

Meta-integration for synthesizing data in a systematic mixed studies review: insights from research on autism spectrum disorder

Kirsten Krabek Frantzen¹ · Michael D. Fetters²

© Springer Science+Business Media Dordrecht 2015

Abstract Systematic reviews conducted using either meta-analysis or meta-synthesis are well established methodological procedures for combining data and results across different quantitative or qualitative studies. Recently, a third option for systematic reviews has emerged. Systematic mixed studies reviews combine data and results across quantitative, qualitative and mixed method studies. An important challenge is how to integrate the quantitative, qualitative and mixed method studies. Here, we introduce the concept of “meta-integration”. Our overarching aim is to define and illustrate the novel concept of meta-integration as applied to convergent systematic mixed studies reviews using examples from our research on parental self-perception and autism spectrum disorder. Specifically, we present a typology for meta-integration procedures at two levels, both basic and advanced meta-integration. Three models, namely, basic convergent meta-integration, basic convergent qualitative meta-integration, and basic convergent quantitative meta-integration, combine quantitative and qualitative studies. Three additional models, namely, advanced convergent qualitative meta-integration, advanced convergent qualitative meta-integration, and advanced convergent quantitative meta-integration, combine quantitative, qualitative and mixed method studies. The models generally follow six steps: (1) categorize data sources; (2) transform the data; (3) conduct intra-method synthesis; (4) conduct inter-method synthesis and/or integration; (5) organize results and assess fit; and (6) draw final conclusions. One basic and one advanced model do not involve data transformation. These models for conducting convergent meta-integration in systematic mixed studies reviews provide guidance for researchers to apply rigorous and coherent methodology. Following these procedures can substantively improve the quality of systematic reviews seeking to use quantitative, qualitative and mixed method studies.

✉ Kirsten Krabek Frantzen
kirfrant@rm.dk

¹ Regional Center for Child and Adolescent Psychiatry, Research Unit, Aarhus University Hospital, Risskov, Skovagervej 2, 8240 Risskov, Aarhus, Denmark

² Department of Family Medicine, University of Michigan, 1018 Fuller St., Ann Arbor, MI 48104-1213, USA

Keywords Review · Methodology · Mixed studies · Mixed method · Synthesis · Meta-integration

1 Introduction

Clinicians and researchers can benefit greatly from synthesizing results across a series of papers using different methods rather than using single methods papers. Moreover, researchers embarking in a new field of research frequently need to thoroughly explore the extant literature systematically in order to gain a comprehensive understanding of the field or a specific phenomenon. Known as systematic reviews, researchers must intentionally employ distinct procedures to bring a series of papers together meaningfully and scientifically. Two widely known synthesis approaches to systematic reviews are meta-analysis using quantitative (QUAN) methods (Higgins and Green 2011) and meta-synthesis (a.k.a. metasynthesis) using qualitative (QUAL) methods (Sandelowski et al. 1997; Jenson and Allen 1994). Both have well defined references and standardized procedures for producing systematic reviews. In this paper, we introduce the notion of meta-integration as a procedure to fully integrate findings from QUAN, QUAL and mixed methods (MM) studies.

With the growth of the modern field of MM research, there have come new opportunities and challenges for approaching systematic reviews. MM research methodology identifies procedures for incorporating QUAL and QUAN data and/or results and/or methods (Creswell and Plano Clark 2011). The field has been evolving rapidly since around the turn of the twenty first century. There are a growing number of empirical papers that have used MM procedures and have been published. Moreover, there is considerably more agreement about the nomenclature for designs than even a decade ago. Consequently, a third option for systematic reviews—one that includes systematically reviewing and synthesizing QUAL, QUAN, and MM papers—has emerged (Pluye and Hong 2014; Heyvaert et al. 2013; Sandelowski et al. 2006). In the course of doing a systematic review on parental self-perception and autism spectrum disorder with the intent of synthesizing QUAL, QUAN and MM papers, we found confusion about the nomenclature for this approach. In addition, while several papers addressed procedures organizing a systematic review study, all of these lacked practical guidance on steps and principles for actually integrating QUAL, QUAN and MM data.

To address this gap in the literature, the overarching purpose of this paper is to define and illustrate the novel concept of meta-integration as applied to convergent systematic mixed studies reviews using examples from our research on parental self-perception and autism spectrum disorder. Specifically, we review relevant methodological literature, we present basic information related to systematic review methods, we provide reasons why meta-integration is necessary and illustrate these points by reporting our experiences and lessons learned with meta-integration in the systematic review on autism spectrum disorder, and finally we present a typology for meta-integration procedures at two levels, both basic and advanced meta-integration. The concept of systematic mixed studies reviews is defined as the synthesis of data or results from studies with diverse designs (Grant and Booth 2009; Pluye et al. 2009; Pluye and Hong 2014).

Our focus in this paper is not to describe all systematic review methods, nor to describe in detail the many steps needed in all systematic reviews. Many components of a systematic review, namely, formulating a research question, defining eligibility criteria,

applying an extensive search strategy, selecting relevant papers, critically appraising the included studies, extracting data, and synthesizing the data to develop the results, are relevant for all studies. Our focus is on characterizing the distinct features, and procedures for building upon these common features to conduct a meta-integration. We do provide sufficient information about review methods for the reader to understand the context of the final step, synthesis.

2 Review of relevant methodological literature

The existing literature related to systematically reviewing and synthesizing QUAL, QUAN and MM research falls into two categories: methodological issues relative to conducting systematic reviews (see below) and previously conducted empirical systematic review papers (Wang and Yeh 2012; Carr et al. 2011; Coles et al. 2012; Lakshman et al. 2009; Lewis et al. 2010; Kennedy et al. 2012; Belanger et al. 2011; Classen and Lopez 2006).

2.1 Literature guiding systematic review of QUAL, QUAN, and MM papers

Here, we focus on literature relative to methodological issues when conducting a systematic review of QUAL, QUAN and MM papers. In 2005 Whittemore and Knafl published a paper presenting the concept of *integrative reviews* that brought together the combination of diverse methodologies in one review (Whittemore and Knafl 2005). The work of Whittemore and Knafl (2005) contributed to the idea of combining varied perspectives on a phenomenon and was related to previous work from Cooper and Cooper (1998) and Kirkevold (1997). Whittemore's paper explains that the 'data analysis stage' of an integrative review requires, that "data from primary sources are ordered, coded, categorized, and summarized into a unified and integrated conclusion about the research problem" (Whittemore and Knafl 2005, p. 550). Since the method of data analysis in the Whittemore et al. paper was inspired by Miles and Huberman 'Qualitative Data Analysis' (Miles and Huberman 1994) the stages of data analysis in an integrative review consists of data reduction, data display, data comparison, conclusion drawing, and verification (Whittemore and Knafl 2005). Even though the integrative review allows inclusion of experimental and non-experimental research and may combine theoretical as well as empirical literature (Whittemore and Knafl 2005), no specific designs for integration of QUAN and QUAL methods were presented. Still, the method of data analysis gave a hint about elements of relevant synthesis procedures as "synthesis of important elements or conclusions of each subgroup into an integrated summation of the topic or phenomenon" was emphasized (Whittemore and Knafl 2005).

In 2006 Sandelowski et al. published a perceptive paper introducing *mixed research synthesis* and addressing the intention to integrate QUAN and QUAL papers in a shared domain of empirical research in systematic reviews (Sandelowski et al. 2006). They introduced three different designs for integration: (1) segregated design, (2) integrated design and, (3) contingent design. In the segregated design the analysis and synthesis of the findings are done separately within the QUAN and QUAL methods, respectively. In the integrated design a researcher conducts a joint MM analysis and synthesis of the findings from the two methods. Finally in the contingent design either mono or MM analysis and synthesis are conducted and followed by further mono or MM analysis and synthesis. The importance of this work from a methodological perspective is that Sandelowski et al.

(2006) introduce the idea for systematically including QUAL and QUAN from a theoretical perspective.

In 2013 Heyvaert et al. described a framework for *mixed methods research synthesis*. Heyvaert et al. (2013) present 18 different classifications based on three dimensions: (1) sequential or concurrent integration, (2) dominant or equal status, and (3) partial or full integration. The Heyvaert et al. (2013) paper illustrates the different designs and synthesis procedures through two different hypothetical applications. In the first, one would “systematically review all available primary level studies on treatment X for a specific target group in order to thoroughly answer the question ‘*what is it about this intervention that works (and does not work), for whom, in what circumstances, in what respects, and why?*’” (original authors’ italics) (Heyvaert et al. 2013, p. 668). In the second application, the purpose would be “to determine which interventions for challenging behavior among persons with intellectual disabilities produce which effects, moderated by which variables.” (Heyvaert et al. 2013). In both depictions, Heyvaert et al. (2013) focus on assessing interventions.

In 2014 Pluye and Hong (2014) published a classification that they refer to as *systematic mixed studies reviews*. Like the Sandelowski et al. (2006) and Heyvaert et al. (2013) articles, the Pluye and Hong (2014) classification system also addresses how to utilize QUAN, QUAL and MM articles in systematic reviews (Pluye and Hong 2014). Moreover, both the Heyvaert et al. (2013) and Pluye and Hong (2014) classification systems follow widely accepted MM design models (Creswell and Plano Clark 2011). While similar in their approaches to classification, Heyvaert et al. (2013) use a classification strategy with 18 different designs. In contrast, Pluye and Hong (2014) have organized these as three different basic designs, namely, sequential explanatory, sequential exploratory and convergent. In a sequential explanatory design, phase one is a QUAN synthesis that is followed and informed by a second phase of a QUAL synthesis. In a sequential exploratory design, phase one is a QUAL synthesis that is followed and informed by a second phase, a QUAN synthesis. Both the sequential designs correspond to the Sandelowski et al. (2006) contingent design. A convergent design involves a parallel QUAN or QUAL synthesis of all the papers. The convergent design corresponds to both the segregated and integrated design from Sandelowski et al. with the difference being whether or not the analysis and synthesis are conducted separately or are integrated. In our view, the Sandelowski et al. (2006) typology has been superseded by using accepted terminology and classifications from the field of MM. While exhaustive and precise, the Heyvaert et al. (2013) typology is unnecessarily complicated. In addition, there remains disagreement about whether designs should be distinguished by predominant type or intent, e.g., QUAN or QUAL. We think it may be splitting hairs more than is necessary as the narrative synthesis community works to achieve a common understanding of terms and concepts. By sticking with the three widely known designs, the Pluye and Hong (2014) approach focuses on the overarching similarities, and thus provides a more unified framework and parlance for most readers. In addition, Whittemore and Knafl (2005) did not refer to any specific designs for integration of QUAN and QUAL papers and used the nomenclature of methodologies instead of a nomenclature related to MM. While Heyvaert et al. (2013) offer highly comprehensive references to theoretical and methodological articles covering various aspects of synthesis (e.g., Sandelowski et al. 2006; Chalmers et al. 2002; Creswell and Tashakkori 2007; Dellinger and Leech 2007; Hart et al. 2009; Harden and Thomas 2005; Pluye et al. 2009; Voils et al. 2008; Sandelowski et al. 2009; Tashakkori and Teddlie 2010), no articles using MM research synthesis were identified by Heyvaert et al. (2013). While not referring to specific examples of mixed research synthesis Sandelowski et al. (2006) point out future

perspectives for constituting shared domains of research by referring to relevant primary level research (Buchanan 1992; Sivesind 1999). Pluye and Hong (2014) have found systematic review examples conducted based on MM principles.

