searched	64	74%	
Intervention Overviews	61	69%	
Mental health/psychology-related topic	9	10%	

† MEDLINE also contains all CDSR content [6]; * DARE was searchable via the Cochrane Library until August 2018, when it was removed along with the other CRD databases NHS EED and HTA (succeeded by INAHTA), as all three were discontinued.[116] IQR = interquartile range

A total of 1219 SRs were included in the 86 overviews overall, with a median of eight SRs. Between one and 25 (median 6) databases had been searched. Among them, the most widely used were MEDLINE and Embase. More than half had searched DARE or the Cochrane Library, which up to 2018 also contained all DARE records. None had searched the international SR-focused database Epistemonikos, which was first launched internationally in August 2012, and was therefore not available at the time of publication of the included overviews [25].

A wide range of subjects were covered by the included Overviews [14]. Sixty-nine percent were intervention Overviews, defined as Overviews of health-related interventions, i.e. actions taken with the intent of modifying a defined outcome, usually to treat or cure a health condition or change behaviour. Non-intervention Overviews focused, for example, on diagnosis, incidence/prevalence, or risk factors for certain outcomes.

Thirty-five percent (n=30/86) of overviews searched PsycINFO, but of these, only 30% (n=9/30) had topics related to mental health (i.e. autism, depression, psychosis, or schizophrenia), or psychology (i.e. psychological or psychosocial interventions (such as behavioural therapy).

Indexing in individual databases and database combinations

Among the 1219 SRs retrieved, 90% (n=1093/1219) were indexed in MEDLINE. The indexing rates in other databases were lower (Table 2, Figure 1). Therefore, MEDLINE was used as the reference database.

In addition to the SRs indexed in MEDLINE, a further 4% of SRs (n=49/1219) were identified by reference checking (see Methods, step B). Combinations of MEDLINE and reference checking with the addition of one database (DARE, Epistemonikos, PsycINFO, and TRIP) led to indexing rates above 95% (n=1170/1219, 1209/1219, 1159/1219, and 1174/1219, respectively). Among these databases, the indexing rate was highest in the combination with Epistemonikos (Table 2, Figure 1).

Table 2. Proportion of SRs indexed in individual databases and their combination with MEDLINE and reference checking.

Database	single DB % [95% CI]	Database + references % [95% CI]	MEDLINE + one Database + references; % [95% CI]
MEDLINE	*89.7% [89.0 to 90.3%]*	93.7% [93.2 to 94.2%]	
CINAHL	44.7% [43.7 to 45.7%]		94.6% [94.1 to 94.2%]
DARE	43.8% [42.2 to 45.4%]		96.0% [95.6 to 96.4%]
Embase	83.7% [82.9 to 84.5%]		94.8% [94.4 to 95.3%]
Epistemonikos	85.6% [84.7 to 86.5%]		*99.2% [99.0 to 99.3%]*
PsycINFO	24.5% [23.1 to 26.0%]		95.1% [94.7 to 95.5%]
TRIP	52.6% [51.0 to 54.1%]		96.3% [95.9 to 96.7%]

Best results in italic. DB = database.

Stratification

Databases searched

The Overviews in the basis set had searched for SRs in 1-25 databases. The indexing rates calculated for Overviews searching 1-3 databases was roughly equal to that calculated for Overviews searching 4 or more databases (Table 3).

Other sources searched

Other sources that were searched by Overview authors include reference lists of included studies, queries to experts, Google, Google Scholar, internal, non-public departmental files from the institutions of Overview authors, hand-searching journals, trial registries, publishers' databases, journals, institutions, and HTA agencies. A total of 74% of Overviews (n=64/86) reported searching at least one other source. In any database combination, the mean indexing of SRs for Overviews that had searched other sources was only slightly lower than for Overviews that had not searched other sources (Table 3).

