International Journal of Public Health (2020) 65:699–703
https://doi.org/10.1007/s00038-020-01386-3

HINTS & KINKS

Systematic mixed studies reviews: leveraging the literature to answer complex questions through the integration of quantitative and qualitative evidence

Helen Cerigo[1] · Amélie Quesnel-Vallée[1,2]

Received: 28 January 2020 / Revised: 22 April 2020 / Accepted: 7 May 2020 / Published online: 3 June 2020

Systematic reviews have become critical tools in the evidence-based decision-making process thanks to their accessible, exhaustive, transparent and critical summaries of the literature (Green et al. 2011). In the health literature, review authors have traditionally given precedence to quantitative studies, such as randomized control trials (RCTs), which are ideally suited to answer questions about effectiveness, and the magnitude and direction of associations (Harden and Thomas 2005; Hong et al. 2017; Pluye et al. 2009). However, this approach underuses the qualitative literature, which provides evidence in the form of stories and experiences, rather than numbers. Qualitative evidence is better positioned to provide an understanding of *how*, *why* and *in what context* an intervention is effective, or an association exists (Lockwood et al. 2015; Pluye et al. 2016). Within the health field, there has been a growing appreciation in the value of qualitative evidence and its ability to answer complex questions. This has also manifested in the field of knowledge synthesis, where the idea of integrating a variety of types of evidence within a single review has gained traction. In this Hints and Kinks article, we provide a methodological introduction to systematic mixed studies reviews (SMSRs), a type of systematic review that integrates evidence from quantitative, qualitative and/or mixed methods studies (Hong et al. 2017; Mays et al. 2005b). This type of knowledge synthesis, also called integrative review, mixed methods review and mixed research synthesis, has greatly increased in popularity, especially in fields that require complex interventions (e.g., public health and social policy) (Heyvaert et al. 2017; Hong et al. 2017; Pluye and Hong 2014). We discuss this emerging methodology, the motivation for its use, key methodological features and challenges.

✉ Amélie Quesnel-Vallée
amelie.quesnelvallee@mcgill.ca

Helen Cerigo
helen.cerigo@mail.mcgill.ca

[1] Department of Epidemiology, Biostatistics, Occupational Health, McGill University, Montreal, Canada

[2] Department of Sociology, McGill University, Montreal, Canada

Why conduct a systematic mixed studies review?

The primary motivation to synthesize both qualitative and quantitative evidence is the ability to answer complex questions, as well as explore complex phenomena (Dixon-Woods et al. 2005; Harden and Thomas 2005; Heyvaert et al. 2017; Mays et al. 2005b; Pluye and Hong 2014). The SMSR approach can be beneficial for broad, overarching research questions, allowing the various types of evidence to give a more comprehensive and detailed understanding of the problem by providing multiple perspectives (i.e., stories and numbers) (Hong et al. 2017). The evidence from one type of literature can help explore, contextualize, generalize or explain the findings of the other type of literature (Harden and Thomas 2005; Hong et al. 2017; Lizarondo et al. 2017; Pluye and Hong 2014). Additionally, multiple questions can be explored to understand interrelated aspects of the same topic (e.g., effectiveness, feasibility, acceptability, cost-effectiveness, contextual and moderating factors, temporal changes, and perceptions), as some of these are more appropriately explored through one type of literature over another (Harden and Thomas 2005; Heyvaert et al. 2013, 2017; Hong et al. 2017; Lizarondo et al. 2017; Pluye and Hong 2014). The breadth of this approach provides richer and more practical knowledge, and informative conclusions, increasing the potential for these syntheses to influence practice, policy and future research (Hong et al. 2017; Lizarondo et al. 2017; Mays et al. 2005b; Sandelowski et al. 2006).

