

Review

A scoring system for appraising mixed methods research, and concomitantly appraising qualitative, quantitative and mixed methods primary studies in Mixed Studies Reviews

Pierre Pluye^{a,*}, Marie-Pierre Gagnon^b, Frances Griffiths^c, Janique Johnson-Lafleur^d

^a *Department of Family Medicine, McGill University, 517 Pine Avenue West, Montreal, QC, Canada H2W 1S4*

^b *Faculty of Nursing, Laval University, UK*

^c *Warwick Medical School, University of Warwick, Canada*

^d *Research Professional, Information Technology Primary Care Research Group, McGill University, Canada*

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Abstract

A new form of literature review has emerged, Mixed Studies Review (MSR). These reviews include qualitative, quantitative and mixed methods studies. In the present paper, we examine MSRs in health sciences, and provide guidance on processes that should be included and reported. However, there are no valid and usable criteria for concomitantly appraising the methodological quality of the qualitative, quantitative and mixed methods studies.

Objective: To propose criteria for concomitantly appraising the methodological quality of qualitative, quantitative and mixed methods studies or study components.

Design: A three-step critical review was conducted.

Data sources: 2322 references were identified in MEDLINE, and their titles and abstracts were screened; 149 potentially relevant references were selected and the full-text papers were examined; 59 MSRs were retained and scrutinized using a deductive–inductive qualitative thematic data analysis. This revealed three types of MSR: convenience, reproducible, and systematic.

Review methods: Guided by a proposal, we conducted a qualitative thematic data analysis of the quality appraisal procedures used in the 17 systematic MSRs (SMSRs).

Results: Of 17 SMSRs, 12 showed clear quality appraisal procedures with explicit criteria but no SMSR used valid checklists to concomitantly appraise qualitative, quantitative and mixed methods studies. In two SMSRs, criteria were developed following a specific procedure. Checklists usually contained more criteria than needed. In four SMSRs, a reliability assessment was described or mentioned. While criteria for quality appraisal were usually based on descriptors that require specific methodological expertise (e.g., appropriateness), no SMSR described the fit between reviewers' expertise and appraised studies. Quality appraisal usually resulted in studies being ranked by methodological quality.

Abbreviations: CMSR, Convenience Mixed Studies Review; MSR, Mixed Studies Review; RMSR, Reproducible Mixed Studies Review; SMSR, Systematic Mixed Studies Review.

* Corresponding author. Tel.: +1 514 398 8483; fax: +1 514 398 4202.

E-mail address: pierre.pluye@mcgill.ca (P. Pluye).

Conclusion: A scoring system is proposed for concomitantly appraising the methodological quality of qualitative, quantitative and mixed methods studies for SMSRs. This scoring system may also be used to appraise the methodological quality of qualitative, quantitative and mixed methods components of mixed methods research.

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Keywords: Literature review; Methodology; Mixed methods research; Mixed Studies Reviews; Quality appraisal; Research synthesis

What is already known about the topic?

- Quality appraisal is an important stage in undertaking literature reviews and guidance exists for different methodologies about how to undertake this appraisal.
- Mixed methods research and Mixed Studies Reviews can provide greater understanding of a health issue than one type of research approach alone.

What does this paper add?

- It proposes a scoring system for appraising mixed methods research, and concomitantly appraising qualitative, quantitative and mixed methods studies.
- It provides guidance for conducting and reporting Mixed Studies Reviews.

1. Introduction

The use of mixed methods research increases in health sciences (Creswell et al., 2004). Mixed methods research is defined as a combination of qualitative and quantitative methods conducted by a researcher or researcher team, for the broad purpose of gaining breadth and depth of understanding or corroboration, within a single study or closely related studies (Johnson et al., 2007). For example, mixed methods research may combine a quantitative cross-sectional survey on the accessibility of mental healthcare with a qualitative ethnographic study to better understand the lack of access in a culturally diverse community (Groleau et al., 2007). While combining qualitative and quantitative methods constitutes a longstanding practice in evaluation and research (Greene, 2006; Pluye et al., 2009b), it has only recently been conceptualized in terms of mixed methods research (Tashakkori and Teddlie, 2003).

The division of methods within health sciences as qualitative or quantitative has its roots in the different ‘world views’ of constructivism and logical empiricism, which are usually presented as competing paradigms (Creswell and Plano Clark, 2007; Greene, 2007; Johnson et al., 2007; Pluye et al., 2009b; Teddlie and Tashakkori, 2003). Constructivism is associated with idealism, relativism and (inter)subjectivity, while logical empiricism is associated with materialism, realism and objectivity. Constructivism is most frequently associated with inductive qualitative studies, and logical empiricism is most frequently associated with deductive quantitative studies. Mixed methods may be conceived as

methods that loop between constructivism and logical empiricism, and include the notion that something can be “both socially constructed and yet real” (Hacking, 1999, p. 119).

There is no consensus on criteria for appraising the methodological quality of mixed methods research (O’Cathain et al., 2008). While there are general criteria for planning, designing, reporting and globally assessing mixed methods research (Creswell and Plano Clark, 2007; O’Cathain et al., 2008), researchers must refine further the criteria for evaluating its quality (Creswell et al., 2004). In the present paper, we examine systematic Mixed Studies Reviews, and criteria for appraising the quality of qualitative, quantitative and mixed methods studies.

A mixed studies review (MSR) is a literature review that concomitantly examines qualitative, quantitative and mixed methods primary studies. We found examples of MSR in education, health, management and social sciences such as reviews to synthesize existing knowledge about an intervention or a program that is to be evaluated. We conceptualize MSR as mixed methods research where data consist of the text of publications reporting qualitative and quantitative studies and/or mixed methods studies.

In the present paper, we review MSRs in health sciences, define three categories of MSRs (convenience, reproducible and systematic), and provide guidance on processes that should be included and reported. Our main objective is to critically scrutinize the different ‘quality appraisal tools’ used in systematic MSRs, and propose a scoring system for concomitantly appraising the methodological quality of qualitative, quantitative and mixed methods studies in a systematic MSR. This scoring system may also be used to appraise the methodological quality of qualitative, quantitative and mixed methods components of mixed methods research.

2. Background

2.1. Mixed studies review as an emerging form of literature review in health sciences

We use the term MSR to refer to reviews with many different names such as integrative review, meta-needs assessment, mixed approaches to evidence synthesis, mixed methods review, mixed methods synthesis, mixed research synthesis, and realist review. These terms and corresponding

Table 1

Terms used to refer to Mixed Studies Reviews.

