

REVIEW

A scoping review describes methods used to identify, prioritize and display gaps in health research

Linda Nyanchoka^{a,b,*}, Catrin Tudur-Smith^b, Van Nguyen Thu^a, Valentia Iversen^c, Andrea C. Tricco^{d,e}, Raphaël Porcher^a

^aCentre de Recherche Épidémiologie et Statistique Sorbonne Paris Cité (CRESS-UMR1153) Inserm / Université Paris Descartes, Paris, France

^bUniversity of Liverpool, Institute of Translational Medicine, Liverpool, United Kingdom

^cDepartment of Mental Health, Norwegian, Faculty of Medicine and Health Sciences, University of Science and Technology, St Olav's University Hospital HF, Tiller District Psychiatric Centre, Trondheim, Norway

^dLi Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario M5BB 1W8, Canada

^eEpidemiology Division, Dalla Lana School of Public Health, University of Toronto, 155 College Street, 6th floor, Toronto, Ontario M5T 3M7, Canada

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Abstract

Background and Objectives: Different methods to examine research gaps have been described, but there are still no standard methods for identifying, prioritizing, or reporting research gaps. This study aimed to describe the methods used to identify, prioritize, and display gaps in health research.

Methods: A scoping review using the Arksey and O'Malley methodological framework was carried out. We included all study types describing or reporting on methods to identify, prioritize, and display gaps or priorities in health research. Data synthesis is both quantitative and qualitative.

Results: Among 1,938 identified documents, 139 articles were selected for analysis; 90 (65%) aimed to identify gaps, 23 (17%) aimed to determine research priorities, and 26 (19%) had both aims. The most frequent methods in the review were aimed at gap identification and involved secondary research, which included knowledge synthesis (80/116 articles, 69%), specifically systematic reviews and scoping reviews (58/80, 73%). Among 49 studies aimed at research prioritization, the most frequent methods were both primary and secondary research, accounting for 24 (49%) reports. Finally, 52 (37%) articles described methods for displaying gaps and/or priorities in health research.

Conclusion: This study provides a mapping of different methods used to identify, prioritize, and display gaps or priorities in health research. © 2019 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Keywords: Evidence synthesis; Knowledge synthesis; Scoping review; Evidence mapping; Gaps in health research; Treatment uncertainties; Research gaps; Research priorities; Displaying gaps; Evidence gap maps

1. Introduction

The current body of research is growing, with more than 1 million clinical research papers published from clinical

trials alone [1]. Planning a study focusing on the wrong question is a frequent cause of waste in research [2]. Hence, completed and on-going research should be used to assess whether research gaps justify new research and can inform the design, conduct, and reporting of further research [3]. Initiatives such as the James Lind Alliance (JLA), UK Database of Uncertainties about the Effects of Treatments, Cochrane Agenda and Priority Setting Methods Group and Evidence-based Research Network are some examples of existing efforts to identify and prioritize research gaps in health.

The term “research gap” is not standardized, and its meaning can differ depending on the research context. In this study, we adopted the definition from the National

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* Corresponding author. Centre de Recherche Épidémiologie et Statistique Sorbonne Paris Cité (CRESS-UMR1153) Inserm / Université Paris Descartes, Paris, France; University of Liverpool, Institute of Translational Medicine, Liverpool, United Kingdom. Tel.: +33(0)753429417; fax: +33(0)142348790.

E-mail address: lnyanchoka@gmail.com (L. Nyanchoka).

What is new?

Key findings

- We identified 12 different definitions of the term research gaps. We found seven specific methods for identifying research gaps involving secondary and primary research: quantitative survey, academic crowd-sourcing, needs assessment, knowledge synthesis, bibliometric study, priority setting, and global evidence-mapping methods. We found five specific methods for determining research priorities involving secondary and primary research: Delphi survey, quantitative survey, knowledge synthesis, priority setting, and global evidence mapping method. We also identified 14 unique methods used to display research gaps and/or research priorities.

What this adds to what was known?

- This is the first study to describe methods used to identify research gaps, determine research priorities, and display research gaps or research priorities.

What is the implication and what should change now?

- The term “research gap” is not standardized, and its meaning can differ depending on the research context.
- The study findings can be adopted to inform the development of standardized methods to identify, prioritize, and display gaps in health research.
- We propose convening an international group of leaders in the field to clarify the methods for identifying, prioritizing, and displaying gaps in health research.

Collaborating Center for Methods and Tools in Canada, which describes a research gap as a research question for which missing or insufficient information limits the ability to reach a conclusion [4]. To further understand research gaps and their causes, we also referred to an article by Robinson et al. that developed a framework on identifying research gaps from systematic reviews by characterizing the gap with use of PICOS (population, intervention, comparison, outcomes, setting) elements and identifying reason(s) for why the gap exists, including insufficient or imprecise information, biased information, inconsistency or unknown consistency, and incorrect information [5].

On identifying research gaps, prioritizing research based on the gaps is essential to determine its importance and relevance, especially based on feedback from key

stakeholders such as patients, clinicians, researchers, advocates, and funders. Research priority setting is not commonly defined in a consistent way, although it has been described as any interpersonal activity that leads to the selection of topics or key questions to further investigate [6]. Research prioritization processes can help researchers and policy-makers effectively target research that has the greatest potential health benefit.

Consensus is lacking on what constitutes the best methodological approaches to identify research gaps [5,7], determine research priorities [6,8] and display research gaps or priorities. Therefore, we considered that a scoping review on this topic area was warranted. Our objectives were to (1) identify different definitions reported on the term “research gap”; (2) explore methods used to identify research gaps; (3) describe methods used to determine research priorities; and (4) map methods used to display research gaps or research priorities.

2. Materials and methods

The analytic framework for this scoping review involved the methodology outlined by Arksey and O’Malley [9] and further refined by the Joanna Briggs Institute [10]. It entails identifying the research question; expert consultation on conceptualizing the research topic, identifying the different key terms for the search strategy, developing the items for the data extraction form and reviewing the article; searching for relevant studies using key terms; selecting studies; charting the data; collating, summarizing, and reporting the results; and consulting with stakeholders to inform study findings. Experts played a major role in this study; their role was important because of the uncharted nature of this topic area. A detailed study protocol is included as supplementary material.