SMSRs are also particularly helpful for understanding complex phenomena, such as complex interventions and programs, which are often used in public health. These programs often consist of multiple layers and components, and SMSRs are more appropriate than mono-method reviews to explore how these components are related and interact (Heyvaert et al. 2017). To understand these interventions, researchers often need questions that go beyond effectiveness alone, such as those described above. Finally, many of the benefits of synthesizing multiple types of evidence within a review are similar to those described for primary mixed methods studies, including the ability to corroborate findings and to pool the respective strengths of each literature base, while offsetting their weaknesses (Bryman 2006; Heyvaert et al. 2013; Hong and Pluye 2018; Hong et al. 2017; Lizarondo et al. 2017; Tricco et al. 2016).

Design considerations

SMSRs follow the universal phases of systematic reviews, characterized by an explicit and reproducible methodology with a clearly defined research question and eligibility criteria, systematic search of the literature, selection of relevant studies, data extraction and quality assessment of included studies, synthesis and interpretation (Green et al. 2011; Heyvaert et al. 2017; Hong et al. 2017; Pluye et al. 2009; Pluye and Hong 2014). However, during the synthesis phase, when the extracted evidence from primary studies is brought together, there is an added layer of complexity as the different types of evidence must be integrated into a coherent whole (Hong and Pluye 2018; Mays et al. 2005a). There are a variety of ways that integration can be achieved in an SMSR, and several design typologies have been proposed based on prioritization of evidence, temporal order of integration and purpose of the study (Frantzen and Fetters 2016; Heyvaert et al. 2013, 2017; Pluye and Hong 2014; Sandelowski et al. 2006). In this review of SMSR, we adopt Hong et al.'s (Hong et al. 2017) literature-driven typology, as it has found the most support in the literature. Table 1 describes their four major synthesis designs, which are organized by the concepts of sequence (i.e., temporal relationships between the collection and analysis of the different evidence types) and location of integration within the review (e.g., data, results or discussion).

As with traditional systematic reviews, qualitative, quantitative or mixed synthesis methods may be used within each design (Harden and Thomas 2005; Hong et al. 2017; Mays et al. 2005b). Qualitative synthesis methods summarize results with qualitative outputs (e.g., themes, concepts and patterns), such as grouping and clustering, and narrative synthesis (Heyvaert et al. 2017; Hong et al. 2017; Pluye and Hong 2014). Quantitative synthesis methods summarize results with quantitative outputs (i.e., variables with numeric values), such as meta-analysis and vote counting (Heyvaert et al. 2017; Hong et al. 2017; Pluye and Hong 2014). Some methods are neither strictly quantitative nor qualitative (i.e., configurational comparative method) and more than one method can be used within a review, leading to the classification of mixed synthesis methods (Hong et al. 2017).

The choice of SMSR synthesis design is primarily dictated by the research question, and it is possible that multiple approaches may work for a particular topic (Heyvaert et al. 2017; Mays et al. 2005b). This choice is often restricted by the nature and size of the current literature base and the resources available (Heyvaert et al. 2017). Given the flexibility of SMSR study design, it is important that review authors are transparent and explicit with their methodology and decisions (Frantzen and Fetters 2016; Hong et al. 2017).

Quality assessment considerations

An appraisal of the validity, reliability and generalizability of all included primary studies helps users understand the extent to which SMSR findings are empirically supported (Higgins and Sterne 2011; Mays et al. 2005b). As with traditional systematic reviews, a criterion-based approach by means of critical appraisal tools is preferred for SMSRs over expert judgment or numerical scoring, as transparency and reliability are increased when each component can be fully described (Heyvaert et al. 2017; Higgins and Sterne 2011). However, SMSR authors have a choice in how they implement the criterion-based approach, as they may use critical appraisal tools that are generic, comprehensive or design specific (Heyvaert et al. 2017; Pluye et al. 2009, 2016). These three approaches to quality assessment, their advantages and limitations and examples of relevant critical appraisal tools are described in Table 2.