Overview types

Overviews were classified into three types, i.e. Cochrane overviews (n = 3), HTA reports (n = 14), and non-Cochrane overviews (n = 69). Indexing of SRs included in Cochrane overviews was complete for combinations of MEDLINE plus reference checking and each of the databases Embase, DARE, TRIP, and Epistemonikos (Figure 2). In contrast, the indexing rate for HTA reports was substantially lower for some databases. Still, MEDLINE, Epistemonikos, and reference checking remained the best combination, reaching a mean rate of 97.7% [96.5 to 98.9]. For other overviews, which made up 80% (n=69/86) of the total set and contributed 89% (n=1087/1219) of SRs, the results were similar to the results for the total set. Thus, the indexing rate for MEDLINE, Epistemonikos, and reference checking was 99.3% [99.1 to 99.4%].

Intervention/other Overviews

Intervention Overviews represented 69% of the overall sample. Once more, the differences between strata were minimal in the combination with Epistemonikos (Table 3).

Mental health- or psychology-related topic

The present dataset included only 10% (n=9/86) Overviews in the stratum with a mental health- or psychology-related topic, corresponding to 8% (n=98/1219) of included SRs. In this stratum, the indexing rate in PsycINFO combined with MEDLINE and reference checking was slightly higher than

in the stratum without psychology-related topics (Table 3). However, the combination of the non-specialist databases Epistemonikos, MEDLINE and reference checking was superior, with 100% of SRs with a mental health- or psychology-related topic indexed.

Table 3. Stratified indexing rates in database combinations with MEDLINE and reference checking (mean [95% CI]).

Stratum	CINAHL	DARE	Embase	Epistemonikos	PsycINFO	TRIP
≥4 DBs	94.4% [93.8 to 94.9%]	96.0% [95.4 to 96.5%]	94.5% [93.9 to 95.1%]	*99.3% [99.2 to 99.5%]*	94.8% [94.3 to 95.4%]	96.4% [95.9 to 96.9%]
1-3 DBs	95.1% [94.5 to 95.8%]	96.0% [95.5 to 96.6%]	95.7% [95.1 to 96.4%]	*98.8% [98.4 to 99.2%]*	95.7% [95.2 to 96.3%]	96.0% [95.4 to 96.7%]
D in means	0.7%	0.1%	1.3%	*0.5%*	0.9%	0.4%
p-value	0.078	0.814	0.004	0.009	0.020	0.370
Other sources	93.5% [92.8 to 94.2%]	94.4% [93.8 to 95.1%]	93.9% [93.2 to 94.6%]	*98.9% [98.7 to 99.2%]*	94.3% [93.7 to 95.0%]	95.3% [94.7 to 95.9%]
No other sources	96.3% [96.0 to 96.6%]	98.3% [98.2 to 98.5%]	96.3% [95.9 to 96.6%]	*99.6% [99.5 to 99.7%]*	96.3% [96.0 to 96.5%]	97.9% [97.8 to 98.1%]
D in means	2.8%	3.9%	2.4%	0.7%	1.9%	2.7%
p-value	0	0	<0.00000001	<0.000001	<0.0000001	0
HTA report	86.2% [82.8 to 89.6%]	86.2% [83.3 to 89.1%]	86.2% [82.8 to 89.6%]	*97.7% [96.5 to 98.9%]*	83.9% [80.7 to 87.1%]	95.4% [93.7 to 97.1%]
Cochrane overview	97.8% [97.5 to 98.1%]	*100.0%*	*100.0%*	*100.0%*	97.8% [97.5 to 98.1%]	*100.0%*
Non-Cochrane overview	95.1 % [94.7 to 95.5%]	96.6% [96.2 to 97.0%]	95.3% [94.9 to 95.7%]	*99.3% [99.1 to 99.4%]*	95.9% [95.5 to 96.2%]	96.2% [95.8 to 96.6%]
D in means for HTA vs. other	9.0%	10.5%	9.3%	*1.6%*	12.0%	1.0%
p-value for HTA vs. other	<0.00001	0	<0.000001	0.012	0	0.274
Intervention Overview	95.0% [94.6 to 95.5%]	96.6% [96.2 to 97.0%]	95.0% [94.6 to 95.5%]	*99.3% [99.1 to 99.5%]*	95.5% [95.1 to 95.9%]	96.0% [95.6 to 96.5%]
Non-intervention Overview	93.2% [92.1 to 94.4%]	94.2% [93.2 to 95.2%]	94.2% [93.1 to 95.3%]	98.7% [98.5 to 99.0%]	93.9% [92.8 to 95.0%]	*97.1% [96.7 to 97.6%]*
D in means	-1.8%	-2.4%	-0.8%	-0.6%	-1.6%	1.1%
p-value	<0.01	<0.0001	0.182	<0.0001	0.010	0.001
Psyc. topic	91.8% [89.8 to 93.8%]	95.9% [94.7 to 97.1%]	95.9% [94.6 to 97.2%]	*100.0%*	95.9% [94.5 to 97.4%]	93.9% [92.0 to 95.8%]
No psyc. topic	94.8% [94.3 to 95.4%]	96.0% [95.4 to 96.5%]	94.7% [94.1 to 95.3%]	*99.1% [98.9 to 99.3%]*	95.0% [94.5 to 95.5%]	96.5% [96.1 to 97.0%]
D in means	3.0%	0.1%	-1.2%	-0.9%	-0.9%	2.6%
p-value	0.005	0.919	0.093	0.000	0.243	0.010