2.1. Search methods for identification of documents

The scoping review aimed to identify and include a wide range of article types, including original research, protocols, conference proceedings, and website content. The goal of the search strategy was to identify a diversity of methods used to identify, prioritize, and display gaps or priorities in health research. To build the search terms for the search strategy, because of the variability in terminology used, we began by contacting experts for the terms, descriptions, and definitions they use to refer to research gaps. On compiling different terms, we built our search terms with the assistance of a research librarian. The final search terms included “identifying gaps in research”, “research gaps,” “evidence gaps,” “research uncertainties,” “research gaps identification,” “research gaps prioritization,” and “methods” in health research including public health and clinical research. Two reviewers (LN and VN) conducted the searches by using the Peer Review of Electronic Search

Strategies (PRESS) guideline checklist, which aims to improve the quality of database searches [11].

The databases searched were MEDLINE, PubMed, EMBASE, Cochrane Library, Scopus, Web of Science, PROSPERO register, TRIP, Google Scholar, and Google. To focus on the most current research, database searches were limited to the past 10 years (2007–2017). Additional searches involved hand searches, web searches, expert suggestions, and checking reference lists of highly relevant articles. Only studies reported in English and involving humans were included to increase the feasibility of this scoping review. See Appendix B for complete search strategies.

2.2. Eligibility criteria

Studies were included if they aimed to describe a methodology and/or applied some methodology to identify gaps, determine research priorities, and/or display gaps or priorities in health research. All study designs were eligible, including those that used qualitative or quantitative methods, methodology, or guideline reports. We focused

our inclusion criteria to capture reports scoping within the domain of health, reporting on and/or describing methods for identifying, prioritizing and/or displaying research gaps. We excluded publications that did not explicitly describe how they aimed to identify, prioritize, and/or display research gaps. For addition information see Appendix C.

2.3. Abstract and full-text screening and selection of articles

Abstract and full-text screening was performed by two authors. The first reviewer (LN) performed the entire screening of 1,938 abstracts, and a second reviewer (VN), screened 10% (194/1,938) of all abstracts. Agreement on selection of abstracts was 174/194 (90%). In total, 237 articles were selected for full-text screening. LN performed the entire screening and VN screened 10% (24/237) of articles. Among the 24 articles that were double screened, agreement was reached on 20 (85%). Title and abstract screening involved use of the software package Covidence for conducting systematic reviews. Full-text screening involved using EndNote to manage and retrieve full texts.

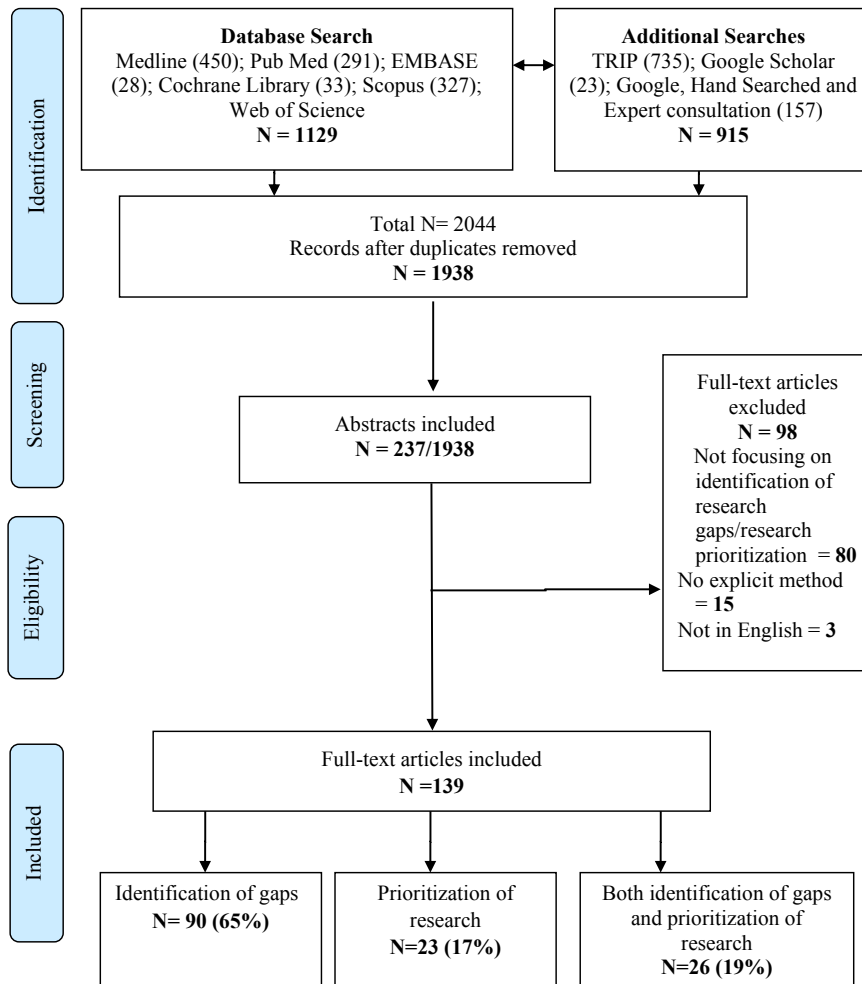


Fig. 1. Scoping review flow diagram.

