**Abraham S. Fischler College of Education and School of Criminal Justice – Nova Southeastern University**

**Systematic Review and Meta-Analysis Dissertations**

**A Brief Overview**

In an effort to expand options for doctoral candidates conducting research at the Abraham S. Fischler School of Education and School of Criminal Justice, Systematic Review and Meta-Analysis dissertations are offered as possible options. These dissertation types were originally developed through the disciplines of Education and the Social Sciences. However, because they are particularly suited to resolving differing results from quantitative, random experimental design studies and are conducted only after defining a strict apriori protocol, these studies quickly became attached to medicine, nursing, and other clinical specialties where experimental research is the standard. This overview is to present enough information to doctoral students so that they can determine if this research selection, evaluation and reporting paradigm is appropriate for their study.

Meta-Analysis and Systematic Reviews vary in significant ways including the objectives of the study. **The objective of a Meta-Analysis** is to resolve conflicting evidence in two or more quantitative studies where conflicts are already known to exist. It is the resolution of the conflict that is the objective of the study, rather than an exhaustive review and synthesis of all significant, published and unpublished research in an area, which is expected in a Systematic Review. Practitioners in the medical arts and other clinical specialties seek to resolve these research conflicts due to the potential impact of a given treatment on the health and well-being of others.

In Education and the Social Sciences, there are often significant qualitative studies. These studies call for a “meta-synthesis” of the qualitative data. **The objectives of a Systematic Review** include both: (a) synthesizing the state of knowledge with regard to an intervention or set of interventions, their components or models; and (b) discovering and resolving any conflicting research evidence among studies. A systematic review is a good choice when the studies include various quantitative and/or qualitative and/or mixed method studies, as well as when the studies are sets of non-homogenous quantitative studies. Analysis and synthesis of the research is needed on each approach. Practitioners and policy makers often want to know “what works” in various settings and with various target populations.

Analysis techniques differ between Meta-Analysis and Systematic Review studies. If quantitative studies of the same type are discovered to be in conflict when the Systematic Review is conducted, then the studies are evaluated using meta-analysis techniques inside of the Systematic Review. These techniques include varying mathematical treatments depending on the type of quantitative studies being evaluated. If the studies you are evaluating are qualitative, then you evaluate them using a “meta-synthesis” technique inside of the systematic review study. In both cases you evaluate bias and effect variations due to setting, populations and other critical criteria.

These two dissertation types are neither quick nor easy, are mathematically oriented, are usually longer than normal dissertations, and require strict adherence to a prescribed protocol. Some doctoral candidates may select these dissertation types because they do not have an institution or organization easily available for data collection. In addition, the candidate rejected quantitative research study types such as evaluation research and descriptive studies using publicly available data; and, they also rejected various qualitative studies such as historical, psychological, biographical, or philosophical dissertations. The doctoral candidate should consider the expectations of Meta-Analysis and Systematic Review studies before investing both time and financial resources into such a research effort.

Meta-Analysis and Systematic Reviews have two main detractors in the research community. One criticism is that some researchers do not establish their protocol for excluding and including studies to be reviewed prior to evaluating all of the published and unpublished studies that exist. This is argued to be a source of bias. A second major criticism is that some researchers attempt to use Meta-Analysis to evaluate non-homogenous quantitative studies: such as comparing double-blind, randomized experimental trials with quasi-experimental, descriptive research results. Careful attention to these design components in the study will limit such criticism.

Interestingly, both Systematic Review and Meta-Analysis dissertations have quantitative components; however, the research questions are formulated as one would a qualitative study, with a central question and both issue-based and procedural sub-questions that are to be answered by the researcher. While these dissertation types are relatively rare in the education community, they are valuable to practitioners and policymakers.

A final thought: While you may not consider yourself a research “expert”, particularly in quantitative, statistical analysis; conducting one of these dissertation types will provide you will life-long professional skills. You learn to assess each study for various sources of selection and internal bias, as well as become more adept at identifying non-homogenous studies and aware of sources of error and bias in attempting to generalize results from differing study designs and data. Each are valuable research skills.