Regarding additional methodological perspectives, the Cochrane Collaboration addresses the high level of complexities in systematic review and suggests that integration of QUAN and QUAL research can be accomplished by applying either a multilevel synthesis where synthesis can be conducted as separate streams and the product of each synthesis is then combined, or as a parallel synthesis where the product is used in parallel and juxtaposed alongside to aid interpretation (Higgins and Green 2011). While not comprehensive like the above four papers, additional methodological literature covers specific components or stages addressed by Heyvaert et al. (2013) and Pluye and Hong (2014). These fall primarily into three areas relative to systematically reviewing and synthesizing QUAL, QUAN, and MM papers. Five sources address the central aspect of combining and including QUAN and QUAL papers to frame the actual design of the review (The Joanna Briggs Institute 2014; Thomas et al. 2004; Harden et al. 2006; Dixon-Woods et al. 2005; Oliver et al. 2005). Seven sources address conceptualization of synthesizing opportunities (The Joanna Briggs Institute 2014; Thomas et al. 2004; Popay et al. 2006; Jones 2005; Pope et al. 2007; Pawson 2002; Lucas et al. 2007). Six sources address procedures of data transformation (Pope et al. 2007; Creswell and Plano Clark 2011; Tashakkori and Teddlie 2010; Teddlie and Tashakkori 2009; Miles et al. 2013; Greene 2007).

In short, Whitemore and Knafl (2005) highlights the advantage of comprehensive understanding of a phenomenon, Sandelowski et al. (2006) provide detailed information about differences in QUAN and QUAL synthesis procedures while Heyvaert et al. (2013), Pluye and Hong (2014) and Cochrane (Higgins and Green 2011) give detailed and practical guidance for essential decisions in relation to review methods. Despite the additional literature on specific steps, Whitemore and Knafl (2005), Sandelowski et al. (2006), Heyvaert et al. (2013) and Pluye and Hong (2014) cover the full spectrum of procedures. That said, a key limitation of all papers is the lack of critical detailed guidance for the synthesis procedures.

3 Systematic review methods

The role of synthesis procedures should be placed in the context of overall systematic review methods. The steps and basic principles of systematic reviews are based on decades of work by a multitude of researchers from disciplines across the world, specifically through the Cochrane (health sciences) and the Campbell (social sciences) collaborations including their working groups on systematic reviews of implementation studies (QUAN, QUAL and MM). These principles apply to all types of systematic reviews: qualitative reviews (reviews of qualitative research), quantitative reviews (reviews of quantitative studies) and systematic mixed studies reviews (reviews of quantitative, qualitative and MM studies). As there are numerous references books and publications on these principles, a full review of these procedures is beyond the scope of this paper. However, below we provide a summary of these steps to situate meta-integration procedures in the overall process of systematic review methods.

3.1 Searching, selecting and appraising the literature in preparation for synthesis

Regardless of the type of review, the initial procedures for all systematic reviews are similar and demand a highly systematic workflow where documentation of decisions at each stage of inclusion or exclusion is essential. Slightly different descriptions of review procedures relevant for systematic mixed studies reviews are available and they often differ in the number of stages involved. Whitemore and Knafel (2005) utilize five stages: (1) problem identification, (2) literature search, (3) data evaluation, (4) data analysis and (5) presentation. Sandelowski et al. (2006) outline an approach that incorporates four stages including: (1) identification of the research question, (2) retrieval of studies, (3) analysis of findings and (4) synthesis of findings. Heyvaert et al. (2013) incorporates six stages including: (1) problem identification and question formulation, (2) development of a review protocol and the literature search, (3) selection of an appropriate design and method, (4) data extraction and evaluation, (5) the data analysis and interpretation stage, and (6) reporting and discussing of research findings. The Pluye and Hong (2014) framework for conducting a systematic mixed studies review comprises seven stages including: (1) formulation of a review question, (2) definition of eligibility criteria, (3) application of an extensive search strategy, (4) identification of relevant studies, (5) selection of relevant studies, (6) quality appraisal of the included studies, and (7) synthesis of the literature. Suffice it is to say that regardless of which specific review procedures the researcher chooses, comprehensive review procedures must be strictly adhered to prior to and during synthesis.

For all systematic reviews, the stage of quality assessment merits elaboration. In relation to meta-integration quality assessment is particularly complicated. Even though different methods of quality assessment of papers are available, it is crucial in systematic reviews using meta-integration to identify a simple and uncomplicated tool that can assess the quality of MM papers and assess various types of QUAN and QUAL papers. The mixed methods appraisal tool (MMAT) (Pluye et al. 2011) considers all necessary elements for the different data sources, including the merged component of the MM papers. The MMAT tool differs from other quality assessment tools, such as the Critical Appraisal Skills Program (CASP) (CASP UK 2013) by providing guidelines for quality appraisal of the specific integration of the MM articles. Based on the quality assessment, the usual recommendation is to include all papers. A refinement of the synthesis can be conducted through a sub-analysis comparing the synthesis of the lower versus the higher quality papers and thereby strengthen the full synthesis. A final important comment about review methods is not to include other review papers, since reviews may contain articles already part of the initial search for the meta-integration. Incorporation of reviews risks choosing certain papers twice—both directly from the search and indirectly from the review.

4 Why mixed methods meta-integration is necessary?

Despite the pioneering work of Whitemore and Knafel (2005), Sandelowski et al. (2006), Heyvaert et al. (2013) and Pluye and Hong (2014) exploring procedures for systematic reviews when there are QUAL, QUAN and MM papers, a key gap in the literature has been the lack of practical methodological guidance on how to complete the synthesis and integrate data from QUAL, QUAN and MM. The importance of this gap became very clear

to us in the process of conducting a systematic mixed studies review *Parental Self-perception in the Autism Spectrum Disorder Literature: A Systematic Mixed Studies Review* (article under review). While conducting the project, we couldn't find guidance on how to do the integration. The procedures from Sandelowski et al. (2006), Heyvaert et al. (2013) and Pluye and Hong (2014) were insufficient. For example, questions arose as to how diverse types of findings, QUAL, QUAN and MM would be brought together, on what grounds should each choice be made, and what order should be followed in procedures of integration. It became apparent that the difficulty of the review content (parental self-perception and autism spectrum disorder) was minor compared to the methodological challenges we faced. Below, we explain how this unfolded and how it led to development of the concept of meta-integration and a typology of meta-integration procedures.

Table 1 Concepts related to meta-integration

Concept	Explanation	Basic meta-integration	Advanced meta-integration
Data	Retrieved information from included papers	✓	✓
Dataset	Collection of data from different papers	✓	✓
Evidence	Retrieved information from the integrated part of the MM papers		✓
Fractionation	The process by which QUAL data and evidence and QUAN data and evidence from MM papers are divided into distinct components		✓
Transformation	Procedure related to changing data format from QUAN → QUAL or QUAL → QUAN	✓	✓
Intra-method	Intra-method refers to remaining within method, e.g., analysis and synthesis of all QUAN papers conducted in parallel with analysis and synthesis of all QUAL papers	✓	✓
Inter-method	Inter-method denotes that there is a bringing together of data for analysis and synthesis of the datasets of the QUAN and QUAL strands	✓	✓
Analysis-synthesis	Iterative process of separating and combining results from single studies into overall findings across the dataset	✓	✓
Mindful comparison	Conscious and intentional consideration of the findings, commonalities and differences between the two datasets	✓	✓
Integration	Combining the QUAN and QUAL findings into a comprehensible format for interpretation	✓	✓
Meta-integration	Combining QUAN with QUAL paper, and if available MM papers, through procedures of separation according to the underlying type of data or evidence, synthesizing the data according to underlying type, conducting data transformation, mindful comparison and integrating the information to obtain the results and make final conclusions. Basic meta-integration does not include MM studies, whereas advanced meta-integration does include MM studies	✓	✓

4.1 Experiences and lessons learned from research on autism spectrum disorder

To explain the context of our systematic mixed studies review on parental self-perception and autism spectrum disorder we will generally outline the methodological steps in the review process though only in sufficient detail to illustrate the problems encountered, the choices made, and the thought processes guiding those choices. In our systematic mixed studies review, we used Pluye and Hong's (2014) seven stages as a framework and were further inspired by previous literature (Pluye and Hong 2014; Gough et al. 2012; Aveyard 2010).

To avoid confusion in describing our study, several definitions are needed (Table 1). In this paper 'data' refers to the information that is extracted from the included papers. 'dataset' refers to the combined data from grouped papers. 'Transformation' refers to procedures related to changing QUAN data into QUAL data or QUAL data into QUAN data. The procedure of 'analysis-synthesis' refers to the process when the researcher strives to find the overarching findings by elucidating the full complexity and patterns found cumulatively in each the QUAN and QUAL datasets. 'Integration' describes the bringing together of all the findings from the analysis-synthesis into a comprehensible format for interpretation. For the purposes of this paper 'analysis-synthesis' and 'integration' represent two different levels of combining. When the research has integrated findings from QUAN, QUAL and MM (when available) papers, meta-integration has been achieved. Two additional concepts related to more advanced designs are 'fractionation' and 'evidence'. 'Fractionation' is the process of dividing MM papers into QUAN 'data' and 'evidence' and QUAL 'data' and 'evidence'. 'Evidence' is the findings identified in the integrated part of MM papers. Finally 'mindful comparison' refers to a conscious and intentional consideration of the findings, commonalities and differences between the two datasets.

4.1.1 Parental self-perception in the autism spectrum disorder literature: a systematic mixed studies review

The purpose of our systematic mixed studies review was to: (a) systematically examine the psychological constructs of competence, control and self-efficacy and assess for any additional relevant constructs, and (b) to identify and review suitable parental self-report measures for each of the psychological constructs of importance. The nature of these research questions required clear eligibility criteria and an extensive and explorative search strategy. We chose the databases PubMed, Embase and PsycINFO. This work required specialist expertise and was therefore conducted in collaboration with a research-trained librarian.