Term (reference)	Key aspects of each type of review
Integrative review (Nurios and Yeaton, 1987)	Guidelines on how to conduct such reviews have been published since 1980, and “the interpretation stage is one in which the complementary nature of qualitative and quantitative approaches to integrative review becomes particularly obvious” (p. 706)
Meta-needs assessment (Gaber, 2000)	Meta-needs assessment examines existing needs assessments using secondary data analysis, and “often compiles both quantitative and qualitative data sets in one analysis” (p. 142). Places to look for information and documents might be state, regional, and local organizations that provide health care services. Reports and plans published by these agencies serve as data (grey literature)
Mixed approaches to evidence synthesis (Pope et al., 2007)	Four ‘mixed approaches’ are described: mixed methods synthesis, realist synthesis, thematic analysis and narrative synthesis. Of those, only the first two refer to review processes, and are presented below
Mixed methods review or synthesis (Harden and Thomas, 2005)	As proposed by the EPPI (Evidence for Policy and Practice Information Center, London), mixed methods reviews consist of combining results from two separate syntheses: (1) a synthesis of findings of primary studies about participants’ perspective on program-related issues under-scrutiny (typically derived from qualitative research) and (2) a synthesis of findings of primary studies on the effectiveness of programs (typically derived from (quasi)experimental studies)
Mixed research synthesis (Sandelowski, 2006)	“ <i>Mixed research synthesis</i> ” is our name for the type of systematic review aimed at the integration of results from both qualitative and quantitative studies in a shared domain of empirical research” (p. 29). Based on mixed methods designs, three designs for conducting such synthesis are proposed
Realist review (Pawson et al., 2005)	Realist reviews examine qualitative and quantitative studies that support or contradict, and may refine, conceptual frameworks and theoretical models underlying programs. They are particularly useful for decision-makers since such reviews aim to better understand how programs work in a certain context, and not in another context. “Under realism, the basic evaluative question – what works? – changes to ‘what is it about this programme that works for whom in what circumstances?’” (p. 22). Qualitative and quantitative studies permit respectively to examine processes and consequences of programs

Note: While all these publications describe how to concomitantly review primary qualitative and quantitative studies, they do not necessarily mention or take into account primary mixed methods studies. The inclusion of primary mixed methods studies in the literature review process is not specifically mentioned in Nurios and Yeaton (1987), Gaber (2000), and Pope et al. (2007). Sandelowski (2006) mentioned that primary mixed methods studies may be included into a mixed research synthesis. In contrast, Harden and Thomas (2005) take into account mixed methods studies as they suggest synthesizing qualitative findings and quantitative results of primary mixed methods studies with those of qualitative and quantitative primary studies, respectively.

references are presented in Table 1. This profusion of terminology is testament to the significant desire for better comprehension and conceptualization of MSR. We suggest the term ‘Mixed Studies Review’ as a generic concept for reviews which we outline here.

MSR is more precise compared to the term ‘integrative review’, which is used for literature reviews that do not necessarily include both qualitative and quantitative studies. However, the original use of this term was for MSRs, following a seminal paper in clinical psychology (Nurios and Yeaton, 1987) which promoted the integration of qualitative research into systematic reviews of quantitative studies: “The richest and most reliable summarizations of ‘what we know’ in a given area can best be achieved through an alliance between qualitative and quantitative information and methods of investigation” (p. 707). MSR is clearer than the terms ‘mixed methods review’ (EPPI-Centre, 2007) or ‘mixed methods synthesis’ (Harden and Thomas, 2005) or ‘mixed research synthesis’ (Sandelowski, 2006), which may be literally misunderstood as limited to the review of mixed methods studies or the synthesis of their results. MSR also encompasses the whole review process (defined below as a sequence of five activities: question, identification, selection, appraisal and synthesis), and therefore is more com-

prehensive than the terms ‘synthesis of results of quantitative and qualitative studies’ (Popay, 2006) or ‘mixed approaches to evidence synthesis’ (Pope et al., 2007) that refer only to the last stage of a literature review (synthesis of results of primary studies). ‘Meta-needs assessments’ may be seen as a type of MSR with a focus on a specific topic. ‘Realist reviews’ may also be considered as a type of MSR with focus on conceptual frameworks and theoretical models underlying programs. Indeed, our proposal for systematic MSR complements the characteristics of realist reviews as defined by Pawson et al. (2005) who do not develop explicit criteria for methodological quality appraisal of primary studies.

The health sciences have tended to value systematic literature reviews of experimental quantitative studies with meta-analysis (Chalmers et al., 2002), and rarely use qualitative research as a source of evidence for literature reviews (Dixon-Woods et al., 2001). However, a small number of literature reviews do include both quantitative and qualitative studies (Sheldon, 2005). The health sciences have emphasized the importance of systematic reviews of quantitative experimental studies for scrutinizing the effectiveness of biomedical interventions and public health programs (e.g., meta-analyses of randomized controlled trials), and

such reviews have been institutionalized through Cochrane and Campbell international collaborations. Indeed, textbooks on literature reviews usually develop methods, data analysis techniques and data collection instrumentation for reviewing quantitative studies, while they briefly mention that reviews may also examine conceptual frameworks, theoretical models, hypotheses, and qualitative research (Clarke and Oxman, 2003; Cooper, 1998; Fink, 2005; Garrard, 2007). Systematic reviews of quantitative experimental studies might nevertheless provide “little or no clue as to why [complex] interventions worked or did not work when applied in different contexts or circumstances, deployed by different stakeholders, or used for different purposes” (Pawson et al., 2005, p. 21).

There are an increasing number of meta-syntheses of qualitative study findings aiming to produce better conceptualizations or theories compared to single studies (e.g., meta-ethnography), and deeper understanding of complex phenomena compared to reviews of quantitative studies. Reviews of qualitative studies sometimes require the collaboration of authors of primary studies, and time-consuming secondary analysis of primary qualitative data (Britten et al., 2002). Recent textbooks present methods for separate review of quantitative and qualitative studies, but do not mention primary mixed methods studies or MSRs (Aveyard, 2007; Galvan, 2006).

MSRs are emerging as a new form of literature review. They are a departure from that which has until now distinguished and legitimized systematic review methodology (Sheldon, 2005). MSRs may provide rich, detailed and highly practical understanding of complex health interventions and programs. Pope et al. (2007)'s book is the first attempt to summarize knowledge on how to concomitantly review qualitative, quantitative and mixed methods studies, and synthesize their results. A high quality literature review requires “appropriate breadth and depth, rigour and consistency, clarity and brevity, and effective analysis and synthesis” (Hart, 1998); however, the quality of a narrative synthesis may vary greatly from a structured synthesis of relevant and valid study results, derived from a comprehensive, reproducible and systematic review (Hart, 1998; Popay et al., 2006), to a non-structured synthesis of results of a convenience sample of studies, derived from a non-comprehensive non-reproducible and non-systematic review (Aveyard, 2007; Pope et al., 2007).

Recommendations for conducting MSRs in education and social sciences are available (Coren and Fisher, 2006; Gaber, 2000; EPPI-Centre, 2007), and different strategies for conducting MSRs were proposed in nursing (Forbes and Griffiths, 2002), health administration (Mays et al., 2005; Sandelowski et al., 2007), health promotion (Harden et al., 2004) and public health (Pawson et al., 2005). A range of methods permits the synthesis of different types of study results (Dixon-Woods et al., 2005; Popay et al., 2006), and the imperative to be more methodologically inclusive generates a burgeoning interest in MSRs (Sandelowski et al.,

2007). We reviewed MSRs in health sciences with a focus on quality appraisal issues.

2.2. Conceptualizing Mixed Studies Reviews

We define MSR in line with Johnson et al. (2007)'s definition of mixed methods research. We consider MSRs to be a form of literature review in which a reviewer or reviewer team concomitantly reviews qualitative and quantitative studies, and/or mixed methods studies, for the broad purpose of breadth and depth of understanding and corroboration of knowledge based on all types of empirical research, and synthesizes qualitative findings and quantitative results of primary studies. The purpose of MSR may be exploratory where the qualitative component dominates (qualitative mixed) or confirmatory where the quantitative component dominates (quantitative mixed) or both exploratory and confirmatory where there is some equality of the quantitative and qualitative components (pure mixed).