Best results in italic; all data are weighted. Psyc. topic = mental health- or psychology-related topic.

Qualitative analysis of missed SRs

Ten SRs (n=10/1219, 0.8%) were not identified by the best database combination (Table 4). Of these, one was incorrectly cited in the original Overview [117]. The correct citation [118] was indexed in the databases CINAHL, Epistemonikos, and Embase. Two were evidence syntheses published on the web

only, for which alternative versions were found by database searching [119, 120]. Thus, the evidence for 3/10 missed records would have been included in alternative form, resulting in a total coverage of 99.43% (n=1212/1219) of SRs.

Three missed references (n=3/1219, 0.24%) were websites not indexed in any of the databases investigated in the present study [121-123]. Two missed SRs (n=2/1219, 0.16%) were indexed in both CINAHL and Embase [124, 125]. One (n=1/1219, 0.08%) was listed on the publisher's website (ScienceDirect) and found via Google Scholar [126]. Finally, one was not found via any of the routes explored in this study [127]. However, it was indexed in the Education Resources Information Center (ERIC), sponsored by the Institute of Education Sciences of the U.S. Department of Education [30], which had been searched by the Overview authors [95].

Table 4. Qualitative analysis of SRs not indexed in MEDLINE, Epistemonikos and reference checking.

Ref.	Topic	Website	DB Indexing	Publisher's DB	Google Scholar
Brunton 2003 [117]	Promoting physical activity amongst children outside of physical education classes	–	–		–
Büssing 2009 [126]	Impact of yoga on chronic pain	–	–	Y (ScienceDirect)	Y
Christopher 1995 [127]	Adolescent Pregnancy Prevention	–	ERIC		–
Clamp 2005 [122]	The value of electronic health records	Y	–		Y
Erny-Albrecht 2007 [124]	Sublingual immunotherapy in allergic rhinitis and asthma	–	CINAHL, Embase		Y
Evans 2008 [125]	Yoga as treatment for chronic pain conditions	–	CINAHL, Embase	Y (De Gruyter)	Y
Horta 2007 [123]	Evidence on the long-term effects of breastfeeding	Y	–		–
ISMP 2010 [121]	Principles of Designing a Medication Label for Injectable Syringes	Y	–		–
Nelson 2004 [119]	Screening for ovarian cancer	Y	-- §		Y
Shekelle 2009 [120]	Costs and benefits of health information technology	Y	-- §		Y

DB = database; ERIC = Education Resources Information Center. §Alternative versions in several databases including Epistemonikos and MEDLINE. Website = Availability of the Overview available on the internet.

Discussion

We identified MEDLINE/Epistemonikos, complemented by reference checking, as the best combination to retrieve SRs for an Overview of Reviews on health-related topics.

No single database was found to be sufficiently comprehensive by itself for a systematic search for SRs in the context of preparing Overviews. MEDLINE emerged as the best primary source for retrieval of SRs (indexing rate 89.7%). MEDLINE using the PubMed interface has a good indexing rate for SRs, and is free of charge.