In total, we identified 911 articles and through three stages of applying inclusion and exclusion criteria, we judged 53 articles to be relevant and included them in the review. The included articles were quality appraised using the MMAT (Pluye et al. 2011). A convergent QUAL synthesis was implemented (Pluye and Hong 2014). A QUAL synthesis occurs when QUAL, QUAN, and MM data are transformed into QUAL findings (Pluye and Hong 2014). As anticipated, the search and analysis ultimately identified new constructs, namely, coherence and self-esteem. We included papers with these constructs among the 53 study papers, as they were relevant according to the purpose of the review.

4.1.2 Confusion in naming conventions

A source of confusion apparent from the outset was the question: what is the name of a systematic review of QUAN, QUAL and MM papers? As the strategy of systematically reviewing and synthesizing QUAL, QUAN, and MM papers is new, it is not surprising that the field currently lacks agreement about nomenclature for such papers. Sandelowski et al. (2006) use *mixed research synthesis*, Heyvaert et al. (2013) use *mixed method research synthesis*, and Pluye and Hong (2014) use *systematic mixed studies review*. While the terminology differs, fundamentally the concepts behind Sandelowski et al. (2006) *mixed research synthesis*, Heyvaert et al. (2013) *mixed method research synthesis*, and Pluye and Hong's (2014) *systematic mixed studies review* are equivalent. As Pluye and Hong (2014) have articulated a compelling rationale for use of the term "systematic mixed studies review", we have thus followed that naming convention.

4.1.3 Challenges to categorization

Another source of confusion related to how to categorize various data sources. Several questions emerged, e.g., How to categorize the different QUAN, QUAL and MM papers?, How to create a collective overview of very diverse papers? and How to identify the important details of the papers? Categorization of the 53 included papers revealed 41 QUAN papers, 9 QUAL papers and 3 MM papers. Categorization is an extremely important step and must *not* be misconstrued as an easy step of just dividing the included papers into the QUAN, QUAL and MM categories. The description, specification, subdivision and classification in detail entailed a great amount of work and dictated the next steps in the synthesizing process. For example, categorization led to several significant decisions. One decision was that QUAL and QUAN data of the 3 MM papers would be separated and the MM papers thereby contributed to both the QUAN and QUAL datasets of the review through a process we now call fractionation (see below). Thus the QUAN data of the 3 MM papers were included with the 41 QUAN papers and the QUAL data of the 3 MM papers were included with the 9 QUAL papers.

In regard to the QUAN papers, the categorization also incorporated a further classification based on the psychological construct defined and explained by the purpose of the systematic mixed studies review. Categorizing the papers by the psychological constructs covered in the 41 QUAN papers and the QUAN part of the 3 MM papers resulted in 12 papers that covered competence, 7 that covered control, 17 that covered self-efficacy, 8 that covered coherence and 2 that covered self-esteem. Another pattern was that the 12 competence papers all used the same scale, the 7 control papers used 6 different scales, the 17 self-efficacy papers used 10 different scales, the 8 coherence papers used 3 different versions of the same scale and the 2 self-esteem papers used 2 different versions of the same scale. Combining this information in a spreadsheet with information about each paper led to an important decision regarding the psychological constructs. The careful process of categorization revealed that the constructs of competence, self-efficacy and self-esteem in the context of autism spectrum disorder overlapped to such an extent that they functioned as the same construct. Therefore self-efficacy and self-esteem were subsumed into the construct of competence and the categorization of the QUAN papers was guided by this decision. This led to three overarching constructs; competence, control and coherence.

In the case of the 9 QUAL papers and the QUAL data of the 3 MM papers, the QUAL papers utilized different words and more diverse terminology related to the constructs of

competence, control and coherence. Five papers were mostly related to competence and covered aspects of self, self-identity, personal growth and parenting competence. Four papers were mostly related to control and covered aspects of control and vigilance. Three papers were mostly related to coherence and covered aspects of coherence and sense making. The QUAL papers had more overlap. They contained and dealt with several associated elements of competence, control and coherence simultaneously. To prevent a narrowing of understanding, the decision was made to not forcibly categorize on a paper-by-paper basis the QUAL papers into same three overall constructs of the QUAN papers. Thus, all the QUAL papers informed the three constructs of competence, control and coherence.

4.1.4 Challenges to data transformation

Another challenge was how to actually integrate the data from the QUAN, QUAL and MM papers. Since there was a high degree of heterogeneity in the QUAN papers, meta-analysis or other QUAN analysis would be problematic, we conducted a convergent QUAL synthesis (Pluye and Hong 2014). The QUAL synthesis would systematically and comprehensively examine competence, control and coherence in relation to parents of children with autism spectrum disorder. However, doing so required data transformation of the QUAN data to QUAL data. The outcome of data transformation was creation of two QUAL datasets. This entailed data from QUAL papers remaining QUAL (represented as $QUAL = QUAL$), while data from the QUAN papers were transformed into QUAL data (represented as $QUAN \rightarrow QUAL$) The latter process involved identifying and extracting QUAL themes entailed in the QUAN papers to ensure correspondence and comparability between the QUAN and QUAL datasets. After data transformation extracted QUAL data from the QUAN dataset, the $QUAN \rightarrow QUAL$ and $QUAL = QUAL$ datasets were ready for the stage of integration.

4.1.5 Challenges to analysis and synthesis

A final point of confusion related to the analysis and synthesis of the QUAN, QUAL and MM papers. First we kept the QUAN and QUAL datasets separated and focused on identification of themes, refinement of details and finally synthesis and analysis respectively within the constructed QUAN and QUAL datasets. Having three different constructs competence, control and coherence, required that each construct should be identified and analyzed individually. This need complicated this stage of our systematic mixed studies review substantially. The maintenance of separate datasets for the $QUAN \rightarrow QUAL$ strand, and the $QUAL = QUAL$ strand ensured a thorough analysis and synthesis of the data within the $QUAL = QUAL$ and $QUAN \rightarrow QUAL$ strands. This gave us a deeper understanding about which themes were pivotal in relation in the $QUAN \rightarrow QUAL$ dataset and which themes were pivotal in the $QUAL = QUAL$ dataset. Careful analysis and synthesis of the $QUAL = QUAL$ and $QUAN \rightarrow QUAL$ datasets created new insights and knowledge about competence, control and coherence in relation to parents of children with autism spectrum disorder. Finally bringing together similar data from the $QUAN \rightarrow QUAL$ and $QUAL = QUAL$ datasets gave a full perspective and overview of the pivotal themes related to competence, control and coherence. This was first conducted for each of the constructs of competence, control and coherence separately to outline the themes central for each of the constructs. The results were organized into matrices for each of the constructs.

To examine and visualize the level of overlap between the three constructs we conducted a conceptual mapping of the pivotal themes from each of the constructs. Thereby it was possible to assess the level of fit between themes from the QUAN → QUAL and QUAL = QUAL datasets within each of the constructs and across the three constructs. The assessment of fit in this review was characterized as an expansion as the themes from the QUAN → QUAL and QUAL = QUAL datasets. The overarching QUAL themes addressed different aspects of competence, control and coherence and thereby expanded the understanding of these constructs.

Based on these procedures, we concluded that competence, control and coherence were three vitally important concepts for understanding parents of children with autism spectrum disorder. Moreover, the systematic review and synthesis procedures demonstrated that there was a need for a more unified and elegant conception and nomenclature of psychological constructs based upon the overarching concept of self-perception.

Given the experience gained and the challenges faced by conducting this systematic review of QUAN, QUAL and MM papers it became clear that there were additional steps NOT previously described in the literature, and that there were additional possibilities for integration depending on whether or not there were MM studies to include with the QUAL and QUAN studies, whether any identified MM studies had integrated QUAL and QUAN study data together, and what kind of data transformation had occurred. As the process involved required multiple steps and new lexicon, we coined the term meta-integration. This was to distinguish it from meta-analysis that focuses on analysis of QUAN studies, and to distinguish from meta-synthesis that focuses on analysis of QUAL studies. In mapping out the various iterations of meta-integration procedures, we developed six visual models for depicting the different steps, and thus a typology of meta-integration procedures. The meta-integration procedures differ by whether MM studies are available, whether there are data transformation procedures and finally, whether the data transformation is from QUAL → QUAN or QUAN → QUAL.

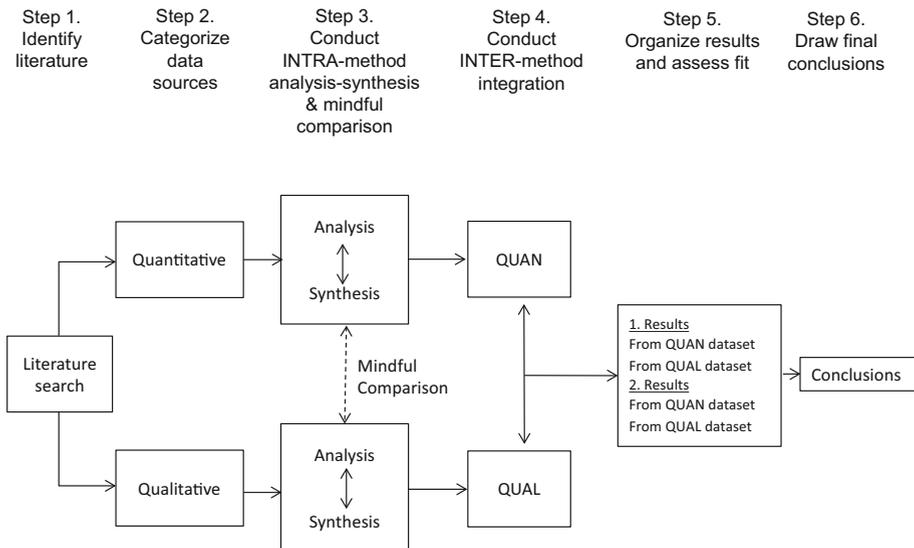


Fig. 1 Basic convergent meta-integration

5 A typology for mixed methods meta-integration

While initially it seemed that it was only the synthesis procedures that were problematic, there were additional, previously undescribed steps needed. Specifically, there were unique procedures for separating the data into component parts, bringing the data together into datasets, analyzing datasets based on QUAN and QUAL origins, and ultimately bringing those two strands together. Based on our experience with parental self-perception and autism spectrum disorder, and systematic considerations of potential integration procedures, we present below a typology for meta-integration. There are three basic convergent meta-integration procedures applicable when MM studies are not available or used, and three advance convergent meta-integration procedures applicable when MM studies are utilized.

5.1 Basic convergent meta-integration

When conducting a meta-integration, there are three categories of papers that are potentially available, namely, QUAN, QUAL, and MM. When MM literature is not available or simply not included, researchers can conduct a basic convergent meta-integration (Figs. 1, 2, 3).