Box 1 Definitions of research gaps as reported by the scoping review

Missing information

Research/evidence/knowledge gaps

- Evidence is missing from a body of research on a particular topic that could otherwise potentially answer the questions of decision-makers (clinicians, other practitioner groups, administrators, policy-makers) [14]

Synthesis/unidentified gaps

- Little or no evidence from systematic reviews is available and could be a valuable resource to inform the evidence base in a particular area [15,16]
- Lack of up-to-date and conclusive systematic reviews at low risk of bias mapped to a clinical question [17]

Treatment uncertainty

- Lack of up-to-date, reliable systematic reviews of research evidence addressing the uncertainty about the effects of treatment, and/or up-to-date systematic reviews of research evidence show that uncertainty exists [18]

Absolute evidence gaps

- Little or no evidence from primary studies is available [15]

Knowledge gap (knowledge void gap)

- Desired research findings do not exist [10,19,20]

Practical knowledge gap (action–knowledge conflict gap)

- Professional behavior or practices deviate from research findings or are not covered by research [10,19,20]

Inadequate information

Research/evidence/knowledge gaps

- The evidence base inadequately addresses a key question [21]

Empirical gap (evaluation void gap)

- Research findings or propositions need to be evaluated or empirically verified [10,19,20]

Population gap

- Research regarding a population that is not adequately represented or under-researched in the evidence base or prior research (e.g., sex, race/ethnicity, age) [5]

Insufficient information

Research/evidence/knowledge gaps

- Not much information is available and/or there is a lot of uncertainty about the accuracy of the existing estimates/evidence [7]
- Additional research is needed, from policy-makers perspectives, to address the evidence gap in the available primary research [14]

Methodological gap (method and research design gap)

- A variation in research methods is required to generate new insights or to avoid distorted findings [10,19,20]

Theoretical gap (theory-application void gap)

- Theory should be applied to certain research issues to generate new insights; theory is lacking, so a gap exists [10,19,20]

Discrepancies in both abstract and full-text screening were resolved in a meeting with senior researchers.

2.4. Data charting and synthesis

Data charting involved the use of Google Forms developed by LN with expert consultation, guidance from senior researchers and reviewing a previous methodological study [12]; the form was calibrated by LN and VN. See

Appendix D for the complete data extraction form. All data collection and analyses were conducted by LN, and VN extracted 10% (14/139 of all full-text articles). As an additional data cleaning step, two senior researchers then verified and discussed the 14 articles extracted by the second reviewer, to ensure data accuracy. A 95% agreement was achieved; disagreements were mainly on interpretation of methods used to identify gaps and/or determine research priorities. Disagreements were resolved in a meeting with

senior researchers. We extracted the following data from articles: type of article, main objective of the study, main study methodology, definition of research gaps, and specific methods to identify research gaps, determine research priorities and display research gaps or priorities [12]. The synthesis included quantitative analysis (i.e., frequency analysis) and qualitative analysis (i.e., thematic analysis) of the components of the methods to identify, prioritize, and/or display gaps in health research and conceptual definitions of gaps in health research [13].

3. Results

3.1. Results of the search

The literature search retrieved 2,044 citations, and after duplicates were removed, 1,938 remained. Overall, 247 references were considered potentially eligible. After full-text assessment, 98 articles were excluded, and 139 were included. Fig. 1 shows the flow chart of articles through the scoping review.

3.2. Summary of study designs

Among the 139 included articles, 90 (65%) aimed to identify gaps, 23 (17%) aimed to determine research

priorities, and 26 (19%) focused on both identifying gaps and determining research priorities.

3.3. Definitions of research gaps reported in articles

We explored the definitions as reported in the included studies. We identified a total of 12 different definitions, some of which overlapped, as presented in Box 1. Three cross-cutting themes were identified: definitions related to missing information, inadequate information, and insufficient information.

3.4. Specific methods for identifying research gaps

We then classified the methods used to identify research gaps. The most frequent methods in the review were aimed at gap identification (including both identification and prioritization) and involved secondary research, including knowledge synthesis (80/116 articles, 69%), specifically systematic reviews and scoping reviews (58/80, 73%) (Table 1). Overall, 24/116 (21%) articles described the use of both primary and secondary research and (12/116, 10%) only primary research. We found seven specific methods for identifying research gaps that we describe along with the purpose of the method (Table 2).

Table 1. Study designs used

Study design	All articles (N = 139)	Identification of research gaps (N = 90)	Research prioritization (N = 23)	Both identification and prioritization (N = 26)
Primary research	25 (18%)	8 (9%)	13 (56%)	4 (15%)
Qualitative study	3 (12%)	1 (13%)	2 (15%)	0
Quantitative survey	2 (8%)	1 (12%)	2 (15%)	1 (25%)
Both qualitative study and quantitative survey	20 (80%)	6 (75%)	9 (69%)	3 (75%)
Secondary research	85 (61%)	77 (86%)	5 (22%)	3 (12%)
Knowledge synthesis				
Systematic review ^a	36 (42%)	33 (43%)	1 (20%)	2 (67%)
Scoping review	25 (29%)	23 (30%)	2 (40%)	0
Evidence mapping	4 (4%)	3 (4%)	0	1 (33%)
Mapping study	2 (2%)	2 (3%)	0	0
Literature review	4 (4%)	4 (5%)	0	0
Umbrella review	4 (4%)	4 (5%)	0	0
Other (integrative review, critical interpretive synthesis)	8 (9%)	6 (8%)	2 (40%)	0
Bibliometric analysis	2 (1%)	2 (3%)	0	0
Both primary and secondary research	29 (21%)	5 (6%)	5 (22%)	19 (73%)
Review of evidence and quantitative study	6 (21%)	0	1 (20%)	5 (26%)
Review of evidence and qualitative study	3 (10%)	2 (40%)	0	1 (5%)
Review of evidence and both quantitative and qualitative study	20 (69%)	3 (20%)	4 (80%)	13 (68%)

^a Including methods used in Health Technology Assessments.