The attached dissertation template was formulated from a variety of scholarly sources, including dissertations that addressed various clinical, educational and other social science topics. Major contributions to the template were adapted directly from Systematic Reviews and Meta-Analysis by Little, Corcoran and Pillai (2008) and from the “Checklist” reported by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Group (at [www.prisma-statement.org](http://www.prisma-statement.org)). PRISMA is an incarnation of the QUOROM Group that was previously involved in reporting standards for these study types.

The following template has similarities to Fischler’s qualitative dissertation template. However, it can be seen that because other research results and their conflicts are the problem, and the synthesis of the data and resolution of conflicts are the purposes, each chapter has its own unique components at make this dissertation type distinctive.

[Insert Title Here]

**For use with Systematic Reviews and Meta-Analysis Studies Only**

Please note that this is only a template. These studies vary widely, therefore relevant headings and subheadings may be added or excluded. Since Systematic Reviews and Meta-Analysis studies are similar but are distinct kinds of studies from one another, there will be differences. **Differences are addressed in RED typeface**.

**The title should identify the study as a systematic review, meta-analysis, or both.**

by

[Insert Name Here]

An Applied Dissertation Submitted to the

Abraham S. Fischler College of Education

 and School of Criminal Justice in Partial

Fulfillment of the Requirements for the

Degree of Doctor of Education

Nova Southeastern University

[Enter Month and Year Here]

**Approval Page**

This applied dissertation was submitted by [*Insert Name*] under the direction of the persons listed below. It was submitted to the Abraham S. Fischler College of Education and School of Criminal Justice and approved in partial fulfillment of the requirements for the degree of Doctor of Education at Nova Southeastern University.

*Insert Name and Degree, e.g.,* Al Smith, EdD

Committee Chair

*Insert Name and Degree*

Committee Member

Kimberly Durham, PsyD

Dean

**Statement of Original Work**

I declare the following:

I have read the Code of Student Conduct and Academic Responsibility as described in the *Student Handbook* of Nova Southeastern University. This applied dissertation represents my original work, except where I have acknowledged the ideas, words, or material of other authors.

Where another author’s ideas have been presented in this applied dissertation, I have acknowledged the author’s ideas by citing them in the required style.

Where another author’s words have been presented in this applied dissertation, I have acknowledged the author’s words by using appropriate quotation devices and citations in the required style.

I have obtained permission from the author or publisher—in accordance with the required guidelines—to include any copyrighted material (e.g., tables, figures, survey instruments, large portions of text) in this applied dissertation manuscript.

*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

Name *>above the line, type your name<*

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Date *>above the line, type the date signed,* *e.g.,* March 31, 2013*<*

**Abstract**

[Insert Dissertation Title]. [Insert Name, e.g.,Richard Dadier, 2011]: Applied Dissertation, Nova Southeastern University, Abraham S. Fischler College of Education and School of Criminal Justice. [Insert 4 or 5 Keywords, e.g., Keywords: Databases, Internet, Media Selection, Middle Schools, Teacher Education]

The abstract narrative is a structured summary that should include: background, objectives of the systematic review (**or meta-analysis)**, search strategy and include the databases used, study selection [inclusion and exclusion] criteria and the search protocol, participants and interventions evaluated, study appraisal and synthesis methods, main results, limitations, conclusions, implications of key findings, and systematic review registration number (if any).

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**Chapter 1: Introduction**

**Statement of the Problem**

This should include (a) a clear statement that a problem regarding one or more interventions or intervention strategies or models exist in the research record, (b) evidence that supports the argument that large numbers of studies and/or conflicting data and conclusions exist along with the role(s) of the intervention(s) in current practice or policy, (c) evidence of any trend or change over time that has led to this problem, (d) a description of the setting in which the problem exists, and (e) probable causes that related to the problem.