There are three approaches to a basic convergent meta-integration. A key procedure in meta-integration is the use of data transformation, the process of transforming one type of data into the other, e.g., QUAL data are transformed into a QUAN format, or QUAN data are transformed to a QUAL format. When there is no data transformation, researchers conduct a convergent meta-integration (Fig. 1). When data transformation occurs, there can be a qualitative convergent meta-integration using synthesis (QUAL data remain as QUAL data $QUAL = QUAL$ and QUAN data are transformed to QUAL data $QUAN \rightarrow QUAL$ -Fig. 2) or a quantitative convergent meta-integration using synthesis (QUAN data remain as QUAN data, and QUAL data are transformed to QUAN data-Fig. 3). To date, regardless of design, the most common approach to integration of QUAN,

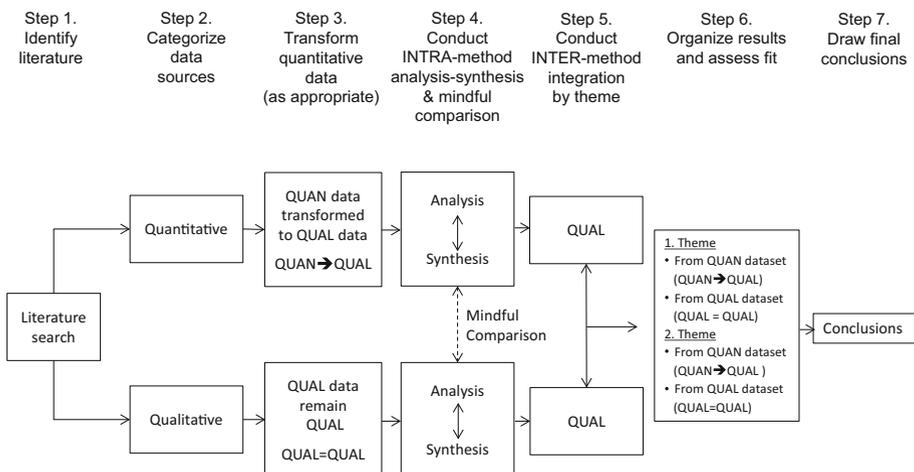


Fig. 2 Basic convergent QUALITATIVE meta-integration

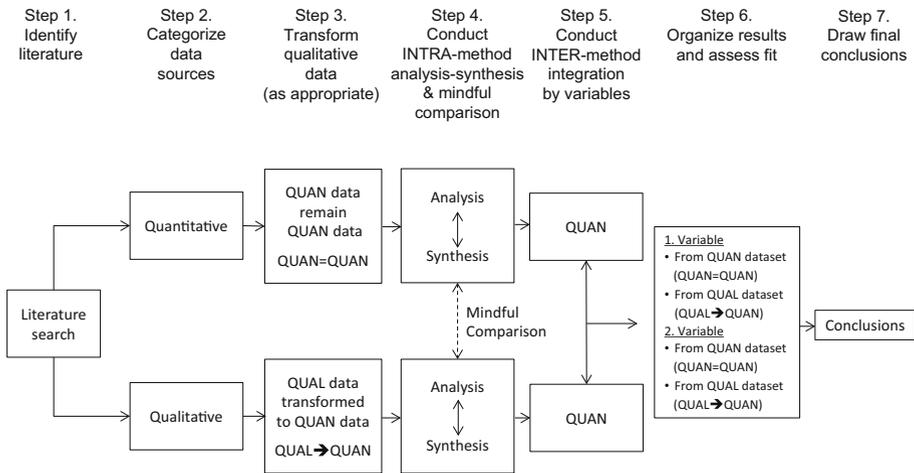


Fig. 3 Basic convergent QUANTITATIVE meta-integration

QUAL and MM papers are studies without data transformation procedures. Rather synthesis is conducted as a final integration of the overall QUAN and QUAL findings in the discussion as illustrated by a convergent review (Fig. 1) (Wang and Yeh 2012; Lewis et al. 2010; Kennedy et al. 2012; Coles et al. 2012; Lakshman et al. 2009) or separately with either a sequential approach consistent with the exploratory design (Rosewilliam et al. 2011; Pluye et al. 2005) or explanatory design (Classen and Lopez 2006). The overall steps for a basic convergent synthesis and how they differ by model follow below.

5.1.1 Identify literature

An exhaustive search in relevant databases (Step 1) must be conducted, often with a research-trained librarian to ensure uniformity and stringency with the search strategy. Since this step relates to systematic literature review procedures covered well elsewhere, further discussion is beyond the scope of this paper.

5.1.2 Categorize data sources

After a meticulous literature search, the first step of a convergent meta-integration is to segregate and categorize the papers into QUAN papers and QUAL papers. This breakdown provides researchers an overview of the heterogeneity of all the papers. A brief description of each study with information about purpose, number of participants, study design, methodology, analysis and results recorded in a spreadsheet provides an invaluable organizational tool. This is step 2 in all basic designs (Figs. 1, 2, 3).

5.1.3 Transform the data

In a basic convergent meta-integration data transformation does not apply (Fig. 1), but it does apply for basic convergent qualitative meta-integration (Fig. 2) and a basic convergent quantitative meta-integration (Fig. 3). There are two generally accepted approaches to data integration using data transformation, namely, QUAL integration and QUAN

integration. While these techniques were mostly developed for primary research, they can be applied readily in systematic mixed studies reviews. Full details of these approaches are beyond the scope of the current paper, but are summarized here to illustrate for the reader various types of procedures that can be used and the type of outcome produced (Table 2).

5.1.3.1 Quantitative to qualitative data transformation (QUAN → QUAL) In a QUAL synthesis, QUAN data are transformed into QUAL data and integrated with QUAL data. This can be depicted as QUAN + QUAL data → QUAL. For example, in our systematic review on parental self-perception and autism spectrum disorder, QUAN data (and “evidence”-see below), the three constructs from the QUAL literature review were used as themes to fit with the QUAL findings, and the breadth of the QUAL findings were used to illustrate the breadth of meaning. There are at least four approaches to QUAN → QUAL data transformation, for example, thematic analysis producing themes (Boyatzis 1998) critical interpretative synthesis producing frameworks (Dixon-Woods et al. 2006) meta-narrative synthesis developing storylines (Greenhalgh et al. 2005) and realist synthesis producing theory (Pawson et al. 2005). The autism spectrum disorder data transformation used thematic analysis (Boyatzis 1998; Thomas and Harden 2008).

5.1.3.2 Qualitative to quantitative data transformation (QUAL → QUAN) In QUAN synthesis, QUAL data are transformed into QUAN data and integrated with QUAN data to produce a QUAN synthesis. This can be depicted as QUAN + QUAL data → QUAN variables. There are at least three approaches, for example, content analysis producing variables (Krippendorff 2004; Neuendorf 2002) Bayesian analysis producing probabilities (Roberts et al. 2002; Voils et al. 2009) and Boolean analysis producing configurations. (Rihoux and Ragin 2009; Rihoux et al. 2013; Rivard and Lapointe 2012).

Table 2 Techniques for data transformation

Qualitative methods	Description	Product
(QUAL + QUAN → QUAL)		
Thematic analysis	To identify patterns through the process of coding and describe a relevant phenomenon or associations	Themes
Critical interpretive synthesis	To develop new theoretical models to provide a comprehensive understanding	Framework
Meta-narrative synthesis	To establish concepts through a process of identifying different theories from different disciplines	Storylines
Realist synthesis	A theory-driven evaluation of public health interventions and programs	Theory
(QUAL + QUAN → QUAN)		
Content analysis	Reducing large amount of textual data into a small number of variables	Variables
Bayesian	Measuring the probability of an association between two variables	Probabilities
Boolean	To identify commonalities in the relationships between conditions and outcomes across studies, referred to as configurations	Configurations

Including QUAN and QUAL papers in a review facilitates comprehensive conceptualization of the phenomenon being analyzed. The process of data transformation creates two datasets, one each from the QUAN and QUAL research methodologies that can be compared. As the model of convergent meta-integration (Fig. 1) does not transform data, the data transformation step is skipped. In convergent meta-integration with data transformation, the transformation occurs in two ways.

In QUAL transformation (Fig. 2), QUAL thematic analysis is conducted where QUAN data are converted into QUAL themes and patterns, i.e., $\text{QUAN} + \text{QUAL data} \rightarrow \text{QUAL themes}$ (Wang and Yeh 2012; Carr et al. 2011; Coles et al. 2012; Lakshman et al. 2009; Lewis et al. 2010; Kennedy et al. 2012; Belanger et al. 2011). In one common approach, QUAN variables are converted into QUAL themes by utilizing descriptive conclusions from the QUAN papers without using the numeric results.

In QUAN transformation (Fig. 3), QUAN content analysis (Krippendorff 2004; Pope et al. 2007) is conducted where QUAL data are converted into QUAN variables, i.e., $\text{QUAN} + \text{QUAL data} \rightarrow \text{QUAN variables}$, see for example (Sandelowski et al. 2009; Pope et al. 2007; Classen and Lopez 2006). QUAL themes can be converted into QUAN variables by rigorously applying counting strategies with the specific intent to generate numeric results (Pope et al. 2007). Data transformation ensures that the researcher has two datasets with a corresponding format categorized by the research methodology the data were collected under and allows for initial intra-method synthesis.

5.1.4 Conduct intra-method analysis and synthesis

During the iterative intra-method analysis and synthesis the researcher synthesizes all the QUAN papers with each other, and synthesizes all the QUAL papers with each other. Intra-method refers to remaining within method, e.g., analysis and synthesis of all QUAN papers conducted in parallel with analysis and synthesis of all QUAL papers. This approach ensures that a separate overview is created for each of the QUAN and QUAL datasets. Synthesis brings together the main findings from the respective datasets and combines results and/or interpretations to create a new connected and summative whole among all the QUAL papers, and among all the QUAN papers. The iterative synthesis occurs simultaneously with the analytic process as results and interpretations of the data are deconstructed and separated into their previous state before being recombined. The iterative synthesis-analysis process is needed to create new perceptions and knowledge of research phenomenon.

Even though the two datasets from both the QUAN and QUAL methods are not yet integrated at this step, the researcher cannot disentangle thinking about the emerging findings from the two respective QUAN and QUAL synthesis-analysis procedures. This thinking can occur at a sub-conscious level, and it is possible one could actively try and remain “objective”, though we think this is difficult and probably not meaningful. Rather, we propose a “mindful comparison” as the two intra-method syntheses occur. As illustrated by the dashed, two-headed arrow in Figs. 1, 2, 3, “mindful comparison”, is the process of conscious and intentional consideration of the findings, commonalities and differences between the two constructed QUAL and QUAN datasets and ultimately how they relate to each other. This process lays the intellectual groundwork for the subsequent inter-method synthesis. For illustration purposes, we have listed only two examples of integrated data in Figs. 1, 2, 3 under the organize results and assess fit, but the range could be one to multiple (probably no more than 5–7) depending on the individual study.