Table 2. Overview of specific methods to identify research gaps

Methods to identify research gaps	Definition	Purpose
Primary research methods		
Quantitative survey [17]	A scientific procedure for collecting information and making quantitative inferences about a predefined population	Determine evidence gaps by using a Likert-type response scale and scoring from 0 (not important at all) to 10 (highly important)
Academic crowd- sourcing [7]	An emerging paradigm that is based on harnessing the power of the crowd to solve problems [7]	Aims to reach a wider range of people, which may sometimes be required to solve a problem correctly and efficiently including identifying research gaps [7]
Needs assessment [22,23]	A systematic process for determining and addressing needs, or “gaps” between current conditions and desired conditions or “wants” by using various techniques including primary or secondary research methods (e.g., reviewing evidence, guidelines, and conducting interviews) [19]	Clarify problems and identify appropriate interventions or solutions [19]
Secondary research methods		
Knowledge synthesis		
Systematic review [14,24–27] ^a	Efficient scientific approach to identify and summarize evidence that allows for generalizability and consistency of the research findings to be assessed and data inconsistencies to be explored [28]	Summarize all pertinent studies on a specific question; improve the understanding of inconsistencies in diverse evidence and identify gaps in research evidence to define future research agendas [28]
Scoping review [12,29,30]		
Evidence mapping [15,31,32]		
Mapping study [33–35]		
Umbrella review [6]		
Integrative review [36]		
Critical interpretive synthesis [37]		
Bibliometric study [38,39]	The quantitative study of bibliographic material used to examine the knowledge structure and development of research fields based on analysis of related publications [40]	Provide a general picture of a research field that can be classified by papers, authors, and journals [40]
Both primary and secondary research methods		
Priority setting [17,18,41–51]		
James Lind Alliance priority setting partnership (JLA PSP), Cochrane Priority Setting (<i>consists of four steps: the first two aim at gap identification and the last two aim at research prioritization</i>)	JLA PSP methods were designed to allow clinicians, patients, and caregivers to work together to identify and prioritize uncertainties about the effects of treatments that could be answered by research by gathering research questions, checking existing research evidence, interim prioritization, and a final consensus meeting to reach agreement on the top 10 research priorities [41]	Raise awareness of research questions that are of direct relevance and potential benefit to patients and the clinicians who treat them, to lead to changes in how research funding is granted [41]
Global evidence-mapping methods [31,52]	Maps available research and provides an overview of a broad range of research questions and identifies evidence gaps [31]	Characterize the breadth, depth, methodology of relevant evidence and make this readily accessible [53]; identify research gaps

Italics represents an additional information on method.

^a Including methods used in Health Technology Assessments.

3.5. Specific methods for determining research priorities

Among the 49 studies aiming at research prioritization, the most frequent method involved both primary and secondary research, accounting for 24 (49%) studies, followed by primary research 17 (35%), and secondary research 8 (16%) (Table 1). We identified five

specific methods for determining research priorities (Table 3).

3.6. Specific methods for displaying research gaps and research priorities

We identified 14 unique methods used to display research gaps and/or research priorities and give some

Table 3. Overview of specific methods to determine research priorities

Methods to determine research priorities	Description	Summary of steps if specified
Primary research		
Delphi survey [51,54–56]	A group facilitation technique that seeks to obtain consensus on the opinions of relevant stakeholders by a series of structured questionnaires (commonly referred to as rounds). The questionnaires are completed anonymously by the experts (commonly referred to as panelists, participants, or respondents) [41]	Involves a series of questionnaires that are completed anonymously by experts. A process of group communication without the group ever meeting face to face. The responses from each set of questionnaires are analyzed, summarized, and then sent back to the participants until a large degree of consensus is reached in the area of interest.
Quantitative survey [17]	Adapted to determine participant research priorities by using forced ranking of research questions and Likert-type scale for responses	Developing and testing questionnaires to address research questions Forced ranking of research questions Likert-type scale
Secondary research		
Knowledge synthesis	Efficient scientific approach for identifying and summarizing evidence that allows for assessing the generalizability and consistency of research findings and exploring data inconsistencies [28]	Summarize all pertinent studies on a specific question; can improve the understanding of inconsistencies in diverse evidence, and identify gaps in research evidence to define future research agendas [28]
Systematic review [25] ^a		
Scoping review [29,30]		
Both primary and secondary research		
Priority setting [1,17,18,42–44, 46,47,49,50,54,57–65] <i>Example: JLA PSP methods</i>	Designed to enable clinicians, patients, and caregivers to work together to identify and prioritize uncertainties about the effects of treatments that could be answered by research [18]	Survey to identify treatment uncertainties Review of existing systematic reviews to explore existing evidence and address treatment uncertainties Interim prioritization to identify the priorities of relevant individuals and stakeholder groups Focus groups to discuss the research priorities based on missing or inadequate evidence A final consensus meeting to reach agreement on the top 10 research priorities [18]
Global evidence-mapping method [31,52]	Maps available research and provides an overview of a broad range of research questions and identifies evidence gaps [31]	Question development involving expert consultation, preliminary literature search, mapping workshop, online survey, and development of clinical question Question prioritization Evidence search and selections

Italics represents an example of method.

^a Including methods used in Health Technology Assessments.

examples of these methods (Table 4). We provide some illustrations of nontraditional methods. An illustration of all methods can also be found in Appendix E.

4. Discussion

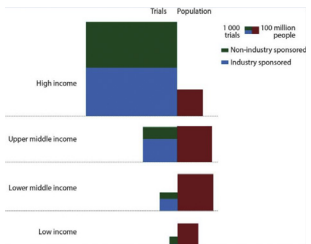
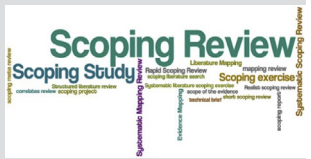
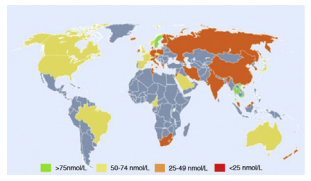
Our findings demonstrate that the term “research gap” significantly differs across research contexts, and there is no common definition. It also reveals no clear methodological guidance on which methods should be used to identify research gaps or determine research priorities. This situation leads to a wide variety in methodology, for difficulties in comparing results across studies.

Also, many studies aimed at identifying gaps relied on secondary research, primarily systematic reviews. Systematic reviews are considered the gold standard in providing

the highest level of evidence for the relative efficacy and safety of interventions [83] and summarizing the overall quality and results of research. A study on identifying and prioritizing research gaps corroborated that systematic reviews are the standard for evaluating the existing state of scientific knowledge regarding a specific clinical or policy question [79]. Robinson et al. [5] also developed a framework for using systematic reviews to identify research gaps. Although these two studies show that systematic reviews can identify research gaps, most systematic reviews address a highly focused question related to the existing evidence and thus present difficulties for explicitly identifying research gaps in a general area [5,79,84].


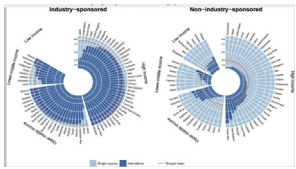
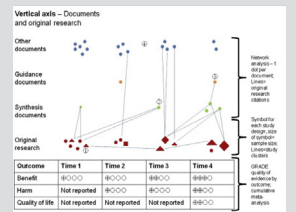
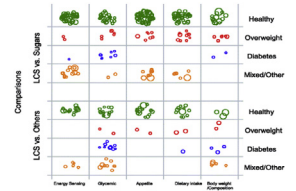
Other secondary research methods identified in this review were overviews of reviews, also known as umbrella reviews, scoping reviews, and evidence mapping.