**Need for Systematic Review (or Meta-Analysis)**

Provide evidence from the literature and experience showing that the problem in the research record exists and the relevance and perceived justification for conducting the study. The quantity and quality of existing research data and conclusions should be discussed within specific context and include assumption, biases, experience, intuitions, and perceptions related to the belief that inquiry into the research data is important.

**Significance of Review**

**Scholarly Significance** – How will the review clarify or resolve differences found in the research record?

**Practical Significance** – Who is affected and how will they benefit?

**Definition of Terms**

Provide complete definitions with regard to the intervention(s) and any included components and models as well as other terms if necessary. Include as many terms or variables as needed to clarify terms used in the dissertation.

**Definition of Acronyms**

Because several studies that are published or unpublished will be evaluated, a large number of acronyms are often found in the written record. Be sure you identify all acronyms, including those used and referenced in all extracted studies and tell what each acronym represents.

**Purpose of the Study**

The purpose statement should provide a general statement regarding the overall purpose of the study. Refer to Chapter 4 in Creswell, 4th Edition, 2012 for examples of qualitative and quantitative purpose statements. Key points to keep in mind when preparing a purpose statement are as follows:

1. Create a sentence that begins with “The purpose of this study is . .. .” or “The purposes of this study are….”
2. Clearly identify and define the central concepts and objectives of the study.
3. Identify the critical intervention(s) that are the target of the study.

**Chapter 2: Literature Review**

**Chapter Introduction**

Briefly state the purpose of the statement and briefly state what will be presented in this chapter.

The literature review is a listing and thorough development of the intervention(s) being addressed in the systematic review [**meta-analysis**] and may contain the following elements as appropriate:

(a) **historical development** and context of all major intervention component, such as models or types along with their applications and target populations;

(b) **discussion of the *theoretical* or *conceptual* framework**, including learning theory, upon which the intervention(s) and any models or components is/are based. Since different models frequently are based on different theoretical frameworks, discuss each;

(c) **defining characteristics** of the intervention(s) and major components, models or types;

(d) **current practice** regarding the various interventions and any models or components. Include any relevant factors such as typical setting and population served;

(e) **detailed study analysis** including the numbers and types of quantitative, qualitative, and mixed methods studies that have been both published and unpublished with regard to the intervention(s) and any of its components or models;

(f) **study discussion** of how this research should extend, differ from, or replicate any past systematic reviews or meta-analyses; and

(g) **indicate shortcomings** in any prior study, if any, that should be avoided, as well as strengths to be repeated in conducting this study.

**Research Questions**

The research questions are formulated to achieve the purpose of the study and should logically follow from the literature review. Refer to Chapter 4 in Creswell’s (2012) *Educational Research*, for formulation of qualitative research questions as well as both issue-based and procedural sub-questions. The research questions for both systematic reviews and meta-analysis studies generally follow a qualitative research question format and adhere to the following guidelines: (a) formation of question or questions based on theory, previous research found in the literature review, and experience; (b) refer to participants, interventions, comparisons, outcomes, and study design (PICOS), (c) stated in the form of a question that cannot be answered with a simple yes/no; (d) answer a “Central Question” that is the overarching question you explore in the research study; and (e) the central question is followed by “Sub-questions” that divide the central question into smaller, specific questions that are used as to guide the evaluation and development of the data extraction form for the included studies in the review.

As with qualitative studies, sub-questions in these dissertation types consist of both “issue sub-questions” that refer to issues related to the intervention(s) and “procedural sub-questions” that are non-issue components of the intervention(s) being extracted and evaluated. Systematic review and meta-analysis standards require that these questions address participants, interventions, comparisons, outcomes, and study design (PICOS). See the PRISMA checklist (Item 4). The PICOS attributes are important because they are the factors addressed when creating the protocol for screening, and selecting/deselecting studies for analysis.