5.1.5 Conduct inter-method integration

The iterative intra-method analysis and synthesis, is followed by iterative inter-method integration. Inter-method denotes that there is a bringing together of data for analysis and synthesis of the datasets from the QUAN and QUAL strands. While demarcated as two steps, namely 3 and 4 in Fig. 1, and steps 4 and 5 in Figs. 2, 3, in reality this process is a gradual, iterative transition from intra-method analysis and synthesis to inter-method synthesis and integration. Though iterative, *completing* the intra-method analysis and synthesis before moving to the inter-method analysis and synthesis is important for comprehending the data attributable respectively with QUAN and QUAL methods. The intra-method analysis and synthesis in our review taught us that the QUAN papers presented more objective themes relating to presence or absence of disorder, stability of constructs and associations to other related variables. The QUAL papers presented more subjective examples of experience, e.g. vigilant overseeing social situations, values and beliefs and different perceptions of abilities in relation to the parental role. An understanding of each separate area was essential before integrating the results across the QUAN

Table 3 Display of integration

Type	Model	Concept	QUAN	QUAL	MM	Integration		
Basic convergent meta-integration	Convergent SMSR integration	Topic 1	Variable	Theme		Conclusion based on variables and themes		
			Variable	Theme				
		Topic 2	Variable	Theme				
			Variable	Theme				
	Convergent QUAN synthesis	Topic 1	Variable	Variable		Conclusion based on variables		
			Variable	Variable				
		Topic 2	Variable	Variable				
			Variable	Variable				
	Convergent QUAL synthesis	Topic 1	Theme	Theme		Conclusion based on themes		
Theme			Theme					
Topic 2		Theme	Theme					
		Theme	Theme					
Advanced convergent meta-integration	Convergent SMSR integration with MM papers	Topic 1	Variable	Theme	Variable	Conclusion based on variables and themes		
			Variable	Theme	Variable			
		Topic 2	Variable	Theme	Theme			
			Variable	Theme	Theme			
		Convergent QUAN synthesis with MM papers	Topic 1	Variable	Variable		Variable	Conclusion based on variables
				Variable	Variable		Variable	
	Topic 2		Variable	Variable	Variable			
			Variable	Variable	Variable			
	Convergent QUAL synthesis with MM papers	Topic 1	Theme	Theme	Theme	Conclusion based on themes		
			Theme	Theme	Theme			
		Topic 2	Theme	Theme	Theme			
			Theme	Theme	Theme			

SMSR Systematic mixed studies review

and QUAL datasets. This was important because we needed to fully understand the justification behind each of the results before the inter-method integration could proceed.

These steps are particularly challenging as integration approaches change depending on MM design used, e.g., sequential or convergent (Fetters et al. 2013). In the convergent meta-integration with integration model, as the two constructed datasets are in different formats, namely, QUAN and QUAL, synthesis is not performed, and Step 4 only involves integration (Fig. 1). For the other two models, the inter-method synthesis involves bringing together the synthesized $QUAL = QUAL$ data and transformed and synthesized $QUAN \rightarrow QUAL$ data (Fig. 2), and the synthesized $QUAN = QUAN$ data and $QUAL \rightarrow QUAN$ data (Fig. 3) by constantly cross-checking, connecting and co-informing each other. This iterative and dynamic process ensures the final synthesis is based on results from both the QUAN and QUAL papers, and the process can create new insights and knowledge. For example, in our parental self-perception and autism spectrum disorder research, we found that parents' psychological resources potentially have substantial impact on major decisions parents makes about their child with autism spectrum disorder. Synthesizing and integrating is time-consuming and requires meticulous attention to process, curiosity and an open-minded approach to new associations and constellations.

A useful tool for the integration process is the production of joint displays that provide an overview of complex inter-relational connections (Table 3). Joint displays can take many forms and shapes, and should be adapted to the purpose of review and research questions. In the authors' experience, the development of joint displays goes through several iterations, and it is during these refinements that insights about the data emerge. Joint displays can support and foster a better understanding of disparate data during the analytic phase while also having utility when finalized for presentation or publication. Throughout, persistence is a must given the voluminous data that must be comprehended and integrated using this organic analytic process.

5.1.6 Organize results and assess fit

Inter-method analysis and synthesis is followed by organization and assessment of fit. Organization refers to the comprehensive arrangement of the data for final presentation. As in Steps 3–4 in Fig. 1 and Steps 4–5 Figs. 2 and 3, the transition from integration to organization will be a process that is iterative (Step 5–6 in Fig. 1 and Step 6–7 in Figs. 2, 3). Here organization refers to the final, comprehensive grouping of the data for presentation of the end product. A critical component of the organization process involves back-tracking and ascertainment of the origins of the data with full clarity and accountability. By back-tracking, we mean a constant effort to keep track of each statement that leads to a conclusion. It should be noted that the inter-method synthesis involves bringing together the synthesized $QUAL = QUAL$ evidence and the transformed and synthesized $QUAN \rightarrow QUAL$ evidence for a basic convergent qualitative meta-integration (Fig. 2), and the synthesized $QUAN = QUAN$ evidence and $QUAL \rightarrow QUAN$ evidence for a basic convergent quantitative meta-integration (Fig. 3).

One final aspect of organization is the evaluation of “fit” (Fetters et al. 2013). Fit examines concordance between the findings of integrated datasets. If there are similar results and conclusions, there is confirmation. If the results contradict each other, there is discordance. If the results address different aspects of the phenomenon, there is expansion. Reflections about and arguments for the “fit” of integration not only strengthen the quality of the conclusions but also may produce hypotheses for future research. In our parental self-perception and autism spectrum disorder example, the fit between the QUAN, QUAL

and MM papers demonstrated an expansion of understanding as the papers were addressing different aspects and expanding the understanding of the constructs.

5.1.7 Draw final conclusions

Having ventured through the synthesis/integration and organization procedures, the researcher will draw final conclusions (step 6 of Fig. 1, and step 7 of Figs. 2, 3) based on all the included papers. Rather than just reiterating the specific findings, the conclusions should be presented synthetically and focus on what new information has been learned, based on the convergent meta-integration findings. An important notion is that even though the steps are presented as demarcated, the actual process between the steps is gradual and iterative.

5.2 Advanced convergent meta-integration

While there remain very few MM papers in some fields, with the recent growth in MM methodology and empirical research, an increasing number of fields now have genuine MM publications with integrated data, often times, integrated data based on a data transformation procedure. With the advances in MM research applications, it is safe to say that the number of high-quality MM publications is likely to grow rapidly in many fields. With the ever-increasing number of empirical MM papers either published or already underway, the possibility of an even more advanced type of systematic review using meta-integration emerges. Advanced meta-integration models need to be developed that can accommodate QUAN, QUAL and MM papers. When MM papers are of sufficient number and quality, the possibility of researchers conducting advanced convergent MM designs

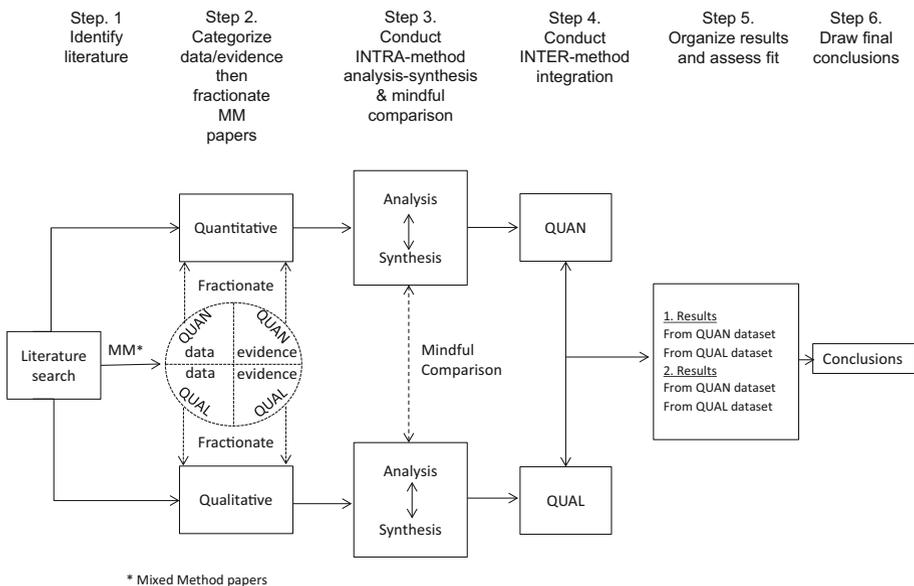


Fig. 4 Advanced convergent meta-integration

will become a reality. By definition, basic meta-integration does NOT include MM papers, while advanced meta-integration includes QUAN, QUAL, and MM papers.

As advanced designs include MM papers as well as QUAN and QUAL papers, a note of caution is needed. Authors might not describe some papers as MM research even though they meet criteria as a MM research paper. Conversely, a paper classified by the authors as MM research may only marginally meet criteria for an MM study since QUAN and QUAL conclusions are presented separately without evidence for integration. We advise researchers use papers based on the actual approach rather than the approach reported by authors when mis-representation has occurred.

Figures 4, 5, and 6 illustrate conceptually advanced meta-integration. All are respective extensions of the logic of the three already introduced basic models of convergent meta-integration in Figs. 1, 2, and 3. Thus, the three approaches to advanced convergent meta-integration parallel the basic designs. When there is no data transformation, researchers conduct an advanced convergent meta-integration (Fig. 4). When data transformation occurs, there are two options. There is an advanced QUAL convergent meta-integration when there is integration of synthesized QUAL = QUAL data and evidence and transformed and synthesized QUAN → QUAL data and evidence (Fig. 5). There is an advanced QUAN meta-integration when there is integration of the synthesized QUAN = QUAN data and evidence and QUAL → QUAN data and evidence (Fig. 6). The overall steps for the advanced designs of convergent meta-integration procedures are similar to the basic designs but there are some important distinctions. The critical difference is that the advanced designs incorporate MM papers.