Among databases assessed in combination with MEDLINE and reference checking, Epistemonikos gave the highest pooled indexing rate with 99.2%, followed by TRIP (96.3%) and DARE (96.0%). All three are databases specialising in the retrieval of SRs. In spite of the fact that the indexing rate of SRs was relatively high in Embase (indexing rate 83.7%), the pooled indexing rate of MEDLINE, Embase and reference checking was below 95%, possibly due to greater overlap with MEDLINE. The subject-specific databases CINAHL (nursing) and PsycINFO (psychology) had pooled indexing rates similar to Embase (94.6 and 95.1%, respectively).

In our stratified analysis, we found that the difference between the number of SRs retrieved which originated from Overviews that had searched in ≥4 databases was minimal compared to Overviews that had searched in 1-3 databases, casting doubt on the value of searching large numbers of databases without specific justification. In this study, an additional 0.16% of SRs were indexed in both CINAHL and Embase, and 0.08% in ERIC. The effect of using other methods of searching beyond searching electronic databases (e.g. searching Google Scholar and publishers' databases) was found to be similarly small (0.5% and 0.16%, respectively, of studies found in addition to the recommended combination). Nevertheless, a limited number of SRs are published on the web only and not identified by searching any of the databases investigated in this study (0.24% in this dataset).

The recommended database combination was slightly more effective for Cochrane overviews and non-Cochrane overviews than for HTA reports, with indexing rates of 100 and 99.3% compared to indexing rates of 97.7%, respectively. The better indexing rate of SRs included in Cochrane overviews is likely a result of guidance for Cochrane overview authors to search for, and include, only Cochrane SRs [1]. Cochrane reviews are more highly indexed than non-Cochrane SRs, because all Cochrane Reviews are indexed in PubMed and other electronic databases [6]. The indexing rate using the recommended combination was slightly lower for HTA reports (97.7% of included SRs). This may be because authors of HTA reports typically search more widely, and might thus identify more studies, than authors of Cochrane or non-Cochrane overviews (median 8 databases, compared to 2 databases for Cochrane overviews and 5 for non-Cochrane overview; all searches in HTA reports complemented by other methods).

One similar study evaluated how many SRs were indexed in each of seven bibliographic databases [16], and focused on SRs of hypertension interventions. Our study was not topic-specific, and included both intervention and non-intervention SRs. Rathbone generated their set of SRs by searching in the same electronic databases that were later used to analyse retrieval. In addition, they

used search filters for SRs to increase precision. Our sample of SRs was larger (1219 vs. 400), and was obtained from published SRs which used various methods to identify relevant literature.

The recall rates in the Rathbone study (88% recall for Cochrane Library and Embase; and 83% for Cochrane Library, Epistemonikos and MEDLINE) were substantially lower than in our study (99.2% indexing in MEDLINE, Epistemonikos and reference checking). The difference between these rates results from the variable performance of the search strategies and search filters employed. In addition, our last search was performed after a major update in the Epistemonikos machine learning algorithms, which increased SR indexing.

Rathbone et al. concluded that “a search of all databases should be performed”. This conclusion is not supported by our results. First, the high indexing rate of >99% for a combination of two databases and reference checking shows that this combination is effective in retrieving SRs. Second, we found no relevant differences when we stratified indexing of SRs by Overviews that had searched in ≥4 vs. 1-3 databases (99.3% vs. 98.8% indexing, respectively).

Table 5 presents a comparison of the present study with studies evaluating indexing rates of primary research in various databases. These studies evaluated the indexing of primary studies (i.e. RCTs and non-randomised studies of interventions, diagnostic tests, or epidemiology), the efficiency of systematic literature searching (in terms of recall, precision, numbers needed to read, retrieval odds ratio), and the effect of selective searching on effect estimates [19, 128-133]. Some of these studies reached specific recommendations, all of which included searching MEDLINE. The choice of one or more additional databases differed across studies. Reasons for this may include the divergent topics and methodological approaches used in each study, as well as the choice of databases evaluated.