The production of MSRs involves moving back and forth between the different types of evidence in an iterative process, described as ‘spiralling’ in mixed methods research (Caracelli and Greene, 1993; Mendlinger and Cwikel, 2008). In line with Hacking's constructionist theory in philosophy of sciences (1999), the production of mixed evidence can be conceived as loops between qualitative evidence and quantitative evidence (‘mixed kinds’ produced by ‘looping effects’). With respect to MSRs, the former evidence derives from qualitative studies and qualitative components of mixed methods studies, and the latter derives from quantitative studies and quantitative components of mixed methods studies.

MSR is a form of mixed methods research where the data is primarily the text of publications reporting qualitative findings and quantitative results of primary empirical studies. There are a number of ways for integrating these data (Bryman, 2006; Creswell and Plano Clark, 2007; Greene, 2006; Johnson et al., 2007; Morgan, 2007; Teddlie and Tashakkori, 2003). In line with Teddlie and Tashakkori (2003), three types of stances refer to the integration of qualitative and quantitative data or results for instance: assimilation (also called transformation), complementarity, and divergence. *Assimilation stance* is when qualitative findings are quantified and pooled with quantitative results, or quantitative results are qualified and merged with qualitative findings. While qualitative findings may often be reduced to frequency counts of themes (Creswell and Plano Clark, 2007), transforming quantitative results is rare (for an example see Pluye et al., 2005). *Complementarity stances* are when qualitative findings and quantitative results are treated separately, and when the qualitative component contributes to the quantitative component, or vice-versa. *Divergence stance* is when there is discrepancy between qualitative findings and quantitative results. Divergence of qualitative and quantitative data or results is rarely published, although a literature review found nine examples in

health sciences (Pluye et al., 2009a). However, there is a lack of consensus on specific criteria for appraising the methodological quality of qualitative, quantitative and mixed methods studies.

2.3. The lack of standard methodological quality appraisal: a barrier for conducting systematic MSRs

Few studies have examined the quality of mixed methods research. Caracelli and Riggan (1994) proposed quality criteria of mixed methods research, but many are redundant (e.g., ‘a rationale for combining methods is provided’, ‘a conceptual framework guided selection of methods’, and ‘the use of mixed methods matches purpose for combining method types’). Sale and Brazil (2004) reviewed the literature in all disciplines on criteria for appraising the methodological quality of mixed methods research. They listed criteria for qualitative and quantitative studies, and stated that they did not find specific criteria for appraising mixed methods studies. Creswell and Plano Clark (2007) suggested no standards to concomitantly appraise the quality of mixed methods studies have been established: “mixed methods research is so new that researchers have yet to reach consensus on the criteria that might be used to evaluate or assess the quality of such studies” (p. 163). O’Cathain et al. (2008) recently proposed a six-item guidance for reporting mixed methods studies (GRAMMS: Good Reporting of A Mixed Methods Study), and started the debate about how to assess and improve quality of mixed methods studies in health sciences. The content validity of quality appraisal tools for mixed methods is still an issue (Onwuegbuzie and Johnson, 2006) which the present paper seeks to address.

In contrast to the appraisal of the methodological quality of quantitative studies, the appraisal of qualitative studies remains controversial (Murphy et al., 1998). It has been suggested that some qualitative studies may be ‘illuminating’ whatever their quality (Sandelowski, 1993), although others state that primary studies must meet minimum criteria of rigour to be retained and synthesized in MSRs (Pawson et al., 2005). The possibility of having one exhaustive set of quality criteria for all types of qualitative studies has also been challenged for two reasons: “methods are not the fixed entities they appear to be in the many quality appraisal tools and checklists” (Sandelowski et al., 2007, p. 240), and there is a lack of agreement “about which quality criteria to use, and how cut off points are to be applied” (Pope et al., 2007, p. 33).

Therefore, we sought to answer the following research question: What is the minimum set of criteria for concomitantly appraising the methodological quality of the qualitative, quantitative and mixed methods studies in a MSR? In other words, what are the criteria without which a judgment about quality cannot be made? Answering this question led us to propose criteria for concomitantly appraising the methodological quality of mixed methods research, which may be valid and usable. In line with Hacking (1999), we

consider the appraisal of different research methods using different criteria as an assessment of interdependent components. We reviewed health related MSRs to gain greater understanding of how they were undertaken, and to test and refine quality appraisal criteria using a sample of MSRs.

3. Methods

3.1. Data sources and sampling

We identified and examined 59 MSRs indexed in MEDLINE up to March 2006.

3.1.1. Identification

We searched MEDLINE, a bibliographic database that covers the fields of medicine, nursing, dentistry, veterinary medicine, the health care system, and the preclinical sciences. We retrieved 2322 references (authors, title, source, abstract) using a standard ‘key word’ search strategy to identify mixed methods research (no time limit, but search limited to reviews with abstract): ‘quantitative AND qualitative OR mixed method(s) OR multi(-)method’ (Bryman, 2006; Creswell and Plano Clark, 2007).

3.1.2. Selection

Two reviewers selected 149 potentially relevant references, and independently scrutinized the corresponding 149 full-text papers, resulting in the retention of 59 papers that reported MSRs. We included papers reporting literature reviews of qualitative and quantitative primary studies, and/or mixed methods studies. Ninety papers were excluded because they reported literature reviews of quantitative studies only ($N = 54$), qualitative studies only ($N = 1$), or mixed methods studies only ($N = 1$); or because they reported activities that were not clearly associated with literature reviews ($N = 16$), or were not review papers such as position papers or reports of primary studies ($N = 18$).

3.1.3. Synthesis

A two-step thematic analysis of the 59 MSRs was conducted. Reviewers went back and forth between full-text papers and themes. *Step one (inductive)*: For each paper, two reviewers completed an initial form structured by the five generic activities defined below, which represented five themes (PP, MPG). They assigned sentences to themes and emerging sub-themes, and built a list of themes and sub-themes with definitions, the coding scheme. *Step two (deductive)*: Using this coding scheme, PP systematically coded extracts of electronic versions of papers by themes and sub-themes, while another reviewer (FG or JLL) independently coded sentences of paper-based versions. PP and FG reached consensus about 12 MSRs, and refined the coding scheme. Then, PP and JLL used the refined scheme to independently analyze the 47 remaining MSRs.

The coding scheme was straightforward since PP and JJJ agreed on 99% of their assignments, and easily reached consensus when they disagreed. We coded close to text, not ‘reading between the lines’ except when PP and JJJ interpreted the type of synthesis where the procedure for synthesizing studies was not specified. Software used was initially word processing software then coded extracts were imported into NVivo7 to assist data handling and description of the MSR sample.

In our coding scheme the five generic themes were the five activities of systematic literature reviews (Lavis et al., 2005; Moynihan, 2002): (1) question (formulating a question); (2) identification (description of the search strategy for finding potentially relevant empirical studies); (3) selection (selecting relevant studies using explicit inclusion/exclusion criteria); (4) appraisal (appraising the methodological quality of studies included in the review); and (5) synthesis (summarizing and synthesizing study results following a critical and transparent process of interpretation of the findings of the studies included in the review).