As there are many different ways of conducting and presenting MM research results the inclusion of MM papers complicates the explanation of the meta-integration. However, a basic principle applying to all types of articles including MM papers is that data and results are presented either in a QUAN or QUAL frame or format. Therefore the difference between MM papers and purely QUAN or QUAL papers is that bona fide MM papers

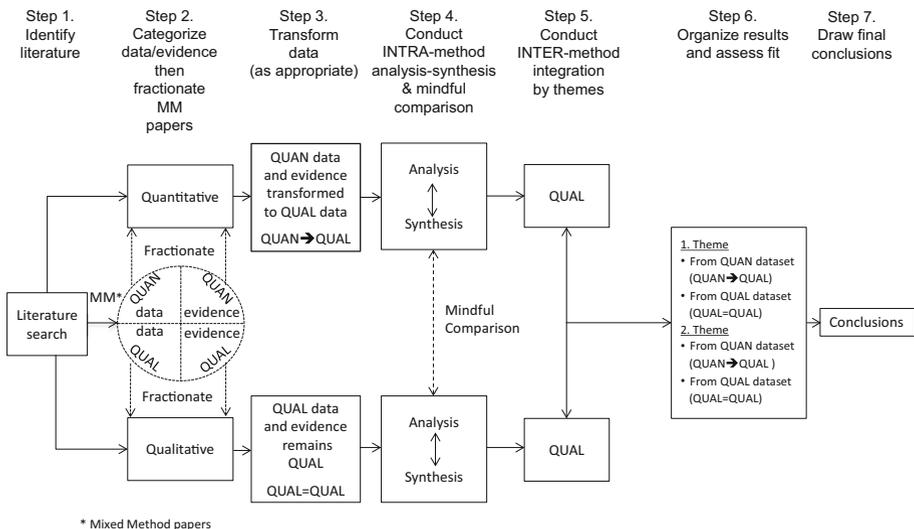


Fig. 5 Advanced convergent QUALITATIVE meta-integration

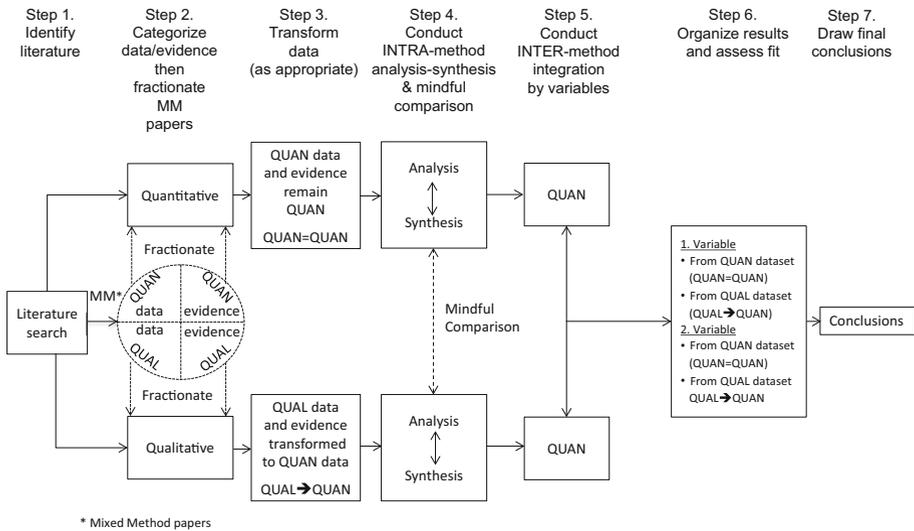


Fig. 6 Advanced convergent QUANTITATIVE meta-integration

feature additional information related to the integration of the QUAN and QUAL results from the MM study.

A particularly critical issue relevant to advanced meta-integration procedures regards the management of the MM papers and the distinction between data and evidence. The difference between ‘data’ and ‘evidence’ in relation to the MM papers is that data here refers to the neutral and unbiased presentation of results. In contrast evidence refers to the integrated part of the QUAN and QUAL components of the papers included in the review and contains an element of interpretation and evaluation.

Hence, from MM papers researchers conducting a systematic review have the option to extract QUAN data results and QUAN evidence. These researchers have also the second option of extracting QUAL data results and QUAL evidence. The results and evidence in MM papers takes either a QUAN or QUAL format that allows synthesis and integration of results and evidence using procedures similar to the basic models.

For meta-integration procedures using original research MM papers, the sources can thus be QUAL data, QUAL evidence, QUAN data and QUAN evidence. Conducting a meta-integration using original MM research papers requires fractionation. Fractionation is defined as the process by which QUAL data and evidence, and QUAN data and evidence are divided into smaller quantities such that the parts can be analyzed and synthesized based on their QUAL or QUAN form.

Fractionation of the MM papers into four parts is illustrated in step 2 of Figs. 4, 5, 6. The researcher extracts data from the ‘results’ sections of the MM paper and/or the researcher can extract evidence from the ‘integrated part’ of the MM paper either found in a specific paragraph on ‘integration’ or in the “discussion” sections. Thus there are four outcomes of fractionating from a MM paper.

- Management of QUAL *data* extracted from the QUAL results of the MM papers.
- Management of QUAL *evidence* extracted from the integrated part of the MM papers.
- Management of QUAN *data* extracted from the QUAN results of the MM papers.

- Management of QUAN *evidence* extracted from the integrated part of the MM papers.

The researcher can choose to extract data or evidence or a combination. This decision must be based on considerations related to various aspects of the overall purpose of the research to the quality and execution of the integration as well as the presentation in the MM papers. As the number of empirical MM research papers grows increasing variation is expected among MM papers especially in relation to the level integration and what QUAL and QUAN data and evidence can be extracted. In our parental self-perception and autism spectrum disorder research, there was no QUAL or QUAN evidence extracted from the three MM papers, so fractionation resulted in including the QUAL data from the three MM studies with the other data from the QUAL papers in the construction of the QUAL dataset. Similarly, QUAN data from the same three MM studies were fractionated and combined with the data from the other QUAN papers to produce the QUAN dataset.

In the data transformation stage, Step 3 of Figs. 5 and 6, there again are critical differences from basic designs. In an advanced convergent qualitative meta-integration (Fig. 5), there will be data transformation of entire QUAN dataset that includes all the QUAN data from QUAN studies as well as QUAN data and evidence derived the MM studies. Moreover, the synthesis of the data in Step 4 will require mixing of QUAL data from the QUAL studies and the QUAL data and evidence from the MM studies. In an advanced convergent quantitative meta-integration (Fig. 6), there will be data transformation of QUAL data and QUAL evidence (derived from the MM studies).

Table 4 Steps of a convergent qualitative meta-integration illustrated with a systematic review of autism spectrum disorder

Step	Illustration from review on autism spectrum disorder
1. Identify literature	PubMed, Embase and PsycINFO were used to identify relevant literature—911 papers were identified and 53 papers were included in the review
2. Categorize data and evidence and fractionate	The 53 papers included 41 QUAN, 9 QUAL and 3 MM papers—fractionation of the three MM papers led to inclusion of QUAN data into the QUAN dataset QUAL data into the QUAL dataset
3. Transform data	To create similar dataset formats, the QUAN dataset was transformed into QUAL format
4. Conduct intra-method analysis and synthesis	Intra-method analysis and synthesis involved a thematic analysis of the two corresponding datasets using a QUAL format—this led to QUAL themes from the QUAN dataset and QUAL themes from the QUAL dataset informed by ‘mindful comparison’ of emerging results
5. Conduct inter-method integration	Inter-method integration elucidated diversity in the themes and constructs guiding the review—creating joint displays of the QUAL themes from the QUAN and QUAL datasets facilitated integration
6. Organize results and assess fit	Organizing results and assessing fit expanded knowledge since the QUAN and the QUAL data told different stories about the constructs of competence, control and coherence
7. Draw final conclusions	Synthesizing QUAN, QUAL and MM studies through meta-integration achieved a greater understanding of competence, control and coherence relative to parenting of children with autism spectrum disorder

5.2.1 Illustration of meta-integration step-by-step using the parental self-perception and autism spectrum disorder study

In our systematic mixed studies review of parental self-perception and autism spectrum disorder, we utilized QUAL, QUAN and MM studies. Thus, it was an advanced meta-integration. As the 3 MM studies had not produced evidence from data transformation, fractionation of MM studies produced additional QUAL and QUAN data, but not QUAL and QUAN evidence. As QUAN data were transformed into QUAL format, the study is an advanced qualitative convergent meta-integration. The full steps of meta-integration using our review on autism spectrum disorder are shown in Table 4.

6 Discussion

Based on this illustration, it can be concluded that there are now three conceptual approaches to systematic reviews. The first, meta-analysis, is defined in the Cochrane Handbook for systematic reviews as, “the statistical combination of results from two or more separate studies” (Deeks et al. 2011), and by the Cochrane Community (2015) as, “The use of statistical techniques in a systematic review to integrate the results of included studies”. The focus is on QUAN studies. The second approach, meta-synthesis, is defined by Sandelowski and Barroso (2007) as, “an interpretive integration of qualitative findings that are themselves interpretive syntheses of data, including the phenomenologies, ethnographies, grounded theories, and other coherent descriptions or explanations of phenomena, events, or cases that are the hallmark findings of qualitative research.” (Sandelowski and Barroso 2007, p. 18) The focus of meta-synthesis is on QUAL studies and developing a fully integrated interpretation. While Sandelowski and Barroso (2007) do not eliminate the use of statistical analysis, it is not the primary focus. A third type of systematic review, can occur, one that uses QUAL findings, QUAN findings and MM findings (though the latter is not prerequisite if the studies do not exist).

There are at least three general names that have been used for describing the third category of systematic review that leverages QUAL, QUAN, and MM studies. Sandelowski et al. (2006) use *mixed research synthesis*, Heyvaert et al. (2013) use *mixed method research synthesis* and Pluye and Hong (2014) use *systematic mixed studies review*. As illustrated in this research, a shortcoming across all of these studies has been the lack of clear procedures for actually separating all the data into formats that allow comparison, and bringing data of all types together. To that end, we propose meta-integration procedures. We define meta-integration as, “the combining and contrasting of results from QUAL, QUAN and MM studies (as applicable) to identify patterns, relationships, and disagreements, and/or to develop deeper insights and interpretations by bringing together and integrating all relevant research findings, regardless of the type of data, for a deeper understanding of a phenomenon.” Meta-integration is characterized as systematically identifying diverse QUAL, QUAN and MM studies (as applicable) categorizing them according to design, fractionating any mixed methods studies into QUAL and QUAN data and evidence, using data transformation procedures depending on the meta-integration procedure employed, conducting intra-method iterative analysis-synthesis for QUAL and QUAN strands respectfully, while making mindful comparison of the emerging findings, conducting an inter-method integration of the QUAL and QUAN strands of the analysis, organizing results and assessing fit, and drawing final conclusions. We note that meta-

integration is more than just synthesis, as it requires also steps of fractionating MM studies into elements that can be synthesized, and in some cases, transforming the data format into another.

As the proposed meta-integration procedures emerged from experience conducting an actual meta-integration, we believe that they do address real methodological issues that can and do emerge. A major hurdle for researchers interested in this type of research has been the lack of clear guidance on procedures for conducting these advanced procedures. It is easy to imagine reviews originally started as a meta-integration procedure that end up being “traditional” QUAN or QUAL systematic reviews simply due to a lack of guidance. This research now clarifies the steps required to categorize, fractionate and transform data and evidence. To overcome some obstacles in preparation of a systematic review using MM papers, this article provides a graphical presentation and guide for the very important part—namely the precise steps for six types of meta-integration.