Table 4. Overview of methods to display gaps and research priorities

Format	The information on research gaps and priorities displayed	Ways of displaying research
Table [1,14,17,18,23,30,31,41,45,47–49,52,58,66,67]	List of clinical questions, gaps, and research priorities Ranking quality of evidence Study designs to address research questions Scoring of each research gap List of research questions Prioritization of research questions Metric of ranking information	Table format ^a
Box plot [17]	List of research questions Ranking of research questions	Box plot format ^a
Bar graph/horizontal bar graph [17,33,61,68–74]	List of research priorities Frequency of questions prioritized Number of studies and categories studied Frequency of research questions Quality of evidence metric	Bar graph format ^a
Scatter plot [75]	Numeric values of desired research and current research	Scatter plot format ^a
Funnel plot [76]	Number of studies included in the review Effect sizes of studies on the x-axis	Funnel plot format ^a
Pie chart [70,77]	Proportional size of health problems being investigated by trials registered in a registry platform	Pie chart format ^a
Mind maps [78]	Diagram used to represent concepts, ideas, or tasks linked to and arranged radially around a central key word or idea Primary branches represent the major ideas or themes around the central topic, and secondary branches tend to include more concrete illustrative examples	Mind map format ^a
Tree map chart [33]	Number of clinical trials, population, and income group Comparison study of clinical registry data vs. global health research data from the Global Burden of Disease	 <p>[33]</p>
Word cloud [12]	Frequency of words Frequency of words between two groups	 <p>[12]</p>
Geographic map [24,79]	Studies mapped around the world using colors on a predefined health outcome. Different shapes and sizes also used for additional information on a map.	 <p>[24]</p>

(Continued)

Table 4. Continued

Format	The information on research gaps and priorities displayed	Ways of displaying research
Dot plot [80]	Number of studies Quality of evidence Different colors to show different study designs	
Radial bar plot/polar histogram [33]	Proportion of trials in several countries using one color per country among two groups over a period of time Comparison of proportion of trials in several countries using one color per country among two groups over a period of time	
Schematic representation [38]	Horizontal axis represents time, and vertical axis represents different documents	
Bubble plot/chart [15,81,82]	Bubbles represent studies; size indicates the relative number of studies and color the study design Number of studies by intervention type and health status Compares three sets of values	

^a Examples available on Appendix E.

Overviews of reviews focus on a much broader area, compiling evidence from multiple reviews into one accessible and usable document and highlighting other reviews within the specified topic area [85,86]. Moreover, scoping reviews and evidence mapping are designed to describe existing evidence in a broader content area [82,87,88]. They descriptively summarize results, which can be presented in a user-friendly format, often a visual figure called an evidence gap map [15], or a searchable database, to improve research planning, strategic research prioritization, and evidence-informed policies.

A mix of primary and secondary research was most frequently used to determine research prioritization, namely, priority setting (e.g., JLA PSP methods). These

methods involve the participation of patients, caregivers, and health and social care professionals in identifying research questions, then prioritizing them by using a combination of primary and secondary research [1,17,18,42–44,46,47,49,50,54,57–65]. The main method for determining research prioritization with primary research was the Delphi survey, which is a practical and productive approach to obtaining opinions from a wide number of relevant experts for identifying potential priority topic areas for research [51,54–56].

To display research gaps, half of the methods still used traditional ways to present findings (e.g., summary table and bar charts), and the other half used more advanced ways to display information (e.g., tree map charts, radial

bar plots, and bubble plots). The nontraditional methods used more colors and diagrams in presenting research gaps or priorities. For example, bubble plots use different shapes, sizes, and colors to display information and can be used to present up to three different variables in one diagram. These characteristics could be further explored to determine the appropriate method to be used along with specified methods to identify research gaps and/or determine research priorities.

Finally, our study confirmed that the various methods identified consist of both emerging and established approaches. Nonetheless, these methods can provide rich contextual details for establishing methodological guidance. We propose more work to improve the understanding of the methods and investigate ways to give the public, patients, clinicians, health researchers, decision-makers, and funders more opportunities to know what methodologies are available and can be used.

Our scoping review had some limitations. How the term “research gap” is used and defined varied widely among different authors and articles, and our exploration of methods for identifying research gaps, determining research priorities and displaying research gaps and priorities relied on definitions used by authors of included studies. Therefore, we may have missed some methods because of lack of clear definitions. Also, we included only documents written in English, relying on key articles to identify the steps involved in each method and as presented by the authors of the included articles. As such, we may have missed important methods that were published in other languages. In addition, the time restriction to the last 10 years provided a comprehensive list of recent methods used rather than an exhaustive list of all methods used.

Finally, we anticipate that our results will be of interest to knowledge users, including patients, public, clinicians, researchers, decision-makers, funders, key organizations such as JLA, the UK Database of Uncertainties about the Effects of Treatments, Joanna Briggs Institute, Campbell Collaboration, Africa Evidence Network, Cochrane Priority Setting Methods Group and Evidence-based Research Network, and finally methodologists focused on identifying and displaying gaps, and determining priorities in health research.

5. Conclusion

This study provides an overview of different methods used for and/or reporting on identifying gaps, determining research priorities and displaying both gaps and research priorities. The findings can be adopted to inform the development of standardized methods to identify, prioritize, and display gaps. They can inform further research and evidence-based decision-making by providing descriptions of different methods that can be adopted in identifying research gaps. These methods will also guide the

development of a qualitative study to explore key stakeholders’ perceived needs in identifying, communicating, and displaying gaps in research.

CRedit authorship contribution statement

Linda Nyanchoka: Conceptualization, Writing - review & editing, Formal analysis, Writing - original draft, Data curation. **Catrin Tudur-Smith:** Conceptualization, Writing - review & editing, Formal analysis. **Van Nguyen Thu:** Formal analysis, Writing - review & editing, Data curation. **Valentia Iversen:** Writing - review & editing. **Andrea C. Tricco:** Writing - review & editing. **Raphaël Porcher:** Conceptualization, Writing - review & editing, Formal analysis.