Key challenges

The major challenge of implementing of SMSRs is that they typically require more time and human resources than a traditional systematic review (Heyvaert et al. 2017). They often yield a larger quantity of data and possibility very divergent data because they are capturing multiple domains of literature and often answering multiple sub-questions. Also, even a well-designed SMSR search strategy can produce an overwhelming number of titles to screen, especially as no specific study design filter may be used. Further, some synthesis designs have more phases and

Table 1 Comparison of synthesis designs for systematic mixed studies reviews, their uses and assumptions

Design[1]	Sequence of synthesis and integration (Hong et al. 2017)	Motivation and use of design (Heyvaert et al. 2017; Hong et al. 2017; Sandelowski et al. 2006)	Assumptions (Sandelowski et al. 2006)
1. Convergent synthesis	Quantitative and qualitative evidence is collected and analyzed simultaneously		
1.1. Data-based integration (or integrated design)	• Same synthesis method is used for both Quantitative and qualitative evidence, and results are presented together • Data are transformed into same format and combined: qualitative data into numerical values OR quantitative data into categories, themes, typologies or narratives	• Usually one question; either broad or specific • More appropriate when different evidence types (i.e., quantitative and qualitative) are assumed to confirm, refute or extend each other • Good for purposes of assimilation and corroboration • Most common approach, as easiest to perform	Quantitative and qualitative evidence: • Not different enough to warrant separate analyses or syntheses • Can address same research question
1.1. Results-based integration (or segregated design)	• Quantitative and qualitative evidence analyzed and presented independently using appropriate synthesis methods • Integration occurs in the *results* section using third synthesis method (i.e., comparing finding using tables or matrices or reanalyzing evidence) • No data transformation	• Usually one overall question with sub-questions • More appropriate when findings viewed as complementary • Synthesis configures findings into a line of argument, theory or narrative • Preserves integrity of findings from different types of studies	Quantitative and qualitative evidence: • different entities and should be treated separately • answers different questions that are related to the same phenomena • Different methods needed for synthesis of different evidence types
1.1. Parallel-results integration (or segregated design)	• Quantitative and qualitative evidence analyzed and presented independently using appropriate synthesis methods • Integration occurs during interpretation of results within the *discussion* section • No data transformation	• Usually for multiple complementary questions • More appropriate when findings viewed as complementary and when synthesis configures findings into a line of argument, theory or narrative • Preserves integrity of findings from different types of studies	Quantitative and qualitative evidence: • different entities and should be treated separately • answers different questions that are related to the same phenomena • Different methods needed for synthesis of different evidence types
1. Sequential synthesis (or contingent design)	• Cyclic approach where evidence is analyzed and presented consecutively • Quantitative, then qualitative, or qualitative, then Quantitative (multiple cycles possible, until objective met) • Collection and analysis of evidence in the first phase inform the collection and analysis in the second phase • May involve data transformation	• Usually for one review question with complementary sub-questions • Rare in practice • Can be exploratory or explanatory • Can assimilate or configure evidence	• Does not necessarily assume that quantitative and qualitative evidence is different and may have different assumptions based on different sub-questions • Integration of both evidence types may or may not occur

[1]Designs described are those identified by Hong et al.'s (2017) typology of SMSR. The corresponding design from Sandelowski et al.'s (2006) typology is also shown in brackets

demand more resources, as they necessitate going between the different types of evidence in an iterative process.

It is the core objective of SMSRs to combine the findings from qualitative and quantitative evidence to provide a more comprehensive evidence synthesis than a mono-method synthesis through integration (Hong and Pluye 2018; Lizarondo et al. 2017; Sandelowski et al. 2006; Tricco et al. 2016). However, appropriate integration can be hampered by poorly focused research questions, and a lack of skill alignment and specialization on the research team (Heyvaert et al. 2017). SMSRs are inherently inter-disciplinary, with a wider variety of methodological and topical expertise needed among the review team than a traditional mono-method review (Heyvaert et al. 2017; Tricco et al. 2016). Given the time and human resources demands, SMSR should be well justified and be conducted