This work provides an important expansion of the methodological literature. Despite the Whittemore and Knafl (2005) description of stages in data analysis, namely, reduction, display, comparison, conclusion and verification, this work provides more concrete descriptions. While both Heyvaert et al. (2013) and Pluye and Hong (2014), suggest the stages in conducting systematic reviews of QUAN, QUAL and MM studies and provide guidance in classification of different MM designs and combinations, this article elucidates additional synthesis processes needed for the meta-integration. To conduct a basic convergent meta-integration, the procedures are straight forward if the included research has only been published in QUAN and QUAL formats. The strength of advanced convergent meta-integration procedures lies in having options for answering important and complex research questions using QUAL, QUAN and MM studies. These procedures provide a clear approach for comparing results across MM papers that having various patterns of integration. Further examples besides our own on parental self-perception and autism spectrum disorder could elucidate additional procedures for managing and synthesizing MM data. Through future research using rigorously conducted sources of published data in a meta-integration, we anticipate superior and naturalistic representations of reality. Further procedures and argumentation could facilitate development and refinement to improve the quality of meta-integration and to explicate the utility of this methodological approach.

While meta-analysis is the top synthesis framework for systematic literature reviews of QUAN papers and meta-synthesis is the top synthesis framework for systematic literature reviews of QUAL papers, it remains to be seen if meta-integration could be seen as the definitive synthesis framework for combining QUAL, QUAN and MM studies. While all systematic reviews of randomized controlled trials follow the initial seven steps, not all contain a meta-analysis. A meta-analysis can be done only when included trials are homogeneous. Similarly, all systematic mixed studies reviews may not lead to meta-integration. Indeed, under some conditions, it will not be feasible to conduct a meta-integration. For example, smaller student projects, reviews with a very limited number of included papers or reviews with a very uneven distribution of the included papers could preclude meta-integration. This discussion suggests that meta-integration is a type of systematic review using QUAL, QUAN and MM studies, and that not all such systematic reviews will involve meta-integration procedures.

Of note, difficulty accessing raw data due to challenges of either ethical controversies or logistical reasons can be a formidable threat to conducting a systematic review using meta-integration. Conducting meta-integration will be meaningful when almost all relevant papers are included. Conducting a systematic review is an essential step prior to pursuing a meta-integration.

While it is possible, one could conduct a systematic review of only MM studies. We do not advocate for this approach as it would systematically eliminate two other sources of information, the information obtainable from QUAL and QUAN studies. Nonetheless, if it actually made sense under extraordinary circumstances, the procedures delineated in the advanced designs could be followed, though there would be no QUAL or QUAN inputs.

6.1 Limitations

Though we have systematically considered meta-integration based on an actual example, it seems unlikely that the full scope of meta-integration procedures and challenges will have emerged through this example. Additional experience using the proposed methods is needed to further discussion about how the methodology can be developed and qualified. We believe this can best be achieved after there are more published reviews using meta-integration methods and strategies. Use of MM in research is still relatively nascent and therefore the use of appropriate MM designs and integration strategies is still not comprehensive and sufficiently described. Implementing MM papers in meta-integration is challenging because MM as a methodological discipline is relatively new. Published MM studies may have compromised descriptions and quality, and may be few in number. It is difficult to anticipate in full detail the consequences of including MM papers in a meta-integration and also how, in fact, a synthesis on both the intra- and inter-method level should be implemented. With further experience conducting advanced meta-integration papers, it will be possible to elaborate further on the possibilities and limitations of processing merged data from MM papers.

The procedures presented are based on a convergent, not a sequential approach. The sequential approach primarily implements traditional QUAN or QUAL analyses and syntheses. How to conduct convergent and sequential procedures needs further exploration. However, we suspect the majority of the procedures will apply to sequential approaches as well. This paper is admittedly pragmatic, and does not delve into epistemological complexities of combining and comparing multidisciplinary data sources—further examination is needed. The implementation of meta-integration papers involving combined data from different methods with potentially very different epistemological standpoints also merits further scientific examination and discussion.

On a final note, the Whittemore and Knafelz (2005) description of stages in data analysis, includes a final step of verification. To our knowledge, articulation of novel procedures for verification has yet to emerge for systematic reviews other than the known options of the peer-review process, independent confirmation, and post-publication commentary. These seem to be the best tools available, but this may also be an area of future inquiry.

7 Conclusions

This article provides meta-integration procedures for the inclusion of QUAN, QUAL and MM articles in systematic reviews. This paper illustrates how the models incorporate fractionation of MM studies, data transformation, iterative intra-method analysis-synthesis and mindful comparison procedures, iterative inter-method integration and the drawing of conclusions. We believe following these procedures will substantively improve the quality of systematic reviews seeking to use QUAL, QUAN and MM studies.

Acknowledgments The Tryg Foundation, the Family Hede Nielsen Foundation and the Central Denmark Region provided generous support for Kirsten Krabek Frantzen and helped make this work possible. We acknowledge Timothy C. Guetterman, PhD, research fellow, Family Medicine, University of Michigan, for feedback on earlier versions of the manuscript. Hanne Munch Kristiansen and Helene Sognstrup, Aarhus University Library, Psychiatry, provided professional library support to conduct the systematic literature search to conduct this study.

Compliance with ethical standards

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

References

Aveyard, H.: *Doing a Literature Review in Health and Social Care: A Practical Guide*. McGraw-Hill International, Maidenhead (2010)

Belanger, E., Rodriguez, C., Groleau, D.: Shared decision-making in palliative care: a systematic mixed studies review using narrative synthesis. *J. Palliat. Med.* **25**(3), 242–261 (2011). doi:[10.1177/0269216310389348](https://doi.org/10.1177/0269216310389348)

Boyatzis, R.E.: *Transforming Qualitative Information: Thematic Analysis and Code Development*. Sage Publications Inc., London (1998)

Buchanan, D.R.: An uneasy alliance: combining qualitative and quantitative research methods. *Health Educ. Q.* **19**(1), 117–135 (1992)

Carr, S.M., Lhussier, M., Forster, N., Geddes, L., Deane, K., Pennington, M., Visram, S., White, M., Michie, S., Donaldson, C., Hildreth, A.: An evidence synthesis of qualitative and quantitative research on component intervention techniques, effectiveness, cost-effectiveness, equity and acceptability of different versions of health-related lifestyle advisor role in improving health. *Health Technol. Assess.* **15**(9), 1–284 (2011). doi:[10.3310/hta15090](https://doi.org/10.3310/hta15090). **iii–iv**

CASP UK Critical appraisal skills programme: Making Sense of Evidence. <http://www.casp-uk.net/-casp-tools-checklists/c18f8> (2013). Accessed 28 Dec. 2014

Chalmers, I., Hedges, L.V., Cooper, H.: A brief history of research synthesis. *Eval. Health Prof.* **25**(1), 12–37 (2002)

Classen, S., Lopez, E.D.S.: Mixed methods approach explaining process of an older driver safety systematic literature review. *Top. Geriatr. Rehabil.* **22**(2), 99–112 (2006)

Coles, E., Themessl-Huber, M., Freeman, R.: Investigating community-based health and health promotion for homeless people: a mixed methods review. *Health Educ. Res.* **27**(4), 624–644 (2012). doi:[10.1093/her/cys065](https://doi.org/10.1093/her/cys065)

Cooper, H.M., Cooper, H.M.: *Synthesizing research : A guide for literature reviews*. Sage, Thousand Oaks (1998)

Cochrane Community: Cochrane Review, Glossary of Cochrane Term <http://community.cochrane.org/glossary/5#letterm>. Oxford, UK: The Cochrane Collaboration; c2004–2013. www.cochrane.org (2015)

Creswell, J.W., Plano Clark, V.L.: *Designing and conducting mixed methods research*, 2nd edn. Sage Publications Inc., Thousand Oaks (2011)

Creswell, J.W., Tashakkori, A.: Differing perspectives on mixed methods research (editorial). *J. Mixed Methods Res.* **1**(4), 303 (2007). doi:[10.1177/1558689807306132](https://doi.org/10.1177/1558689807306132)

Deeks, J.J., Higgins, J.P.T., Altman, D.G. (eds.): Chapter 9: analysing data and undertaking meta-analyses. In: Higgins, J.P.T., Green, S. (eds.) *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0* (updated March 2011). The Cochrane Collaboration (2011). www.cochrane-handbook.org

Dellinger, A.B., Leech, N.L.: Toward a unified validation framework in mixed methods research. *J. Mixed Methods Res.* **1**(4), 309 (2007). doi:[10.1177/1558689807306147](https://doi.org/10.1177/1558689807306147)

Dixon-Woods, M., Agarwal, S., Jones, D., Young, B., Sutton, A.: Synthesising qualitative and quantitative evidence: a review of possible methods. *J. Health Serv. Res. Policy* **10**(1), 45–53 (2005)

Dixon-Woods, M., Cavers, D., Agarwal, S., Annandale, E., Arthur, A., Harvey, J., Sutton, A.J.: Conducting a critical interpretive synthesis of the literature on access to healthcare by vulnerable groups. *BMC Med. Res. Methodol.* **6**(1), 35 (2006). doi:[10.1186/1471-2288-6-35](https://doi.org/10.1186/1471-2288-6-35)

Fetters, M.D., Curry, L.A., Creswell, J.W.: Achieving integration in mixed methods designs-principles and practices. *Health Serv. Res.* **48**(6 Pt 2), 2134–2156 (2013). doi:[10.1111/1475-6773.12117](https://doi.org/10.1111/1475-6773.12117)

Gough, D., Oliver, S., Thomas, J.: *An Introduction to Systematic Reviews*. Sage Publications Ltd., London (2012)