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Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jclinepi.2019.01.005>.

References

- [1] Ioannidis JPA. Why most clinical research is not useful. *PLoS Med* 2016;13(6). e1002049.
- [2] Chalmers I, Glasziou P. Avoidable waste in the production and reporting of research evidence. *Lancet* 2009;374(9683):86–9.
- [3] Young C, Horton R. Putting clinical trials into context. *Lancet* 2005; 366(9480):107–8.
- [4] Framework for identifying research gaps. Hamilton, ON: McMaster University. <http://www.nccmt.ca/resources/search/118>.
- [5] Robinson KA, Saldanha IJ, McKoy NA. Development of a framework to identify research gaps from systematic reviews. *J Clin Epidemiol* 2011;64:1325–30.
- [6] Nasser M. Setting priorities for conducting and updating systematic reviews. UK: Peninsula Schools of Medicine and Dentistry, University of Plymouth; 2018.
- [7] Rudan I, Campbell H, Marusic A, Sridhar D, Nair H, Adeyoye D, et al. Assembling GHERG: could “academic crowd-sourcing” address gaps in global health estimates? *J Glob Health* 2015;5(1): 010101.

- [8] Viergever RF, Olifson S, Ghaffar A, Terry RF. A checklist for health research priority setting: nine common themes of good practice. *Health Res Policy Syst* 2010;8:36.
- [9] Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005;8(1):19–32.
- [10] Peters MD, Godfrey CM, Khalil H, McInerney P, Parker D, Soares CB. Guidance for conducting systematic scoping reviews. *Int J Evid Based Healthc* 2015;13(3):141–6.
- [11] McGowan J, Sampson M, Salzwedel DM, Cogo E, Foerster V, Lefebvre C. PRESS peer review of electronic search strategies: 2015 guideline statement. *J Clin Epidemiol* 2016;75:40–6.
- [12] Tricco AC, Lillie E, Zarin W, O'Brien K, Colquhoun H, Kastner M, et al. A scoping review on the conduct and reporting of scoping reviews. *BMC Med Res Methodol* 2016;16:15.
- [13] Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. Prisma extension for scoping reviews (prisma-scr): checklist and explanation. *Ann Intern Med* 2018;169:467–73.
- [14] Scott NA, Carmen M, Christa H, Jacques M. Using health technology assessment to identify research gaps: an unexploited resource for increasing the value of clinical research. *Healthc Policy* 2008;3(3):e109–27.
- [15] Birte S, Martina V, Ami B, Jennifer S, Marie G. Evidence & gap maps: a tool for promoting evidence informed policy and strategic research agendas. *J Clin Epidemiol* 2016;79:120–9.
- [16] Brearley SG, Stamatakis Z, Addington-Hall J, Foster C, Hodges L, Jarrett N, et al. The physical and practical problems experienced by cancer survivors: a rapid review and synthesis of the literature. *Eur J Oncol Nurs* 2011;15(3):204–12.
- [17] Yu T, Li T, Lee KJ, Friedman DS, Dickersin K, Puhon MA. Setting priorities for comparative effectiveness research on management of primary angle closure: a survey of Asia-Pacific clinicians. *J Glaucoma* 2015;24:348–55.
- [18] van Middendorp JJ, Allison HC, Ahuja S, Bracher D, Dyson C, Fairbank J, et al. Top ten research priorities for spinal cord injury: the methodology and results of a British priority setting partnership. *Spinal Cord* 2016;54(5):341–6.
- [19] Fulgham SM, Shaughnessy MF. O & a with ed tech leaders: interview with roger kaufman. *Educ Technol* 2008;48(5):49.
- [20] Müller-Bloch C, Kranz J. A framework for rigorously identifying research gaps in qualitative literature reviews. In: *Proceedings of the 36th International Conference on Information Systems*, Fort Worth, Texas, USA. 2015.
- [21] Hiten DP, Emmanuel I, Phillip MP, Stephen MS, Michael HJ, Ritu S, et al. A systematic review of research gaps in the evaluation and management of localized renal masses. *Urology* 2016;98:14.
- [22] Kitson A, Straus SE. The knowledge-to-action cycle: identifying the gaps. *Can Med Assoc J* 2010;182(2):E73–7.
- [23] Thompson A, Brennan K, Cox A, Gee J, Harcourt D, Harris A, et al. Evaluation of the current knowledge limitations in breast cancer research: a gap analysis. *Breast Cancer Res* 2008;10(2):R26.
- [24] Wahl DA, Cooper C, Ebeling PR, Eggersdorfer M, Hilger J, Hoffmann K, et al. A global representation of vitamin D status in healthy populations. *Arch Osteoporos* 2012;7:155–72.
- [25] Chang SM, Carey TS, Kato EU, Guise JM, Sanders GD. Identifying research needs for improving health care. *Ann Intern Med* 2012;157:439–45.