Table 5. Comparison of similar research.*

Ref.	Topic, *Focus*	Method	Studies included	DBs evaluated	Summarised Conclusions/ Recommendations
Betran 2005 [128]	WHO SR of maternal morbidity and mortality *developing countries*	retrospective analysis of electronic DBs and other sources for 1 SR	2580 cross-sectional, cohort, or census studies, RCTs	MEDLINE, Embase, CINAHL, LILACS, and 7 others[§]	studies in journals from less developed countries identified by searching e.g. in regional DBs which index citations from local journals not reaching MEDLINE
Ogilvie 2005 [131]	SR of promoting a population shift from using cars towards walking and cycling *social interventions*	retrospective analysis of electronic DBs and other sources for 1 SR	69 observational / experimental cohort studies, RCTs	MEDLINE, Embase, CINAHL, CDSR, PsycINFO, WoS, and 5 others[†]	unique evidence, provided by a comprehensive rather than a more focused search
Preston 2015 [132]	SRs of diagnostic test accuracy *diagnostic tests*	indexing in MEDLINE + Embase, and retrieval from references based on 9 HTA SRs	302 diagnostic test accuracy studies	MEDLINE, Embase	proposed approach of MEDLINE, EMBASE and the reference lists of included citations accounts for 93% of studies
Royle 2005 [133]	SR of epidemiology in diabetes *epidemiological studies*	extensive search in all languages to evaluate indexing and identify the most useful DBs	696 journals with epidemiological studies in diabetes	MEDLINE, Embase, CINAHL, PsycINFO, LILACS, and 15 others[$]	MEDLINE and Embase suffice for English language papers (94% indexing), LILACS gives additional non-English articles from Latin America
Bramer 2017 [19]	Diverse topics incl. surgery, epidemiology, internal medicine, and orthopaedics	analysis of the actual retrieval from the original searches for 58 SRs	1830 primary studies incl. RCTs and non-randomised studies	MEDLINE, Embase, CINAHL, PsycINFO, WoS, and 3 others[**]	a combination of Embase, MEDLINE, WoS, and Google Scholar performed best (98.3% recall)
Goossen 2018 [129]	Surgical SRs *surgical interventions*	systematic literature searches in electronic DBs and reference lists, and forward citation screening repeated for 10 SRs	527 RCTs and non-randomised studies	MEDLINE, CENTRAL, Embase, WoS	RCTs: MEDLINE, CENTRAL, reference lists and forward citation screening (98.6% recall) NRS: MEDLINE, WoS, reference lists and forward citation screening (99.5% recall)
Hartling 2016 [130]	SRs of acute respiratory infections, infectious diseases, developmental psychosocial / learning problems	contribution of DBs or their combination meta-analysis results for 129 SRs from three Cochrane Review Groups	780 studies, focus on RCTs	MEDLINE, Embase. CINAHL, PsycINFO, LILACS, and 5 others[‡]	selective searching in MEDLINE + 1 further DB may not introduce bias in terms of effect estimates
Rathbone 2016 [16]	Identifying SRs of interventions for hypertension *hypertension interventions*	systematic literature searches with SR filter in electronic DBs, to evaluate precision/sensitivity	400 SRs	Cochrane Library, DARE, Embase, Epistemonikos, MEDLINE, PubMed Health, TRIP	Cochrane Library+Embase: 88% recall; Cochrane Library+Epistemonikos+MEDLINE: 83% recall. Multiple databases should be searched
This work	Overviews published 2009-2011 *any topic*	evaluation of SR indexing based on 86 Overviews	1219 SRs	MEDLINE, Embase, CINAHL, PsycINFO, DARE, Epistemonikos, TRIP	MEDLINE, Epistemonikos and reference checking recommended (99.2% indexing)

[*] Studies indexed in electronic databases, studies found via systematic literature searching, and effect of selective searching on effect estimates. [§] Population Information Online (Popline, a reproductive health database), CAB Abstracts, Econlit, SocioFile, BIOSIS, Public Affairs Information Service (PAIS International), Index Medicus for the Eastern Mediterranean Region (IMEMR); [†] Cochrane Clinical Trials Registry (CCTR), PreMedline, Applied Social Sciences Index Abstracts (ASSIA), International Bibliography of the Social Sciences (IBSS), Sociology Abstracts; [$] Allied and Complementary Medicine Database (AMED), ASSIA, BIOSIS, British Nursing Index (BNI), Conference Papers Index, Dissertation Abstracts US, Health Management Information Consortium (HMIC), Index to Theses UK, ISI Proceedings, NLM Gateway, National Research Register (NRR), System for Information on Grey Literature in Europe (SIGLE), Science Citation Index (SCI), Social Science Citation Index (SSCI), Zetoc (the British Library's Electronic Table of

Contents);[‡] BIOSIS, CAB Direct, Educational Resources Information Center (ERIC), Health and Psychosocial Instruments (HaPI), International Pharmaceutical Abstracts (IPA); [**] Google Scholar, Scopus, SportDiscus. DB = database; LILACS = Latin American and Caribbean Health Sciences, WoS = Web of Science.