Both sub-question types should be framed to support and contribute to the inclusion and exclusion criteria used in the study selection process detailed in the methodology section. Also, both of these sub-question types are used to select, modify or develop the data extraction form(s), for assessing the included studies being reviewed.

**Chapter 3: Methodology**

**Introduction**

This section should include a brief overview of the general purpose and outcomes of the study as well as an overview of what is presented in this chapter.

**Introduction**

This section should include a brief overview of the general purpose and outcomes of the study. If an existing protocol is being replicated, this is where it is identified and where it can be found. If available, provide the existing protocol registration number and if in either the Cochrane Collaboration or the Campbell Collaboration.

**Research Studies Eligibility Criteria**

 This section lists the characteristics of the studies being reviewed and includes a complete PICOS description of the thresholds for inclusion, including significance, conduct of the researchers, peer review, data treatment, and/or other relevant criteria. Justification for exclusion of studies is detailed and justified in this section. Critical PICOS subsections include:

**Participants.** This section should include a complete description of the participants who would be included in the studies being reviewed. Include the following elements: (a) the participants defined, consistent with the problem, diagnosis, or conditions of interest that would qualify them to be included in the studies being reviewed; and (b) demographic information such as age, gender, ethnicity, setting or other individual or group characteristics.

**Intervention Types.**  List the types of studies that exist in the studies being analyzed and provide a brief summary of the intervention, including goals, theoretical foundations, key techniques or activities, staff qualifications, and typical frequency, intensity and duration of the intervention(s).

**Comparisons.** Specify the conditions that will be compared in the treatment being studied and the nature of the comparisons. State if it in includes experimental and control/comparison conditions, central comparisons of interest, restrictions on application of the treatment or dose, frequency of administration, intensity, or duration of the treatment in question. Contrasts may include a contrast between one intervention and another. Provide information about relative effects of the treatments. It may also include contrasts between no-treatment control groups to provide evidence of absolute effects, including placebo effects. If the researcher wishes to do both comparisons, each comparison condition should be kept in a separate analysis.

**Outcomes.** List the various outcomes measures found in the research studies in question. These include primary and secondary outcomes, adverse outcomes, economic data, and/or timing of outcomes assessment due to interventions of varying duration or follow-up.

**Study Design.** Certain designs are superior to others for a given question. Since these studies often address different kinds of questions, the researcher should identify inclusion criteria that specify the research study design that will be used to select studies for analysis.

Because most studies in education and the social sciences focus on “what works”, study designs that are appropriate for intervention effects and causal inferences should be selected. The literature recommends techniques such as randomized controlled trials, propensity score matching, Heckman selection models, differences-in-differences, regression discontinuity, interrupted time-series, and other appropriate designs. Other designs may be evaluated (e.g., non-randomized control groups, concurrent control groups, groups of convenience, pre-test/post-test, etc.), but are more vulnerable to bias and error. For various reasons, these less rigorous designs may still be worth evaluating in the study. When including both randomized and non-randomized studies, the Campbell Collaboration that targets educational and social science reporting expects researchers to analyze results separately and test the differences with moderator analysis.

**Information Sources**

This section fully describes the information sources to be searched and the date last searched. This includes the databases (a minimum of three) with dates of coverage, contact with study authors by phone, email or other means to identify additional studies, conference proceedings, unpublished manuscript sources, and hand-searched journals.

**Procedures**

This section will be based directly on the research questions (central and sub-questions). Specifically, this is the “how-to” section of the study and will detail a step-by-step protocol of how the research record was searched and the methods used in the selection of studies in the data collection phase resulting in studies extracted for evaluation and synthesis, based on inclusion and exclusion criteria. (Note: At the proposal stage this section tells, apriori, exactly how the search will be conducted and how candidate studies will be tested against the inclusion and exclusion criteria and selected for evaluation and synthesis. This protocol must be established before the research is conducted. At the final report stage, this will be reported in past-tense detailing exactly what was done.)