The descriptive analysis revealed three types of MSR depending on whether and how these activities were undertaken: 17 (29%) papers reported *Systematic MSRs* (SMSRs) as all activities were undertaken; 23 (39%) papers reported *Reproducible MSRs* (RMSRs) where identification and selection were reproducible from the published information, but there was no appraisal of the methodological quality of empirical studies; and 19 (32%) papers reported *Convenience MSRs* (CMSRs) as there was no reproducibility of identification or selection, and no quality appraisal. The 59 retained reviews are classified in the Appendix according to these three types. In all 59 MSRs ‘Question’ and ‘Synthesis’ were considered so these aspect are presented in the next Section 3.2. Only SMSRs and RMSRs included reproducible ‘Identification’ and ‘Selection’, and these aspects are considered in Section 3.3. ‘Appraisal’ was only undertaken in the 17 SMSRs and is considered in Section 3.4.

3.2. ‘Question’ and ‘Synthesis’ in Mixed Studies Reviews

A summary of the coding scheme is presented in Box 1. Of the 59 articles reporting MSRs, 19 (32%) stated research questions and objectives, 37 (63%) did not mention questions and stated only research objectives, and three (5%) did not mention either research questions or objectives, but described activities that achieved non-explicit objectives. The questions/objectives/activities were associated with three purposes: exploratory (broad objective without specific question, e.g., ‘to explore’), confirmatory (objective with specific questions usually linked to hypotheses), or both exploratory and confirmatory. Building on Chalmers (1999)’s definitions of inductive and deductive reasoning in sciences, we considered that MSRs were exploratory when they aimed to generate new ideas, concepts, concep-

Box 1. Coding scheme summary for the generic themes ‘Question’ and ‘Synthesis’.

Question: Analysis of all MSRs

- #1. Review question and/or objective and/or activity
 - #1.1. Mention of review questions with(out) objectives
 - #1.2. Mention of review objectives (no explicit question)
 - #1.3. Description of review activities (no explicit questions or objectives)
- #2. Review perspective
 - #2.1. Exploratory (generate new ideas, concepts, frameworks or theoretical models). For example, “This paper offers a narrative review of selected literature to explore the long-term effect of head injury” (CMSR #11)^a
 - #2.2. Confirmatory (test hypotheses or proposals). For example, “Not all people communicate their use of CAM with their medical practitioner (. . .). [Based on the literature review], the issues that influence non-disclosure, and the reasons patients do not disclose their use are discussed” (RMSR #18)^a
 - #2.3. Both exploratory and confirmatory

Synthesis: Analysis of all MSRs

- #1. Narrative synthesis
 - #1.1. Procedure described (at least one paragraph describing a procedure or one methodological reference)
 - #1.2. Procedure mentioned (e.g., ‘qualitative thematic analysis’, or at least one sentence suggesting a synthesis)
 - #1.3. Procedure not mentioned (deduced from the findings)
- #2. Type of narrative synthesis
 - #2.1. Key findings: at least one sentence per study or per group of studies
 - #2.2. Summaries: at least one paragraph per study (in the body of the paper or in a table)
 - #2.3. Content areas: findings presented according to broad categories (e.g., ‘gender’)
 - #2.4. Content analysis (explicit procedure for assigning textual data to categories) or thematic analysis (qualitative data analysis by ‘theme’)
 - #2.5. Other procedure (e.g., ‘idiomatic translation’)
- #3. Quantitative synthesis
 - #3.1. Descriptive statistics (e.g., a table pooling quantitative results of primary studies)
 - #3.2. Statistical test
- #4. Integration of qualitative findings and quantitative results
 - #4.1. Assimilation stances
 - #4.2. Complementarity stances
 - #4.3. Divergence stances

^a See Appendix A for MSR references.

tual frameworks or theoretical models, while they were confirmatory when they aimed to test hypotheses or specific propositions.

The articles reporting MSRs referred to narrative synthesis, quantitative synthesis, and integration of qualitative findings and quantitative results of retained primary studies. Narrative synthesis consisted of a procedure for describing/ comparing/combining heterogeneous qualitative findings and quantitative results using text and illustrations. Quantitative synthesis was described in terms of a procedure for describing/ comparing/combining quantitative results (e.g., a table). In our sample, quantitative synthesis was limited to description and simple statistical tests with no meta-analyses of experimental findings. Authors of papers reporting MSRs did not usually explicitly state their methodology for synthesising qualitative findings and quantitative results. We interpreted from *stances* or positions taken by the authors in the 'Results' section of their papers. We found papers that used an assimilation stance, with no distinction made between qualitative findings and quantitative results. In other papers there was a clear distinction between qualitative findings and quantitative results, and then a suggestion that qualitative findings and quantitative results were complementary, with or without divergence.

3.3. 'Identification' and 'Selection' in SMSRs and RMSRs

A summary of the coding scheme is presented in Box 2. The identification of potentially relevant primary studies was deemed reproducible, or not, according to information in the papers about the literature search strategy and search flow. We also assessed the comprehensiveness of the identification process using the diversity of cited sources as descriptors (e.g., bibliographic databases). The selection of relevant studies was deemed reproducible, or not, according to information presented in the articles reporting MSRs (inclusion–exclusion criteria). We assessed reports of the number of retained primary qualitative, quantitative and mixed methods studies.

3.4. Theme 'Appraisal': analysis of SMSRs

We scrutinized the 17 SMSRs and described the concomitant quality appraisal of qualitative, quantitative, and mixed methods primary studies, searched for methodological references, and emailed all first authors of SMSRs for validating our analysis and for clarifications. Twelve authors (71%) answered our emails. Of those, only one (6%) did not answer all our questions. In five SMSRs (29%), the 'quality appraisal' procedure was clear in the article reporting the review (e.g., procedure described in the 'Methods' section of MSR papers, with 'appraisal form' or 'quality appraisal checklist'). In seven other SMSRs (41%), the procedure was made clear by combining the analysis of the article reporting the review, the reading of methodological references and authors' answers. In three other SMSRs (18%), all primary studies were appraised without formal procedures (authors' value judgment on 'methodological concerns' or

Box 2. Coding scheme summary for the generic themes 'Identification' and 'Selection'.

Identification: Analysis of SMSRs and RMSRs

#1. Reproducibility

- #1.1. Reproducible (literature search, search strategy, search flow)
- #1.2. Not reproducible or not mentioned

#2. Comprehensiveness

- #2.1. Sources not mentioned or unclear
- #2.2. Bibliographic database (e.g., MEDLINE)
- #2.3. Citation index (e.g., ISI Web of Science)
- #2.4. List of references (relevant/selected papers' bibliographies)
- #2.5. Experts and contacts and authors
- #2.6. Personal files
- #2.7. Hand search
- #2.8. Websites
- #2.9. Conferences
- #2.10. Sample of journals
- #2.11. Seminal publications
- #2.12. Textbooks
- #2.13. Research reports
- #2.14. Previous reviews
- #2.15. Other sources

Selection: Analysis of SMSRs and RMSRs

#1. Reproducibility

- #1.1. Reproducible (inclusion/exclusion criteria)
- #1.2. Not reproducible or not mentioned

#2. Number of retained primary studies by methods

- #2.1. Number not mentioned
- #2.2. Number of qualitative studies
- #2.3. Number of quantitative studies
- #2.4. Number of mixed methods studies

#3. Description of retained primary qualitative studies

- #3.1. Approach-design-tradition and data collection-analysis mentioned for all studies
- #3.2. Approach-design-tradition or data collection-analysis not mentioned for all studies or confounded (e.g., study 1 'phenomenology' and study 2 'interviews')

#4. Description of retained primary quantitative experimental studies

- #4.1. Design and data collection-analysis mentioned for all studies
- #4.2. Design or data collection-analysis not mentioned for all studies

#5. Description of retained primary quantitative observational studies

- #5.1. Design and data collection-analysis mentioned for all studies
- #5.2. Design or data collection-analysis not mentioned for all studies, or confounded (e.g., study 1 'cohort' and study 2 'questionnaire')

‘strengths and limitations’ of primary studies). In two other SMSRs (12%), the procedure was unclear.