- Grant, M.J., Booth, A.: A typology of reviews: an analysis of 14 review types and associated methodologies. *Health Inf. Libr. J.* **26**(2), 91–108 (2009)
- Greene, J.C.: *Mixed Methods in Social Inquiry*. Jossey-Bass, San Francisco (2007)
- Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., Kyriakidou, O., Peacock, R.: Storylines of research in diffusion of innovation: a meta-narrative approach to systematic review. *Soc. Sci. Med.* **61**(2), 417–430 (2005). doi:[10.1016/j.socscimed.2004.12.001](https://doi.org/10.1016/j.socscimed.2004.12.001)
- Harden, A., Brunton, G., Fletcher, A., Oakley, A., Burchett, H., Backhans, M.: *Young people, pregnancy and social exclusion: A systematic synthesis of research evidence to identify effective, appropriate and promising approaches for prevention and support*. London, University of London, EPPI-Centre, Social Science Research Unit, Institute of Education (2006)
- Harden, A., Thomas, J.: Methodological issues in combining diverse study types in systematic reviews. *Int. J. Soc. Res. Methodol.* **8**(3), 257 (2005). doi:[10.1080/13645570500155078](https://doi.org/10.1080/13645570500155078)
- Hart, L.C., Smith, S.Z., Swars, S.L., Smith, M.E.: An examination of research methods in mathematics education. *J. Mixed Methods Res.* **3**(1), 26 (2009). doi:[10.1177/1558689808325771](https://doi.org/10.1177/1558689808325771)
- Heyvaert, M., Maes, B., Onghena, P.: Mixed methods research synthesis: definition, framework, and potential. *Qual. Quant.* **47**(2), 659–676 (2013). doi:[10.1007/s11135-011-9538-6](https://doi.org/10.1007/s11135-011-9538-6)
- Higgins, J., Green, S.: *Cochrane Handbook for Systematic Reviews of Interventions*. <http://www.cochrane-handbook.org> (2011). Accessed 25 July 2014
- Jenson, L.A., Allen, M.N.: A synthesis of qualitative research on wellness-illness. *Qual. Health Res.* **4**(4), 349–369 (1994)
- Jones, M.L.: Role development and effective practice in specialist and advanced practice roles in acute hospital settings: systematic review and meta-synthesis. *J. Adv. Nurs.* **49**(2), 191–209 (2005). doi:[10.1111/j.1365-2648.2004.03279.x](https://doi.org/10.1111/j.1365-2648.2004.03279.x)
- Kennedy, F., McDonnell, A., Gerrish, K., Howarth, A., Pollard, C., Redman, J.: Evaluation of the impact of nurse consultant roles in the United Kingdom: a mixed method systematic literature review. *J. Adv. Nurs.* **68**(4), 721–742 (2012). doi:[10.1111/j.1365-2648.2011.05811.x](https://doi.org/10.1111/j.1365-2648.2011.05811.x)
- Kirkevold, M.: Integrative nursing research—an important strategy to further the development of nursing science and nursing practice. *J. Adv. Nurs.* **25**(5), 977–984 (1997). doi:[10.1046/j.1365-2648.1997.1997025977.x](https://doi.org/10.1046/j.1365-2648.1997.1997025977.x)
- Krippendorff, K.: *Content Analysis. An Introduction to Its Methodology*. Sage Publications Inc., London (2004)
- Lakshman, R., Ogilvie, D., Ong, K.K.: Mothers’ experiences of bottle-feeding: a systematic review of qualitative and quantitative studies. *Arch. Dis. Child.* **94**(8), 596–601 (2009). doi:[10.1136/adc.2008.151910](https://doi.org/10.1136/adc.2008.151910)
- Lewis, S.A., Noyes, J., Mackereth, S.: Knowledge and information needs of young people with epilepsy and their parents: mixed-method systematic review. *BMC Pediatr.* **10**, 103 (2010). doi:[10.1186/1471-2431-10-103](https://doi.org/10.1186/1471-2431-10-103)
- Lucas, P.J., Baird, J., Arai, L., Law, C., Roberts, H.M.: Worked examples of alternative methods for the synthesis of qualitative and quantitative research in systematic reviews. *BMC Med. Res. Methodol.* **7**, 4 (2007). doi:[10.1186/1471-2288-7-4](https://doi.org/10.1186/1471-2288-7-4)
- Miles, M.B., Huberman, A.M.: *Qualitative Data Analysis : An Expanded Sourcebook*, 2nd edn. Sage Publications Inc., Thousand Oaks (1994)
- Miles, M.B., Huberman, A.M., Saldaña, J.: *Qualitative Data Analysis: A Methods Sourcebook*. Sage Publications Inc., Thousand Oaks (2013)
- Neuendorf, K.A.: *The Content Analysis Guidebook*. Sage Publications Inc., Thousand Oaks (2002)
- Oliver, S., Harden, A., Rees, R., et al.: An emerging framework for including different types of evidence in systematic reviews for public policy. *Evaluation* **11**(4), 428–446 (2005)
- Pawson, R.: Evidence-based policy: in search of a method. *Evaluation* **8**(2), 157–181 (2002)
- Pawson, R., Greenhalgh, T., Harvey, G., Walshe, K.: Realist review—a new method of systematic review designed for complex policy interventions. *J. Health Serv. Res. Policy* **10**(Supplement 1), 21–34 (2005). doi:[10.1258/1355819054308530](https://doi.org/10.1258/1355819054308530)
- Pluye, P., Gagnon, M.P., Griffiths, F., Johnson-Lafleur, J.: A scoring system for appraising mixed methods research, and concomitantly appraising qualitative, quantitative and mixed methods primary studies in mixed studies reviews. *Int. J. Nurs. Stud.* **46**(4), 529–546 (2009). doi:[10.1016/j.ijnurstu.2009.01.009](https://doi.org/10.1016/j.ijnurstu.2009.01.009)
- Pluye, P., Grad, R.M., Dunikowski, L.G., Stephenson, R.: Impact of clinical information-retrieval technology on physicians: a literature review of quantitative, qualitative and mixed methods studies. *Int. J. Med. Inform.* **74**(9), 745–768 (2005). doi:[10.1016/j.ijmedinf.2005.05.004](https://doi.org/10.1016/j.ijmedinf.2005.05.004)
- Pluye, P., Hong, Q.N.: Combining the power of stories and the power of numbers: mixed methods research and mixed studies reviews. *Annu. Rev. Public Health* **35**, 29–45 (2014). doi:[10.1146/annurev-publhealth-032013-182440](https://doi.org/10.1146/annurev-publhealth-032013-182440)

- Pluye, P., Robert, E., Cargo, M., Bartlett, G., O’Cathain, A., Griffiths, F., Boardman, F., Gagnon, M.P., Rousseau, M.C.: Proposal: A Mixed Methods Appraisal Tool for Systematic Mixed Studies Reviews. <http://mixedmethodsappraisaltoolpublic.pbworks.com> (2011). Accessed 6 January 2014
- Popay, J., Roberts, H., Sowden, A., Petticrew, M., Arai, L., Rodgers, M., Brittenm, N., Roen, K., Duffy, S.: Guidance on the conduct of narrative synthesis in systematic reviews: A Product from the ESRC Methods Programme. ESRC (2006)
- Pope, C., Mays, N., Popay, J.: Synthesizing qualitative and quantitative health evidence: a guide to methods. Open University Press, McGraw Hill Education, Maidenhead (2007)
- Rihoux, B., Ragin, C.C.: Configurational Comparative Methods: Qualitative Comparative Analysis (OCA) and Related Techniques. Sage Publications Inc., Thousand Oaks (2009)
- Rihoux, B., Marx, A., Ragin, C.C., Rihoux, B., Álamos-Concha, P., Bol, D., Schneider, C.Q.: QCA, 25 years after “the comparative method”: mapping, challenges, and innovations-mini-symposium. *Polit. Res. Q.* **66**(1), 167–235 (2013)
- Rivard, S., Lapointe, L.: Information technology implementers’ responses to user resistance : nature and effects. *Manag. Inf. Syst.* **36**(3), 897–920 (2012)
- Roberts, K.A., Dixon-Woods, M., Fitzpatrick, R., Abrams, K.R., Jones, D.R.: Factors affecting uptake of childhood immunisation: a bayesian synthesis of qualitative and quantitative evidence. *Lancet* **360**(9345), 1596–1599 (2002). doi:[10.1016/S0140-6736\(02\)11560-1](https://doi.org/10.1016/S0140-6736(02)11560-1)
- Rosewilliam, S., Roskell, C.A., Pandyan, A.D.: A systematic review and synthesis of the quantitative and qualitative evidence behind patient-centred goal setting in stroke rehabilitation. *Clin. Rehabil.* **25**(6), 501–514 (2011). doi:[10.1177/0269215510394467](https://doi.org/10.1177/0269215510394467)
- Sandelowski, M., Docherty, S., Emden, C.: Focus on qualitative methods. Qualitative metasynthesis: issues and techniques. *Res. Nurs. Health* **20**(4), 365–371 (1997)
- Sandelowski, M., Voils, C.I., Barroso, J.: Defining and designing mixed research synthesis studies. *Res. Sch.* **13**(1), 29 (2006)
- Sandelowski, M., Barroso, J.: Handbook for Synthesizing Qualitative Research. Springer Publishing Company Inc., New York (2007)
- Sandelowski, M., Voils, C.I., Knafl, G.: On quantizing. *J. Mixed Methods Res.* **3**(3), 208–222 (2009). doi:[10.1177/1558689809334210](https://doi.org/10.1177/1558689809334210)
- Sivesind, K.H.: Structured, qualitative comparison. *Qual. Quant.* **33**(4), 361 (1999). doi:[10.1023/A:1004691318311](https://doi.org/10.1023/A:1004691318311)
- Tashakkori, A., Teddlie, C.: Sage Handbook of Mixed Methods in Social & Behavioral Research. Sage Publications Inc., Los Angeles (2010)
- Teddlie, C., Tashakkori, A. (eds.): Foundations of mixed methods research: integrating quantitative and qualitative approaches in the social and behavioral sciences. Sage Publications Inc., New York (2009)
- The Joanna Briggs Institute: Joanna Briggs Institute Reviewers’ Manual. The University of Adelaide, Adelaide (2014)
- Thomas, J., Harden, A.: Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Med. Res. Methodol.* **8**, 45 (2008). doi:[10.1186/1471-2288-8-45](https://doi.org/10.1186/1471-2288-8-45)
- Thomas, J., Harden, A., Oakley, A., Oliver, S., Sutcliffe, K., Rees, R., Brunton, G., Kavanagh, J.: Integrating qualitative research with trials in systematic reviews. *BMJ* **328**(7446), 1010–1012 (2004). doi:[10.1136/bmj.328.7446.1010](https://doi.org/10.1136/bmj.328.7446.1010)
- Voils, C.I., Sandelowski, M., Barroso, J., Hasselblad, V.: Making sense of qualitative and quantitative findings in mixed research synthesis studies. *Field Methods* **20**(1), 3–25 (2008). doi:[10.1177/1525822X07307463](https://doi.org/10.1177/1525822X07307463)
- Voils, C., Hasselblad, V., Crandell, J., Chang, Y., Lee, E., Sandelowski, M.: A bayesian method for the synthesis of evidence from qualitative and quantitative reports: the example of antiretroviral medication adherence. *J. Health Serv. Res. Policy* **14**(4), 226 (2009). doi:[10.1258/jhsrp.2009.008186](https://doi.org/10.1258/jhsrp.2009.008186)
- Wang, H.F., Yeh, M.C.: Psychological resistance to insulin therapy in adults with type 2 diabetes: mixed-method systematic review. *J. Adv. Nurs.* **68**(4), 743–757 (2012). doi:[10.1111/j.1365-2648.2011.05853.x](https://doi.org/10.1111/j.1365-2648.2011.05853.x)
- Whittemore, R., Knafl, K.: The integrative review: updated methodology. *J. Adv. Nurs.* **52**(5), 546–553 (2005). doi:[10.1111/j.1365-2648.2005.03621.x](https://doi.org/10.1111/j.1365-2648.2005.03621.x)