**Search Strategies**. The intent in a systematic review is the selection of “all” significant studies, both published and unpublished, that meet the inclusion and exclusion criteria established in the search protocol. This section should include search strategies such as the following, as appropriate:

1. Indentify the specific strategy used for electronic searches: bibliographic databases searched, dates and periods searched, constraints such as by country, region or language. Either list each database searched in detail in this section or in a separate table as well as the full step-by-step search strategy for each in a clear, unambiguous protocol that another researcher could imitate. Be sure to include a minimum of three relevant databases, such as ERIC, JSTOR, including advanced search terms and filters, in the order used, to extract the listing of candidate studies for evaluation.
2. Provide a listing of “gray literature” sources, such as reports, monographs and conference proceedings and the strategy used for finding these candidate studies.
3. Provide the titles of any journals that were “hand-searched”.
4. Provide any reference lists that were consulted to find candidate studies.
5. Provide a listing of all Word Wide Web sites searched for candidate studies, including full URLs for all sites evaluated for candidate study extraction.
6. Include personal correspondence with fellow researchers or with those who have conducted potential candidate studies, whether published or unpublished.
7. Discuss the intended outcome from this type of strategy.
8. Discuss the source of this strategy and why it is appropriate for this study.
9. Identify how the use of this strategy will shape the type of questions asked, the form of data collection, the steps and data analysis, and the final narrative.

**Study Selection.** State the process for study selection. It is recommended that the selection process is guided by the PRISMA Flow Diagram at the end of this template. If used, detail the processes in the selection protocol.

**Data collection process**. This section should include a thorough and exhaustive description and framework for the data collection, recording and analysis protocol used to answer the research questions. While writing, keep in mind that the plan will be flexible. This section should contain the following elements as appropriate:

1. Selection of the studies evaluated: how the selection criteria of inclusion and exclusion were applied, number of raters involved with regard to the studies for inclusion, and how disagreements were handled.
2. Data extraction and management: methods used to extract data from the candidate studies or from investigators in follow-up contact, the data extraction forms used [see Mental Measurement Yearbook], number of raters involved, how disagreements were resolved, and methods of processing data to the extraction form in preparation for data analysis. More about the forms are detailed in a special section below.
3. Assessment of methodological quality of included studies: methods used, number or raters, how disagreements were resolved, how results were used in interpretation of results.
4. Measures of treatment effects: choices of effect size metrics for
	1. Dichotomous data (e.g., odds ratio, risk ratio, or risk difference)
	2. Continuous data (e.g., weighted mean difference, standardized mean difference)
	3. Time-to-event data if applicable (e.g., hazard rates)
5. Unit of analysis issues: how reviewers handled studies with multiple treatment or comparison/control groups, crossover trials, or cluster randomized trials.
6. Dealing with missing data on participants or outcomes: attempts to obtain the missing data from investigators, methods for imputing missing data (if applicable), intention-to-treat analysis, methods for handling missing statistics (e.g., means, Standard Deviation).
7. Assessment of heterogeneity: clinical/substantive heterogeneity and statistical heterogeneity as examples.
8. Assessment of reporting biases: how publication bias and other potential biases are addressed (e.g., funnel plots, statistical tests, imputation)

**Data Items.** List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.

**Risk of Bias.** This section should present an assessment of the potential biases within the selected studies and across multiple studies. This section details how publication bias, bias in individual studies, bias across studies, and other potential biases are addressed (e.g., funnel plots, statistical tests, imputation). Discuss the methods used to assess the risk of bias of individual studies. Indicate whether this assessment was conducted at the study level or the outcome level and how the information will be used in any data synthesis in Chapter 4.

**Instruments**. If an established data extraction form or other instrument was used then this section will detail each data-collection instrument. The relevant information pertaining to each instrument should include the source or developers of the instrument and any other salient information. Discuss modifications and if a panel of experts were used to validate changes, detail who the experts were and instrument components added or deleted as a result of the review by the expert panel.