Then, we scrutinized the 12 clear and formal quality appraisal procedures in accordance with six elements: content validity, criteria development, number of criteria, reliability assessment, independence from reviewers’ expertise, and implications of quality appraisal. Results are presented in accordance with these six elements. We considered criteria development to be about the origin of criteria (e.g., a literature review) or the procedure for developing criteria (e.g., a DELPHI method with experts). We defined reliability in accordance with Carmines and Zeller (1979) as the extent to which an assessment provides the same results in different situations; for example when the quality appraisal of one study is conducted by different reviewers.

With respect to content validity, quality appraisal procedures were considered valid when they used different criteria for different methods, and when criteria met the method’s specific characteristics. Content validity is “based on professional [expert] judgments about the relevance” of an assessment to the content of a particular domain, and “about the representativeness with which item content covers that domain” (Messick, 1989, p. 17). This definition suggests appraising (1) qualitative studies and qualitative components of mixed methods studies according to qualitative researchers’ judgments concerning a minimum set of characteristics of ‘good’ qualitative studies that may be shared by all types of qualitative studies, (2) quantitative studies and quantitative components of mixed methods studies according to quantitative scientists’ judgments regarding the characteristics of ‘good’ experimental and observational quantitative studies, and (3) mixed methods studies according to mixed methods researchers’ judgments regarding the characteristics of ‘good’ mixed methods research. This led us to propose the following initial 15 characteristics.

- *Qualitative*: In the 17 SMSRs, two references were frequently cited for appraising the quality of qualitative studies, and six similar characteristics were proposed in both references (Mays and Pope, 2000; Popay et al., 1998). These criteria overlapped with those recommended in a literature review (Murphy et al., 1998), except ‘respondent validation’ that is not always feasible, convincing or appropriate. Thus, we appraised the quality of qualitative studies in line with the presence/absence of a qualitative objective/question, an appropriate qualitative approach/method, a description of the context, a description of participants (sampling), a systematic data collection and analysis, and researchers’ reflectivity.
- *Quantitative experimental*: There was strong evidence to support the generic scale proposed by Jadad et al. (1996). This scale was developed according to accepted methodological principles (Moher et al., 1999), and suggested appraising the quality of quantitative experimental studies according to the presence/absence of the following three

characteristics: randomization, blinding, and low withdrawal/drop-out.

- *Quantitative observational*: Checklists for appraising the methodological quality of quantitative observational studies were systematically reviewed (Sanderson et al., 2007). This review suggested appraising the quality of quantitative observational studies according to the presence/absence of the following three characteristics: description of the selection of participants, description of measurement, and control of confounding variables.
- *Mixed methods*: In addition to the appraisal of qualitative and quantitative components using the above-mentioned criteria, we used the following three characteristics in line with general criteria for planning, designing and assessing mixed methods research (Creswell and Plano Clark, 2007), and the GRAMMS guidance (Box 3) for reporting mixed methods studies (O’Cathain et al., 2008): the presence/absence of stances justifying a mixed methods design, a combination of qualitative and quantitative data collection-analysis technique or procedure, and the integration of qualitative and quantitative data and/or results.

Box 3. Criteria for planning, designing, reporting and assessing mixed methods research.

Creswell and Plano Clark (2007)

- Description of qualitative, quantitative and mixed methods components
- Literature review
- Mixed methods design (triangulation, embedded, exploratory, explanatory)
- Rigorous data collection and data analysis procedures
- Validation of quantitative and qualitative data and/or results
- Integration of quantitative and qualitative data and/or results
- Interpretation of qualitative, quantitative and mixed evidence
- Discussion of qualitative, quantitative and mixed methods limitations
- Expertise in both quantitative and qualitative approaches

O’Cathain et al. (2008)^a

- Describe the justification for using a mixed methods approach to the research question
- Describe the design in terms of the purpose, priority and sequence of methods
- Describe each method in terms of sampling, data collection and analysis
- Describe where integration has occurred, how it has occurred and who has participated in it
- Describe any limitation of one method associated with the presence of the other method
- Describe any insights gained from mixing or integrating methods

^a GRAMMS: Good Reporting of A Mixed Methods Study.

4. Results

4.1. Description of the sample

Of the 59 retained health-related MSRs, 56 (95%) were published after 2000. MSRs were conducted in the following disciplines: nursing (24%), psychosocial and behavioural research (19%), health services and policy research (14%), population health (8%) and aging research (8%). First authors were affiliated with US and UK universities for 23 (39%) and 17 (29%) reviews, respectively. Other first authors' affiliation countries were Netherlands ($N = 5$), Sweden ($n = 4$), Canada ($n = 3$), Finland ($n = 2$), South-Africa ($n = 2$), Australia ($n = 1$), Belgium ($n = 1$) and France ($n = 1$). The contribution of MSRs is most frequently ontological (81%): MSRs aimed to define or refine health-related outcomes (44%) and/or factors (36%), and/or another scientific phenomenon (36%), (e.g., a review of theoretical models and factors associated with an intervention). Their contribution was also ethical (5%) and methodological (24%), specifically to develop new methods or refine existing methods, e.g., a critical review of technology assessments. With respect to the themes 'Question' and 'Synthesis', the MSR sample is described in Table 2 ($N = 59$ CMSRs, RMSRs and SMSRs), and regarding 'Iden-

Table 2
Description of the MSR sample: themes 'Question' and 'Synthesis'.

Themes	All MSRs; $N = 59$
Question or objective (scientific endeavour)	
• Exploratory	37 (62.8%)
• Confirmatory	11 (18.6%)
• Exploratory and confirmatory	11 (18.6%)
Synthesis	
• Quantitative synthesis	1 (1.7%)
• Narrative synthesis ^a	58 (98.3%)
Synthesis: integration of qualitative findings and quantitative results of primary studies ^b	
• Integration unclear	2 (3.4%)
• Findings and results assimilated	20 (33.9%)
• Findings and results presented as complementary [including complementary and dialectical tension in 4 MSRs (6.8%)]	37 (62.7%)

^a In MSR articles, the narrative synthesis involved one or more of the following procedures: summarizing each study using text or tables ($N = 38$); listing key findings ($N = 34$); presenting findings by content areas ($N = 30$); conducting a content analysis or a thematic analysis of papers reporting studies ($N = 25$); and 'idiomatic translation' ($N = 1$).

^b SMSRs, RMSRs and CMSRs differed in terms of integration of qualitative findings and quantitative results. Qualitative findings and quantitative results of primary studies were presented as complementary in 50% of SMSRs, 59% of RMSRs, and 84% of CMSRs.

Table 3
Description of the MSR sample: themes 'Identification' and 'Selection'.