- [26] Mickenautsch S. Research gaps identified during systematic reviews of clinical trials: glass-ionomer cements. *BMC Oral Health* 2012;12(1):18.
- [27] Tunis SR, Turkelson C. Using health Technology assessment to identify gaps in evidence and inform study design for comparative effectiveness research. *J Clin Oncol* 2012;30:4256–61.
- [28] Mulrow CD. Rationale for systematic reviews. *BMJ* 1994;309:597–9.
- [29] Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implement Sci* 2010;5:69.
- [30] Schwartz SR, Baral S. Fertility-related research needs among women at the margins. *Reprod Health Matters* 2015;23(45):30–46.
- [31] Clavisi O, Bragge P, Tavender E, Turner T, Gruen RL. Effective stakeholder participation in setting research priorities using a global evidence mapping approach. *J Clin Epidemiol* 2013;66:496–502.e492.
- [32] Schmucker C, Motschall E, Antes G, Meerpohl JJ. [Methods of evidence mapping. A systematic review]. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2013;56(10):1390.
- [33] Atal I, Trinquart L, Porcher R, Ravaud P. Differential globalization of industry- and non-industry-sponsored clinical trials. *PLoS One* 2015;10:e0145122.
- [34] Ahmad N, Boutron I, Dechartres A, Durieux P, Ravaud P. Geographical representativeness of published and ongoing randomized controlled trials. The example of: tobacco consumption and HIV infection. *PLoS One* 2011;6:e16878.
- [35] Ndounga Diakou LA, Ntoumi F, Ravaud P, Boutron I. Published randomized trials performed in Sub-Saharan Africa focus on high-burden diseases but are frequently funded and led by high-income countries. *J Clin Epidemiol* 2017;82:29–36.e26.
- [36] Marion LM, Fiona C, Susanne K, Renee S, Jenny M, Toni D. Patient, family-centred care interventions within the adult ICU setting: an integrative review. *Aust Crit Care* 2016;29(4):179.
- [37] Johnson M, Tod AM, Brummell S, Collins K. Prognostic communication in cancer: a critical interpretive synthesis of the literature. *Eur J Oncol Nurs* 2015;19(5):554–67.
- [38] Kho ME, Brouwers MC. The systematic review and bibliometric network analysis (SeBriNA) is a new method to contextualize evidence. Part 1: description. *J Clin Epidemiol* 2012;65:1010–5.
- [39] Mbuagbaw L, Kredon T, Welch V, Mursleen S, Ross S, Zani B, et al. Critical EPICOT items were absent in cochrane human immunodeficiency virus systematic reviews: a bibliometric analysis. *J Clin Epidemiol* 2016;74:66–72.
- [40] Merigó JM, Yang J-B. A bibliometric analysis of operations research and management science. *Omega* 2017;73(Supplement C):37–48.
- [41] Boney O, Bell M, Bell N, Conquest A, Cumbers M, Drake S, et al. Identifying research priorities in anaesthesia and perioperative care: final report of the joint national Institute of academic anaesthesia/james lind alliance research priority setting partnership. *BMJ Open* 2015;5(12):e010006.
- [42] Buckley BS, Grant AM, Glazener CM. Case study: a patient-clinician collaboration that identified and prioritized evidence gaps and stimulated research development. *J Clin Epidemiol* 2013;66:483–9.
- [43] Buckley BS, Grant AM, Tincello DG, Wagg A, Firkins L. Reaching a consensus and ranking research priorities in urinary incontinence. *Nurs Times* 2010;106(24):36–7.
- [44] Heazell AE, Whitworth MK, Whitcombe J, Glover SW, Bevan C, Brewin J, et al. Research priorities for stillbirth: process overview and results from UK stillbirth priority setting partnership. *Ultrasound Obstet Gynecol* 2015;46(6):641–7.
- [45] Knight SR, Metcalfe L, O'Donoghue K, Ball ST, Beale A, Beale W, et al. Defining priorities for future research: results of the UK kidney transplant priority setting partnership. *PLoS One* 2016;11:e0162136.
- [46] Welsh E, Stovold E, Karner C, Cates C. Cochrane Airways Group reviews were prioritized for updating using a pragmatic approach. *J Clin Epidemiol* 2015;68:341–6.
- [47] Rees SE, Chadha R, Donovan LE, Guitard AL, Koppula S, Laupacis A, et al. Engaging patients and clinicians in establishing research priorities for gestational diabetes mellitus. *Can J Diabetes* 2017;41:156–63.
- [48] Jennifer MG, Evan RM, Kristine MS, Douglas CM, Remy RC, Matthew JC, et al. Prioritization of patient-centered comparative effectiveness research for osteoarthritis. *Ann Intern Med* 2014;160:836.
- [49] Ingram JR, Abbott R, Ghazavi M, Alexandroff AB, McPhee M, Burton T, et al. The hidradenitis suppurativa priority setting partnership. *Br J Dermatol* 2014;171:1422–7.