Strengths and weaknesses of the study

The present methodological study is based on a large sample of 1219 SRs. The SRs were extracted from published Overviews, and were found in diverse electronic databases, often complemented by reference checking, queries to experts, searches of the web (e.g. Google, Google Scholar, government reports), or hand-searching searching journals. We analysed the rate of SR indexing, and have not used any search strategies. Therefore, our results are independent of the effectiveness of any search strategy employed.

The indexing of SRs in the seven databases is likely to change over time, as the terminology used to describe systematic reviews changes, and as tagging of SRs and algorithms for retrieval of SRs improves. For example, the National Library of Medicine has announced that a new MeSH publication type “Systematic Reviews” will be created, and SRs will retrospectively be re-indexed in MEDLINE [134]. Other databases may decline in indexing rates, such as DARE (not updated since 2015), and the NHS HTA database (not updated since March 2018).

Moreover, our sample of SRs from the included Overviews may have used different definitions of SRs, and some Overview authors may have searched for SRs less extensively or effectively than others. This may affect the absolute values for means and confidence intervals generated within this study. In the worst case, if some Overview authors have missed harder-to-find SRs in their searches, this may tend to even out observable differences between databases and bias the results towards higher overall indexing rates. Some SRs may have been included in more than one Overview, the effect of which was not assessed. Furthermore, the present study was not designed primarily to quantify differences between strata, so that the results of the stratification analysis should be considered exploratory. Finally, indexing was not assessed in duplicate leading to potential errors in extractions and calculations.

Future research

Future research should be directed at validating the recommended approach using up-to-date database searches, and exploring the relative contribution of other methods of study retrieval. Current guidance, which recommends a structured search process using multiple databases (e.g. in databases such as MEDLINE and Embase, additional regional and subject-specific databases [e.g. LILACS,

CINAHL, PsycINFO], and major repositories of SRs such as CDSR, DARE, and the PROSPERO register [1, 2]), needs to be re-evaluated in the context of our recommendations.

Conclusions

The present study has shown that the literature search for Overviews should be performed in MEDLINE and Epistemonikos, complemented by reference checking.

Abbreviations

CI	confidence interval
DB	database
HTA	Health Technology Assessment
IQR	interquartile range
PICOS	Population, Intervention, Comparator, Outcomes, and Study types
SR	systematic review

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analysed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SH performed database searches and collected data. KG designed the analysis methods, analysed and interpreted the data. KG and CL co-wrote the manuscript. DP conceived and supervised the research, and revised the manuscript. All authors read and approved the final manuscript.