Themes	RMSRs and SMSRs; $N = 40$
Identification ^a	
• Specific search strategy and filters for identifying qualitative vs. quantitative primary studies	1 (2.5%)
• Same search strategy for identifying qualitative and quantitative primary studies	39 (97.5%)
Selection: number of selected primary studies by type of methods	
• Number mentioned ^b	34 (85%)
• Not mentioned	6 (15%)
Selection: design and data collection/analysis techniques of primary studies	
• Mentioned for all selected studies ^c	11 (27.5%)
• Not mentioned in a systematic manner	29 (72.5%)

^a On average, 3.4 types of sources of studies were mobilized in SMSRs (range 1–6) compared to 2.7 in RMSRs (range 1–5). Types of sources were as follows (in alphabetic order): bibliographic databases, citation databases (identification of papers citing selected articles), conference proceedings, contacts with experts and authors, e-journals, hand searches in paper-based journals, list of references of selected articles, listservs, previous literature reviews, personal files, research reports, specialized journals, seminal publications, textbooks, and websites.

^b There were on average 28.4 quantitative studies per review (range 1–160), 17.2 qualitative studies per review (range 0–137), and 5.2 mixed methods studies per review (range 0–29).

^c Fifteen reviews selected quantitative experimental studies, but only three mentioned all designs (e.g., randomized controlled trial) and techniques (e.g., validated measurement). Thirty-eight reviews selected quantitative observational studies, but only four mentioned all designs (e.g., survey) and techniques (e.g., structured questionnaire). Forty reviews selected qualitative studies or qualitative parts of mixed methods studies, but only four mentioned all approaches (e.g., phenomenology) and techniques (e.g., open interviews).

ification' and 'Selection', the sample is described in Table 3 ($N = 40$ RMSRs and SMSRs).

4.2. Quality appraisal

For each SMSR, appraisal-related results are presented in Table 4.

4.2.1. Content validity

No SMSR used valid checklists to concomitantly appraise qualitative, quantitative and mixed methods studies (not all characteristics met). Criteria used were valid to appraise the quality of qualitative studies, quantitative experimental studies, and quantitative observational studies, in six SMSRs (35%), one SMSR (6%), and six SMSRs (35%), respectively. In one SMSR (6%), the overall quality of mixed methods studies has been appraised, but criteria were not valid.

Table 4
SMSRs: description of quality appraisal procedures.

SMSRs (see references in the Appendix)	# 01	# 02	# 03	# 04	# 05	# 06	# 07	# 08	# 09	# 10	# 11	# 12	# 13	# 14	# 15	# 16	# 17	Total	% or mean
Clear appraisal procedure^a	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	Yes	No	12	71%
Separate sets of criteria by type of primary studies	Yes	Yes	Yes	Yes	NA	NA	Yes	Yes	NA	Yes	NA	Yes	Yes	Yes	No	Yes	NA	11	65%
Content validity by type of primary studies:																			
~ Qualitative studies	Yes			Yes	NA	NA			NA	Yes	NA	Yes	Yes	Yes			NA	6	35%
~ Quantitative experimental studies					NA	NA			NA	Yes	NA						NA	1	6%
~ Quantitative observational studies	Yes			Yes	NA	NA		Yes	NA	Yes	NA	Yes	Yes				NA	6	35%
~ Mixed methods studies					NA	NA			NA		NA						NA	0	0%
Criteria development:																			
~ Pilot study	Yes				NA	NA			NA		NA			Yes			NA	2	12%
~ Adapted from the literature		Yes		Yes	NA	NA			NA	Yes	NA	Yes	Yes			Yes	NA	6	35%
Number of criteria (appraisal checklists)																			
~ Qualitative studies	14	7	Uk	23	NA	NA	11	9	NA	13	NA	10	24	Uk	10	7	NA	128	16.0
~ Quantitative studies	15	8	Uk	4	NA	NA	13	7	NA	26	NA	14	34	Uk	b	6	NA	127	21.2
~ Mixed methods studies	25				NA	NA			NA		NA						NA	25	NA
Reliability assessment																			
					NA	NA	Yes		NA	Yes	NA	Yes		Yes			NA	4	24%
Independency from reviewers' expertise																			
					NA	NA			NA		NA	Yes					NA	1	6%
Implications:																			
Order primary studies by methodological quality	Yes	Yes	Yes	Yes	NA	NA	Yes	Yes	NA	Yes	NA	Yes	Yes	Yes	Yes	Yes	NA	12	71%
~ Retain all studies whatever the methodological quality		Yes		Yes	NA	NA			NA	Yes	NA			Yes	Yes	Yes	NA	6	35%
~ Exclude 'poor methodological quality' primary studies			Yes		NA	NA	Yes	Yes	NA		NA	Yes	Yes				NA	5	29%
~ Keep 'poor' qualitative studies when illuminating	Yes				NA	NA			NA		NA						NA	1	6%

Abbreviations: 1, Yes; NA, not applicable; Uk, unknown. ^aClear procedure based on the MSR paper, or cited sources, or communication with authors. ^bSame criteria used for quantitative and qualitative studies.

4.2.2. Criteria development

In two SMSRs (12%), criteria were developed following a specific procedure (pilot study). In six SMSRs (35%), criteria were simply adapted from the literature, and usually informed by reviewers' experience and expertise. In the remaining SMSRs, the development of criteria was not described.

4.2.3. Number of criteria

Table 4 shows that SMSRs contained on average 28 criteria for appraising qualitative and quantitative studies (range from 10 to 58). When appraisal checklists were valid, they usually contained more criteria than our proposal. There were two exceptions: three valid criteria were used in SMSR #4 to appraise quantitative observational studies, and 10 valid criteria were used in SMSR #12 for appraising qualitative studies.

4.2.4. Reliability assessment

In four SMSRs (24%), a reliability assessment was described or mentioned. The inter-reviewer reliability agreement was usually high (e.g., 0.84 in SMSR #14).

4.2.5. Independence from reviewers' expertise

No SMSR described the fit between reviewers' expertise and appraised primary studies. In SMSR #12, a manual for reviewers made the appraisal independent from reviewers' expertise. For each criterion, answers 'yes/partial/no' were defined, and the manual permitted reviewers to judge each descriptor in a similar manner. In the remaining SMSRs, criteria for quality appraisal were based on descriptors that require specific expertise (accuracy, adequacy, appropriateness, clarity, credibility, deepness, goodness, importance, usefulness, relevance and sufficiency). For example, judging the value of the appropriateness of an ethnographic method requires specific expertise in anthropology or qualitative research.

4.2.6. Implications

The quality appraisal led to the ordering of primary studies by methodological quality, and SMSR papers described or mentioned a final rating of studies. While six SMSRs (35%) retained all studies whatever their methodological quality (final ratings being available in text or in table format), five SMSRs (29%) excluded 'poor quality' studies, and one retained 'poor quality' qualitative studies when their findings were 'illuminating'.

5. Discussion

Results support the usability of the proposed 15 characteristics for concomitantly appraising the methodological quality of qualitative, quantitative and mixed methods studies in a SMSR context. The content validity of this initial set of criteria is supported by the literature and our review of

SMSRs in health sciences. This minimum set may decrease the burden on reviewers. A revised set of criteria is presented in the next Section 5.1.