- [50] Gadsby R, Snow R, Daly AC, Crowe S, Matyka K, Hall B, et al. Setting research priorities for Type 1 diabetes. *Diabet Med* 2012; 29:1321–6.
- [51] Li T, Vedula SS, Scherer R, Dickersin K. What comparative effectiveness research is needed? A framework for using guidelines and systematic reviews to identify evidence gaps and research priorities. *Ann Intern Med* 2012;156:367–77.
- [52] Jaramillo A, Welch VA, Ueffing E, Gruen RL, Bragge P, Lyddiatt A, et al. Prevention and self-management interventions are top priorities for osteoarthritis systematic reviews. *J Clin Epidemiol* 2013; 66:503–510.e504.
- [53] Katz DL, Williams AL, Girard C, Goodman J, Comerford B, Behrman A, et al. The evidence base for complementary and alternative medicine: methods of evidence mapping with application to CAM. *Altern Ther Health Med* 2003;9(4):22–30.
- [54] Yoshida S. Approaches, tools and methods used for setting priorities in health research in the 21(st) century. *J Glob Health* 2016;6(1): 010507.
- [55] Evelina C, Ludovic R, Amy C, Stephanie S, Xavier B. Cochrane systematic reviews are useful to map research gaps for decreasing maternal mortality. *J Clin Epidemiol* 2013;66:105.
- [56] Mitchell RB, Hussey HM, Setzen G, Jacobs IN, Nussenbaum B, Dawson C, et al. Clinical consensus statement: tracheostomy care. *Otolaryngol Head Neck Surg* 2013;148(1):6–20.
- [57] Wald HL, Leykum LK, Mattison ML, Vasilevskis EE, Meltzer DO. A patient-centered research agenda for the care of the acutely ill older patient. *J Hosp Med* 2015;10(5):318–27.
- [58] Lophatananon A, Tyndale-Biscoe S, Malcolm E, Rippon HJ, Holmes K, Firkins LA, et al. The James Lind Alliance approach to priority setting for prostate cancer research: an integrative methodology based on patient and clinician participation. *BJU Int* 2011; 108:1040–3.
- [59] Pollock A, St George B, Fenton M, Firkins L. Top 10 research priorities relating to life after stroke—consensus from stroke survivors, caregivers, and health professionals. *Int J Stroke* 2014;9(3):313–20.
- [60] Meremikwu M, Udoh E, Nwagbara B, Effa E, Oringanje C, Edet B, et al. Priority setting for systematic review of health care interventions in Nigeria. *Health Policy* 2011;99(3):244–9.
- [61] Mitnick CD, Rodriguez CA, Hatton ML, Brigden G, Cobelens F, Grobusch MP, et al. Programmatic management of drug-resistant tuberculosis: an updated research agenda. *PLoS One* 2016;11:e0155968.
- [62] Pollock A, St George B, Fenton M, Crowe S, Firkins L. Development of a new model to engage patients and clinicians in setting research priorities. *J Health Serv Res Policy* 2014;19:12–8.
- [63] van Furth EF, van der Meer A, Cowan K. Top 10 research priorities for eating disorders. *Lancet Psychiatry* 2016;3(8):706–7.
- [64] Chapman E, Reveiz L, Sangalang S, Manu C, Bonfill X, Munoz S, et al. A survey study identified global research priorities for decreasing maternal mortality. *J Clin Epidemiol* 2014;67:314–24.
- [65] Gierisch JM, Myers ER, Schmit KM, Crowley MJ, McCrory DC, Chatterjee R, et al. Prioritization of research addressing management strategies for ductal carcinoma in situ. *Ann Intern Med* 2014;160:484–91.
- [66] Knight R, Small W, Pakula B, Thomson K, Shoveller J. A scoping study to identify opportunities to advance the ethical implementation and scale-up of HIV treatment as prevention: priorities for empirical research. *BMC Med Ethics* 2014;15:54.
- [67] Sun C, Dohrn J, Omoni G, Malata A, Klopper H, Larson E. Clinical nursing and midwifery research: grey literature in African countries. *Int Nurs Rev* 2016;63(1):104–10.
- [68] Wan YL, Beverley-Stevenson R, Carlisle D, Clarke S, Edmondson RJ, Glover S, et al. Working together to shape the endometrial cancer research agenda: the top ten unanswered research questions. *Gynecol Oncol* 2016;143(2):287–93.
- [69] DeFrank JT, Barclay C, Sheridan S, Brewer NT, Gilliam M, Moon AM, et al. The psychological harms of screening: the evidence we have versus the evidence we need. *J Gen Intern Med* 2015;30:242–8.
- [70] Viergever RF, Terry RF, Karam G. Use of data from registered clinical trials to identify gaps in health research and development. *Bull World Health Organ* 2013;91(6):416–425C.
- [71] Kumar MB, Wesche S, McGuire C. Trends in Metis-related health research (1980-2009): identification of research gaps. *Can J Public Health* 2012;103(1):23–8.
- [72] De Luca Canto G, Pacheco-Pereira C, Aydinov S, Major PW, Flores-Mir C, Gozal D. Biomarkers associated with obstructive sleep apnea and morbidities: a scoping review. *Sleep Med* 2015; 16(3):347–57.
- [73] Tavender EJ, Bosch M, Fiander M, Knott JC, Gruen RL, O'Connor D. Implementation research in emergency medicine: a systematic scoping review. *Emerg Med J* 2016;33(9):652–9.
- [74] Singh Ospina N, Rodriguez-Gutierrez R, Brito JP, Young WF Jr, Montori VM. Is the endocrine research pipeline broken? A systematic evaluation of the Endocrine Society clinical practice guidelines and trial registration. *BMC Med* 2015;13:187.
- [75] Azeredo TB, Luiza VL, Oliveira MA, Emmerick IC, Bigdeli M. Stakeholders' perspectives on access-to-medicines policy and research priorities in Latin America and the Caribbean: face-to-face and web-based interviews. *Health Res Policy Syst* 2014;12:31.
- [76] Umscheid CA. A primer on performing systematic reviews and meta-analyses. *Clin Infect Dis* 2013;57:725–34.
- [77] Atal I, Zeitoun J-D, Névéal A, Ravaud P, Porcher R, Trinquart L. Automatic classification of registered clinical trials towards the global burden of diseases taxonomy of diseases and injuries. *BMC Bioinformatics* 2016;17(1):392.
- [78] van den Eertwegh V, van Dulmen S, van Dalen J, Scherpbier AJ, van der Vleuten CP. Learning in context: identifying gaps in research on the transfer of medical communication skills to the clinical workplace. *Patient Educ Couns* 2013;90(2):184–92.
- [79] Carey T, Yon A, Beadles C, Wines R. Prioritizing future research through examination of research gaps in systematic reviews. USA: Prepared for the Patient-Centered Outcomes Research Institute; 2012.
- [80] Bhavisha V, Emma J, Iris G, Cova B, Elena S. Availability of evidence on cataract in low/middle-income settings: a review of reviews using evidence gap maps approach. *Br J Ophthalmol* 2016; 100:1455–60.
- [81] Miake-Lye IM, Hempel S, Shanman R, Shekelle PG. What is an evidence map? A systematic review of published evidence maps and their definitions, methods, and products. *Syst Rev* 2016;5:28.
- [82] Wang DD, Shams-White M, Bright OJ, Parrott JS, Chung M. Creating a literature database of low-calorie sweeteners and health studies: evidence mapping. *BMC Med Res Methodol* 2016;16:1.
- [83] Impellizzeri FM, Bizzini M. Systematic review and meta-analysis: a primer. *Int J Sports Phys Ther* 2012;7(5):493–503.
- [84] Tricco AC, Zarin W, Ghassemi M, Nincic V, Lillie E, Page MJ, et al. Same family, different species: methodological conduct and quality varies according to purpose for five types of knowledge synthesis. *J Clin Epidemiol* 2018;96:133–42.
- [85] Nikolakopoulou A, Mavridis D, Furukawa TA, Cipriani A, Tricco AC, Straus SE, et al. Living network meta-analysis compared with pairwise meta-analysis in comparative effectiveness research: empirical study. *BMJ* 2018;360:k585.
- [86] Grant MJ, Booth A. A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Info Libr J* 2009;26:91–108.
- [87] Althuis MD, Weed DL. Evidence mapping: methodologic foundations and application to intervention and observational research on sugar-sweetened beverages and health outcomes. *Am J Clin Nutr* 2013;98:755–68.
- [88] Hetrick SE, Parker AG, Callahan P, Purcell R. Evidence mapping: illustrating an emerging methodology to improve evidence-based practice in youth mental health. *J Eval Clin Pract* 2010;16:1025–30.