**Quantitative Data Analysis (meta-analysis)**

Here you may choose a fixed effects or random effects model.

1. Moderator analysis and investigation of heterogeneity: list of pre-determined plans for subgroup analysis, meta-regression, etc.
2. Sensitivity analysis: if and how various studies were tested for the robustness of their conclusions when the study includes some form of statistical modeling with assumed or predicted data elements.

**Qualitative Data Analysis (meta-synthesis)**

Here you list the steps involved in conducting a meta-synthesis of qualitative data extracted from the selected research studies. Describe how the data were organized and transcribed. Detail the coding procedures and getting qualitative data from the studies to the data extraction forms. Discuss specific qualitative software you used for your analysis. Develop a detailed qualitative description. Check the accuracy of your findings and interpretations and include any of the following: (a) member checking—asking members to check the accuracy of the account and (b) triangulation—using corroborating evidence.

**Limitations of the Study**

List the influences that the researcher could not control, including the conditions or influences that places restrictions on the methodology and conclusions. Any limitations that might influence the results should be mentioned. Consider all of the following: (a) incomplete retrieval and analysis of identified research; (b) the nature of self-reporting; (c) the instruments used; (d) the sample size of the articles extracted for review; (e) all potential risks for bias; and (f) any time or other constraints. Certain limitations might mean that the findings cannot be generalized to the larger population. This is especially true when the extracted studies define a specific population that is very narrowly defined or is too broad (ex: elderly women).

**Delimitations of the Study**

**Even though the selection criteria are explained in detail in this chapter, here you will list the** choices made by you, the researcher, which set the parameters of the study. This is the place to explain all of the following: (a) the things that you are not doing (and why you have chosen not to do them); (b) the studies you will not review (and why not); (c) the population you are not studying (and why not); (d) the methodological procedures you will not use (and why you will not use them); and (e) other parameters involving setting, instrumentation and other variables. Limit your delimitations to the things that a reader might reasonably expect you to do but that you, for clearly explained reasons, have decided not to do.

**Chapter 4: Results**

**Chapter Introduction** Give a brief overview statement of the types of studies that were evaluated. Also give a brief listing of what results this chapter presents (e.g., the study retrieval and screening process, identification and summary of all studies that met the inclusion/exclusion criteria, how the studies are categorized, risks of bias, etc.).

**Study Retrieval**

 This major area should use the PRISMA (2009) Flow Diagram at the end of this template, or other flow diagram if replicating a study, to report the results of the selection process. Be sure to include the actual number of studies and details of the studies for the following:

1. identification, including the exact databases and other sources
2. screening methodologies using eligibility and exclusion criteria
3. selected study eligibility criteria (e.g., PICOS, sample size, etc.), giving reasons for exclusions from the eligible list, and
4. final inclusion numbers and list

Charts reporting included/excluded study details, with their full citations, should be in an appendix and referenced in this section.

**Included Studies Characteristics**

 For each study in the final selection list, report the characteristics for which data were extracted to the data extraction form selected. A summary data table that describes each study should be in an appendix and linked to the summary in this section by study eligibility criteria (e.g., PICOS, study size, etc.). For every included study, assess each for risk of bias within the study and present any outcomes assessments that may have been reported.

**Individual Study Results**

 For each intervention type, model or component being studied, create a separate study results sub-heading. In each of these sub-headings, for all outcome benefits and harms evaluated, for each study, present (a) summary data for each intervention group and (b) effects estimates and confidence intervals. Use a Forest Plot and/or other analysis technique to assess the sample bias and effect size of each study.

**Synthesis of Results**

 For each meta-analysis of quantitative study types, present the results including an estimate of average effect using Forest Plots for dichotomous and continuous data, across studies confidence intervals and measures of consistency. For each meta-synthesis of qualitative study types, present the results. Any error risk and bias risk that may be encountered as the various studies should be evaluated (e.g., selective reporting within studies, publication bias, improper data analysis, improper synthesis, etc.) and reported.