In our sample, the fact that only two of 17 SMSRs (12%) described a development of criteria is not idiosyncratic to mixed methods research. Katrak et al. (2004) examined 121 tools for appraising the methodological quality of empirical studies (114 for appraising quantitative studies and seven for appraising qualitative studies), and found only 12% were developed using empirical research. In our sample five SMSRs (29%) described or mentioned a reliability assessment of quality appraisal criteria, while Katrak et al. (2004) documented such reliability assessment for only 8% of the above-mentioned 121 tools.

5.1. A scoring system for SMSRs and mixed methods research

Our results suggest a scoring system to concomitantly appraise the methodological quality of qualitative, quantitative and mixed methods studies for SMSRs (Box 4). This scoring system is based on the proposed 15 quality criteria, which were revised as follows. The criterion 'Qualitative approach or design or method' has been replaced by 'Appropriate qualitative approach or design or method', and 'Description of participants and sampling' by 'Description of participants and justification of sampling' with respect to the appraisal of qualitative studies. Regarding the appraisal of quantitative observational studies, the criterion 'Description of the selection of participants' has been replaced by 'Appropriate sampling and sample', and 'Description of measurements' by 'Justification of measurements (valid or standard)'.

Criteria for appraising quantitative experimental studies have been revised in line with the 2008 version of the Cochrane reviewer handbook (Higgins and Green, 2008). The criterion 'Blinding' has been replaced by 'Allocation concealment and/or blinding'. Indeed, the use of the Jadad et al.'s scale (1996) has been discouraged since it does not cover an important bias in experimental studies, i.e., the allocation concealment (Higgins and Green, 2008, Section 8.10.1). We also replaced the criterion 'Randomization' by 'Appropriate sequence generation and/or randomization' and the criterion 'Low withdrawal/drop-out' by 'Complete outcome data and/or low withdrawal/drop-out'.

For each criterion, the presence/absence may be scored 1 and 0, respectively (Box 4). Then, a 'quality score' can be calculated as a percentage: [(number of 'yes' responses divided by the number of 'relevant criteria') × 100]. For example, studies with good qualitative and quantitative observational components plus good overall mixed methods approach may be scored 100%: [(6 + 3 + 3)/12] × 100. This system offers a rationale for excluding primary studies with a low methodological quality, and for describing retained studies by quality criteria.

Box 4. A scoring system for mixed methods research and mixed studies reviews.

Types of mixed methods study components or primary studies in a SMSR context ^a	Methodological quality criteria ^b
1. Qualitative	<ul style="list-style-type: none"> • Qualitative objective or question • Appropriate qualitative approach or design or method • Description of the context • Description of participants and justification of sampling • Description of qualitative data collection and analysis • Discussion of researchers' reflexivity
2. Quantitative experimental	<ul style="list-style-type: none"> • Appropriate sequence generation and/or randomization • Allocation concealment and/or blinding • Complete outcome data and/or low withdrawal/drop-out
3. Quantitative observational	<ul style="list-style-type: none"> • Appropriate sampling and sample • Justification of measurements (validity and standards) • Control of confounding variables
4. Mixed methods	<ul style="list-style-type: none"> • Justification of the mixed methods design • Combination of qualitative and quantitative data collection-analysis techniques or procedures • Integration of qualitative and quantitative data or results

Caution notice: Outside quantitative experimental studies, the implication of clustering primary studies or study components by quality score has not been critically examined. With respect to systematic reviews of quantitative experimental studies, the clustering of primary studies and the weighting of quantitative results by quality score are discouraged.

^a Potential applications: *With respect to mixed methods research in general*: Appraisal of the methodological quality of qualitative, quantitative and mixed methods components. *With respect to systematic mixed studies reviews*: Concomitant appraisal of the methodological quality of primary qualitative, quantitative and mixed methods studies.

^b Procedure for planning, reporting and assessing mixed methods research or mixed studies reviews. For each type of study component or primary study, describe the methodological quality by criterion. Score presence/absence of criteria respectively 1/0 (complement the retained publication with related documents, and contact authors when more information is needed). Calculate a 'quality score' [(number of 'presence' responses divided by the number of 'relevant criteria') × 100]. Use this score as a rationale for excluding 'poor quality' study components or primary studies. Use the criteria for describing the quality of retained components or studies (qualitative quality appraisal).

After the exclusion of the 'lowest methodological quality' studies, our scoring system provides an assessment of the methodological quality of each retained primary study. The scoring system can be used to order studies by total score, and to report the score for each study within the assessment. Quality scales are not transparent to readers, and "it is preferable to use simple approaches for assessing validity that can be fully reported" (Higgins and Green, 2008, Section 8.3.3). For SMSRs, such 'qualitative quality appraisal' can show how each study (qualitative, quantitative observational, quantitative experimental, mixed) was rated with respect to each relevant criterion.

In addition, we believe that our scoring system can be used to appraise the quality of mixed methods research. In line with GRAMMS (Good Reporting of A Mixed Methods Study), our system permits the separate appraisal of the methodological quality of qualitative components and quantitative components of mixed methods research, which is important since "both components may suffer as a consequence of being part of a mixed methods research" (O'Cathain et al., 2008, p. 2). Furthermore, our system makes no value judgments about the relative merits of

qualitative vs. quantitative methods, while we assume that the quality of studies may be ordered within types of methods and designs.

5.2. Limitations

The proposed scoring system should be applied with caution since its reliability has not been examined. It is not a substitute of usual standards for reporting systematic literature reviews of (1) quantitative experimental studies such as the CONSORT statement (Consolidated Standards of Reporting Trials) and the QUOROM Guidelines for Meta-Analyses and Systematic Reviews of Randomized Controlled Trials or (2) quantitative observational studies such as the recommendations of the MOOSE group (Meta-analysis of Observational Studies in Epidemiology). Such standards may be used for a SMSR when there are enough similar studies of one type to plan a meta-analysis for example.

Outside quantitative experimental studies, the impact of clustering primary studies by range of quality scores has not been examined, and the proposed scoring system should be applied with caution (e.g., to compare results of 'high

quality' studies with those of 'moderate quality' studies). The clustering of primary studies and weighting of quantitative results have been discouraged in systematic reviews of quantitative experimental studies. According to the Cochrane reviewer handbook, "calculating a summary score inevitably involves assigning 'weights' to different items in the scale, and it is difficult to justify the weights assigned" (Higgins and Green, 2008, Section 8.3.3). For example, Jüni et al. (1999) showed that, depending on scales, the final results of meta-analyses of experimental studies differed.

Furthermore, our critical review of 17 SMSRs has three limitations. First, our sample is not representative of SMSRs published in all disciplines, while it is probably representative of SMSRs in health sciences since we searched a bibliographic database, MEDLINE, which covers the fields of medicine, nursing, dentistry, veterinary medicine, the health care system, and the preclinical sciences. Second, our analysis depends on the quality and quantity of reported information in papers on SMSRs (documentary data), although we partially overcame this limitation by emailing authors. Third, we did not address specific issues raised by 'participatory research' approaches since there were no participatory studies or reviews in our sample.

5.3. Lessons learned for conducting and reporting MSRs

In addition to the proposed scoring system, five lessons can be learned from our review of the 59 MSRs, which provide guidance on key processes that should be reported. They are presented below in accordance with the above-mentioned generic activities defining literature reviews. These lessons assist in delineating the nature of MSR, how it is undertaken, and processes that should be included and reported in publications. First, regarding 'Question/objective', the difference between MSRs and other forms of literature reviews is illustrated as follows. While the purpose of MSRs may be exploratory, confirmatory or both exploratory and confirmatory, the purpose of literature reviews of qualitative studies is usually exploratory (Paterson et al., 2003), and that of literature reviews of quantitative studies is usually confirmatory (Clarke and Oxman, 2003).