Table 2 Description of the approaches to quality assessment of the primary studies synthesized in systematic mixed studies reviews

Approach (Heyvaert et al. 2017; Pluye et al. 2016)	Advantages and limitations (Heyvaert et al. 2017; Hong and Pluye 2018; Pluye et al. 2016)	Example(s) of critical appraisal tools
Generic: Instrument with general criteria that can be applied to all study designs included	+ Comparable across study designs + May be preferable for data-based integration − Difficult to elaborate criteria that allows adequate evaluation of all designs − May introduce expert judgment − Requires high degree of methodological expertise in all literature strands	Crowe critical appraisal tool (Crowe and Sheppard 2011)
Comprehensive: Instrument with a minimal set of criteria for each design type	+ Allows for appraisal of different strands at the same time + Can be used for all synthesis approaches − Less comprehensive than design-specific instruments	Mixed methods appraisal tool (MMAT) (Pluye et al. 2009)
Design-specific: Different instruments used for each type of evidence	+ Better for results-based and parallel-results convergent synthesis and sequential synthesis + Variety of well-utilized tools already available within the literature for use or adaptation − Difficult to compare across study designs	Commonly used tools include: *Qualitative:* Joanna Briggs tool (Lockwood et al. 2015), CASP tool (Critical Appraisal Skills Programme 2018) *Quantitative:* Newcastle–Ottawa Scale (Wells et al. 2008), Jadad Scale for RCTs (Jadad et al.) *Mixed methods:* MMAT (Pluye et al. 2009)

Use of quality assessment outcomes: Several strategies have been proposed and used in the literature, such as exclude or stratify based on outcome, assign weights based on methodological score or provide narrative description of assessment (Heyvaert et al. 2017; Higgins and Sterne 2011; Pluye et al. 2009)

+: advantage; −: limitation; MMAT: mixed methods appraisal tool; CASP: critical appraisal skills program; RCT: randomized control trial

only when the research question is one that cannot be adequately answered, or important insights will be missed, by one study design alone (Harden and Thomas 2005).

Conclusion

Evidence is often available in many parallel domains of research, and SMSRs provide an opportunity to integrate these domains within a single review. The integration of evidence derived from diverse methodological traditions and disciplines ensures a more comprehensive understanding of an issue, while contributing rich details that are often missing from systematic reviews of quantitative evidence alone (Dixon-Woods et al. 2005; Heyvaert et al. 2013; Pluye and Hong 2014; Tricco et al. 2016; Whittemore and Knafl 2005). The SMSR methodology is a powerful tool for public health researchers to provide evidence on complex and multifaceted problems, with increased value and utility for a wide range of knowledge users. However, to maximize the benefit of the approach, the review's purpose and questions should drive the decision to conduct an SMSR, and the advantages of SMSR must be weighed with the previously discussed challenges, such as time and human resources trade-offs.

Funding This research is supported by Frederick Banting and Charles Best Canada Graduate Scholarship (HC) and the Canada Research Chairs Program (AQV).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Human and animal rights This research does not involve human participants and/or animals.

References

Bryman A (2006) Integrating quantitative and qualitative research: how is it done? Qual Res 6:97–113. https://doi.org/10.1177/1468794106058877

Crowe M, Sheppard L (2011) A general critical appraisal tool: An evaluation of construct validity. Int J Nurs Stud 48:1505–1516. https://doi.org/10.1016/j.ijnurstu.2011.06.004

Dixon-Woods M, Agarwal S, Jones D, Young B, Sutton A (2005) Synthesising qualitative and quantitative evidence: a review of possible methods. J Health Serv Res Policy 10:45–53. https://doi.org/10.1177/135581960501000110

Frantzen KK, Fetters MD (2016) Meta-integration for synthesizing data in a systematic mixed studies review: insights from research on autism spectrum disorder. Qual Quant 50:2251–2277. https://doi.org/10.1007/s11135-015-0261-6