**Research Question Results**

 Based on the research results, answer the central question and all sub-questions.

**Chapter 5: Discussion**

**Introduction**

Briefly state the overall purpose of the study including any preconceptions and ideas as discussed in your introduction. Briefly state how selected studies resulted from an apriori selection protocol. Tell the reader that this chapter will discuss the implications of the findings for practitioners, policymakers, and future researchers as well as provide recommendations for future research.

**Major Findings**

Summarize each main finding and include the strength of evidence for each main outcome. This section may include sub-headings that indicate studies that confirm prior research and scholarship and studies that refute prior research and scholarship. The findings should be presented in terms of how this will apply to practitioners, policymakers, and future researchers.

**Conclusions**

In Meta-Analysis, the goal is to resolve research findings differences and that resolution should be discussed in detail in this section. In Systematic Reviews, conclusion should be drawn across study types to help practitioners and policymakers determine “what works” in a given setting and with a given population.

**Recommendations for Future Research**

Based on the conclusions and the studies evaluated propose one or more future research studies that are suggested by the data from this study. Place each of those proposed projects in terms of possible contributions to practitioners and policymakers.

**References**

**PRISMA 2009 Flow Diagram**

Studies included in quantitative synthesis (meta-analysis)
(n = )

Studies included in qualitative synthesis
(n = )

Full-text articles excluded, with reasons
(n = )

Full-text articles assessed for eligibility
(n = )

Records excluded
(n = )

Records screened
(n = )

Records after duplicates removed
(n = )

Additional records identified through other sources
(n = )

## Identification

## Eligibility

## Included

## Screening

Records identified through database searching
(n = )

|  |  |  |  |
| --- | --- | --- | --- |
| **Section/topic**  | **#** | **Checklist item**  | **Reported on page #**  |
| **TITLE**  |  |
| Title  | 1 | Identify the report as a systematic review, meta-analysis, or both.  |  |
| **ABSTRACT**  |  |
| Structured summary  | 2 | Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.  |  |
| **INTRODUCTION**  |  |
| Rationale  | 3 | Describe the rationale for the review in the context of what is already known.  |  |
| Objectives  | 4 | Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).  |  |
| **METHODS**  |  |
| Protocol and registration  | 5 | Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.  |  |
| Eligibility criteria  | 6 | Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.  |  |
| Information sources  | 7 | Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.  |  |
| Search  | 8 | Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.  |  |
| Study selection  | 9 | State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).  |  |
| Data collection process  | 10 | Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.  |  |
| Data items  | 11 | List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.  |  |
| Risk of bias in individual studies  | 12 | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.  |  |
| Summary measures  | 13 | State the principal summary measures (e.g., risk ratio, difference in means).  |  |
| Synthesis of results  | 14 | Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I2) for each meta-analysis.  |  |
| **Section/topic**  | **#** | **Checklist item**  | **Reported on page #**  |
| Risk of bias across studies  | 15 | Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).  |  |
| Additional analyses  | 16 | Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.  |  |
| **RESULTS**  |  |
| Study selection  | 17 | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.  |  |
| Study characteristics  | 18 | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.  |  |
| Risk of bias within studies  | 19 | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).  |  |
| Results of individual studies  | 20 | For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.  |  |
| Synthesis of results  | 21 | Present results of each meta-analysis done, including confidence intervals and measures of consistency.  |  |
| Risk of bias across studies  | 22 | Present results of any assessment of risk of bias across studies (see Item 15).  |  |
| Additional analysis  | 23 | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).  |  |
| **DISCUSSION**  |  |
| Summary of evidence  | 24 | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).  |  |
| Limitations  | 25 | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).  |  |
| Conclusions  | 26 | Provide a general interpretation of the results in the context of other evidence, and implications for future research.  |  |
| **FUNDING**  |  |
| Funding  | 27 | Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.  |  |

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