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Figures

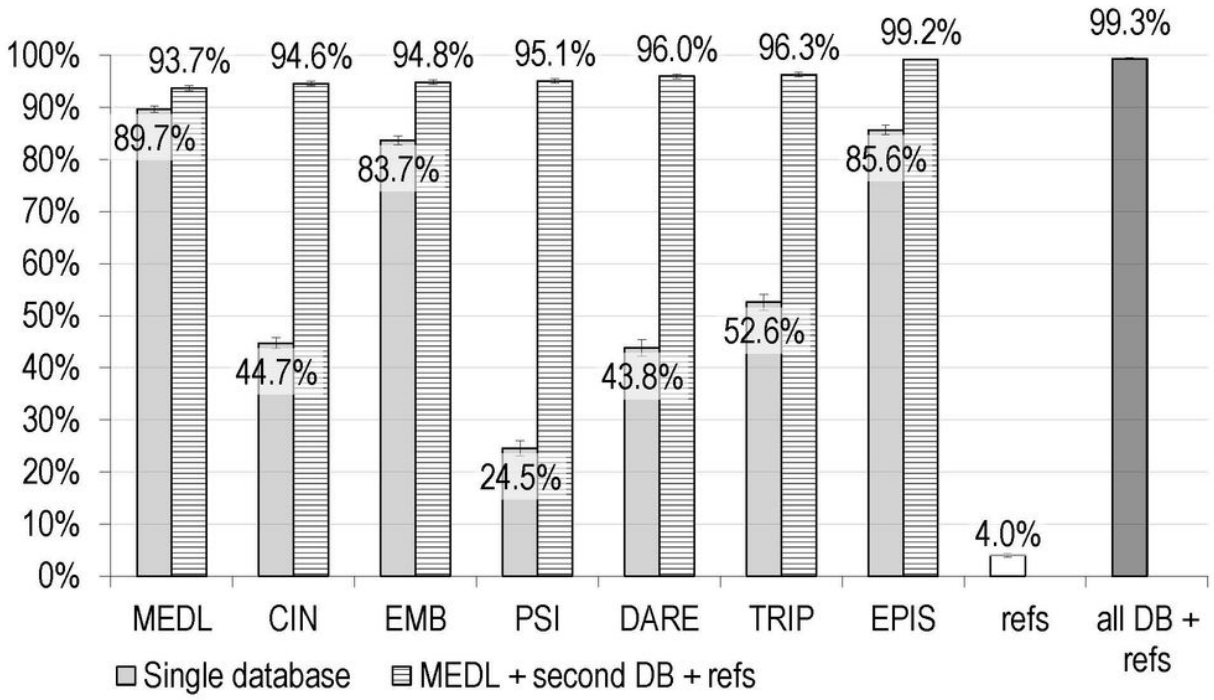

Figure 1

Indexing rate in individual databases and their combination with MEDLINE and reference checking. (Figure 1 legend) MEDL = MEDLINE, CIN = CINAHL, EMB = Embase, PSI = PsycINFO, EPIS = Epistemonikos.

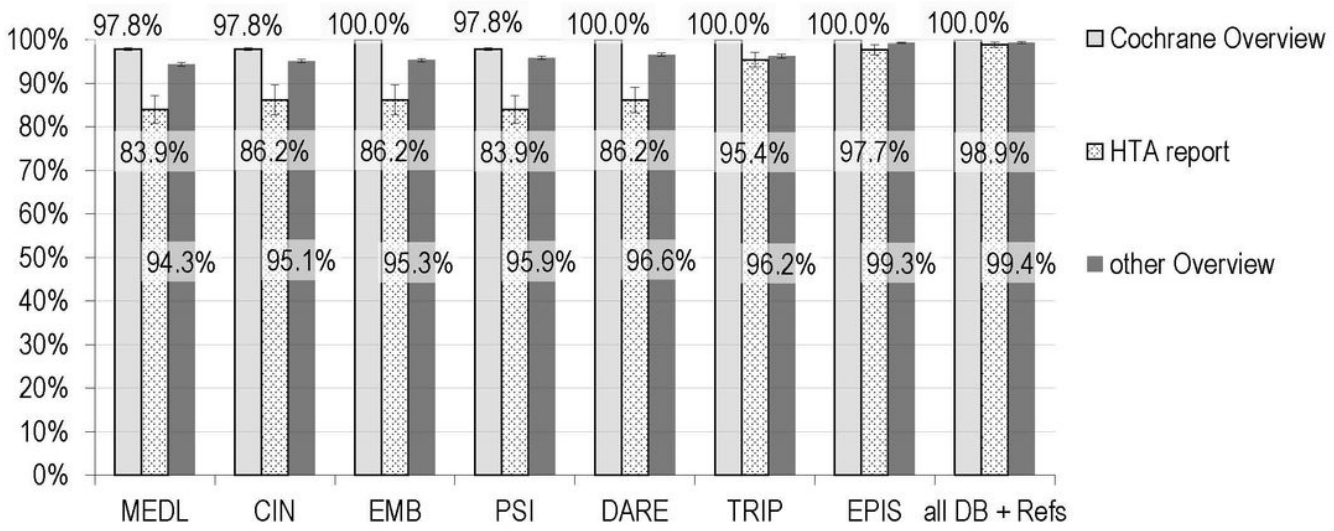

Figure 2

Indexing rate in database combinations with MEDLINE and reference checking, stratified by Over-view type.

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