Green S, Higgins JPT, Alderson P, Clarke M, Mulrow CD, Oxman AD (2011) Chapter 1: introduction. In: Higgins JPT, Green S (eds) Cochrane handbook for systematic reviews of interventions version 5.1.0 (updated March 2011). The Cochrane Collaboration, London

Harden A, Thomas J (2005) Methodological issues in combining diverse study types in systematic reviews. Int J Soc Res Methodol 8:257–271. https://doi.org/10.1080/13645570500155078

Heyvaert M, Maes B, Onghena P (2013) Mixed methods research synthesis: definition, framework, and potential. Qual Quant 47:659–676. https://doi.org/10.1007/s11135-011-9538-6

Heyvaert M, Hannes K, Onghena P (2017) Using mixed methods research synthesis for literature reviews. SAGE mixed methods research series. SAGE Publications Inc., Thousand Oaks

Higgins JPTAD, Sterne JAC (2011) Chapter 8: assessing risk of bias in included studies. In: Higgins JPTGS (ed) Cochrane handbook for systematic reviews of interventions version 5.1.0 (updated March 2011). The Cochrane Collaboration, London

Hong QN, Pluye P (2018) A conceptual framework for critical appraisal in systematic mixed studies reviews. J Mix Methods Res. https://doi.org/10.1177/1558689818770058

Hong QN, Pluye P, Bujold M, Wassef M (2017) Convergent and sequential synthesis designs: implications for conducting and reporting systematic reviews of qualitative and quantitative evidence. Syst Rev 6:61. https://doi.org/10.1186/s13643-017-0454-2

Lizarondo L et al (2017) Chapter 8: Mixed methods systematic reviews. In: Aromataris E, Munn Z (eds) Joanna Briggs institute reviewer's manual. The Joanna Briggs Institute, Adelaide

Lockwood C, Munn Z, Porritt K (2015) Qualitative research synthesis: methodological guidance for systematic reviewers utilizing meta-aggregation. Int J Evid Based Healthc 13:179–187. https://doi.org/10.1097/XEB.0000000000000062

Mays N, Pope C, Popay J (2005a) Systematically reviewing qualitative and quantitative evidence to inform management and policy-making in the health field. J Health Serv Res Policy 10:6–20

Mays N, Pope C, Popay J (2005b) Systematically reviewing qualitative and quantitative evidence to inform management and policy-making in the health field. J Health Serv Res Policy 10(Suppl 1):6–20. https://doi.org/10.1258/1355819054308576

Pluye P, Hong QN (2014) Combining the power of stories and the power of numbers: mixed methods research and mixed studies reviews. Annu Rev Public Health 35:29–45. https://doi.org/10.1146/annurev-publhealth-032013-182440

Pluye P, Gagnon MP, Griffiths F, Johnson-Lafleur J (2009) A scoring system for appraising mixed methods research, and concomitantly appraising qualitative, quantitative and mixed methods primary studies in mixed studies. Rev Int J Nurs Stud 46:529–546. https://doi.org/10.1016/j.ijnurstu.2009.01.009

Pluye P, Hong QN, Vedel I (2016) Toolkit for mixed studies reviews (V3). Department of Family Medicine, McGill University, and Quebec-SPOR SUPPORT Unit. http://toolkit4mixedstudiesreviews.pbworks.com. Accessed 5 Sep 2019

Sandelowski M, Voils CI, Barroso J (2006) Defining and designing mixed research synthesis studies. Res Sch 13:29

Tricco AC et al (2016) Knowledge synthesis methods for integrating qualitative and quantitative data: a scoping review reveals poor operationalization of the methodological steps. J Clin Epidemiol 73:29–35. https://doi.org/10.1016/j.jclinepi.2015.12.011

Whittemore R, Knafl K (2005) The integrative review: updated methodology. J Adv Nurs 52:546–553. https://doi.org/10.1111/j.1365-2648.2005.03621.x