Second, concerning the 'Identification' activity, our MSR sample shows that the comprehensiveness of procedures for identifying potentially relevant studies varies. Not surprisingly, SMSRs were the most comprehensive in terms of identification, and SMSRs may ideally refer to comprehensive searches for references within multiple sources up to saturation (new sources providing no new references). However, comprehensive SMSRs require important resources that are not necessarily available (e.g., to screen thousands of references, select relevant studies from hundreds of full-text papers, and appraise and synthesize retained studies). Less comprehensive RMSRs can be useful, particularly scoping reviews that map different studies in a field to

define/refine research/evaluation questions (Arksey and O'Malley, 2005). Both SMSRs and RMSRs will benefit from specific strategies for searching qualitative, quantitative, and mixed methods studies.

Third, regarding the 'Selection' activity in our MSR sample, the number of reviewed quantitative primary studies is higher than the number of qualitative studies, which in turn is higher than the number of mixed methods studies. This is not surprising, since in health sciences, published studies are most frequently quantitative, while few qualitative studies and even fewer mixed methods studies are published (McKibbin and Gadd, 2004). However, the description of primary studies was frequently confusing in our sample. Reviewers usually confounded designs (e.g., ethnography) and data analysis (e.g., thematic analysis) or data collection techniques (e.g., interviews). SMSRs should ideally mention the design or approach of selected studies, and data collection/analysis techniques, when they describe the retained primary studies.

Fourth, with respect to the 'Appraisal' activity in our MSR sample, no articles reporting SMSRs described how the expertise of reviewers matched the reviewed studies, while quality appraisal depends on reviewer expertise. Qualitative, quantitative, and mixed methods primary studies or study components should ideally be appraised by reviewers with relevant expertise in qualitative, quantitative and mixed methods research, respectively. For instance, a strong background in epidemiology is the basis for assessing quantitative studies, but a 'trialist' is needed for critically appraising quantitative experimental studies. Our work suggests appropriate reviewers' expertise is required for conducting SMSRs, and should be reported.

Fifth, regarding the 'Synthesis' activity in our MSR sample, qualitative findings and quantitative results were assimilated, *or* complementary and/or divergent. However, qualitative findings and quantitative results may be assimilated, *and/or* complementary, *and/or* divergent (Pluye et al., 2005). All MSRs contained a synthesis of qualitative findings and quantitative results in our sample, but the procedures of synthesis were rarely described and most frequently referred to simple techniques (e.g., qualitative thematic analysis). Further MSRs will benefit from the *Cochrane Group for Qualitative Research Methods* that has published a guide to conducting narrative synthesis, which describes diverse and useful techniques (Popay et al., 2006) or other guidance (e.g., Dixon-Woods et al. (2005)).

6. Conclusion

The rationale for conducting mixed methods research lies in combining the strengths of both qualitative and quantitative studies. Typically, the former studies provide in-depth descriptions of complex phenomena that are context-specific, but may suggest theoretical and methodological lessons transferable to other contexts, while the latter examine

observations or causal relationships that may be generalized using statistical inferences. In the present paper, we define MSR as a form of mixed methods research, and propose a scoring system for concomitantly appraising the methodological quality of qualitative, quantitative and mixed methods studies in SMSRs. We believe that this system can also be used to appraise the methodological quality of mixed methods research in general. Our work suggests further research should examine the reliability of the proposed scoring system, and the impact of clustering primary studies or study components by range of quality scores on SMSR results.

Conflict of interest

None.

Appendix A. The 59 retained health-related Mixed Studies Reviews

A.1. Systematic Mixed Studies Reviews (SMSRs)

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- SMSR#01: Alborz, A., McNally, R., 2004. Developing methods for systematic reviewing in health services delivery and organization: an example from a review of access to health care for people with learning disabilities. Part 2. Evaluation of the literature—a practical guide. *Health Information and Libraries Journal*, 21 (4), 227–236.
- SMSR#02: Bahtsevani, C., Uden, G., Willman, A., 2004. Outcomes of evidence-based clinical practice guidelines: a systematic review. *International Journal of Technology Assessment in Health Care*, 20 (4), 427–433.
- SMSR#03: Bamba, C., Whitehead, M., Hamilton, V., 2005. Does ‘welfare-to-work’ work? A systematic review of the effectiveness of the UK’s welfare-to-work programmes for people with a disability or chronic illness. *Social Science and Medicine*, 60 (9), 1905–1918.
- SMSR#04: Davies, E., Higginson, I.J., 2003. Communication, information and support for adults with malignant cerebral glioma: a systematic literature review. *Support Care Cancer*, 11 (1), 21–29.
- SMSR#05: Dhaliwal, S.K., Hunt, R.H., 2004. Doctor–patient interaction for irritable bowel syndrome in primary care: a systematic perspective. *European Journal of Gastroenterology Hepatology*, 16 (11), 1161–1166.
- SMSR#06: Gallant, M.P., 2003. The influence of social support on chronic illness self-management: a review and directions for research. *Health Education and Behavior*, 30 (2), 170–195.
- SMSR#07: Gorman, T.E., Ahern, S.P., Wiseman, J., Skrobik, Y., 2005. Residents’ end-of-life decision making with adult hospitalized patients: a review of the literature. *Academic Medicine*, 80 (7), 622–633.
- SMSR#08: Hallberg, I.R., 2004. Death and dying from old people’s point of view. A literature review. *Aging Clinical and Experimental Research*, 16 (2), 87–103.
- SMSR#09: Halm, M.A., 2005. Family presence during resuscitation: a critical review of the literature. *American Journal of Critical Care*, 14 (6), 494–511.
- SMSR#10: Hignett, S., 2003. Systematic review of patient handling activities starting in lying, sitting and standing positions. *Journal of Advanced Nursing*, 41 (6), 545–552.
- SMSR#11: Houde, S.C., 2002. Methodological issues in male caregiver research: an integrative review of the literature. *Journal of Advanced Nursing*, 40 (6), 626–640.
- SMSR#12: Lee, R.C., Kmet, L., Cook, L.S., Lorenzetti, D., Godlovitch, G., et al., 2005. Risk assessment for inherited susceptibility to cancer: a review of the psychosocial and ethical dimensions. *Genetic Testing*, 9 (1), 66–79.
- SMSR#13: Milton, B., Whitehead, M., Holland, P., Hamilton, V., 2004. The social and economic consequences of childhood asthma across the lifecycle: a systematic review. *Child: Care Health and Development*, 30 (6), 711–728.
- SMSR#14: Morin, K.H., Ashton, K.C., 2004. Research on faculty orientation programs: guidelines and directions for nurse educators. *Journal of Professional Nursing*, 20 (4), 239–250.
- SMSR#15: Payne, S., Kerr, C., Hawker, S., Hardey, M., Powell, J., 2002. The communication of information about older people between health and social care practitioners. *Age and Ageing*, 31 (2), 107–117.
- SMSR#16: Verbeek, J., Sengers, M.J., Riemens, L., Haafkens, J., 2004. Patient expectations of treatment for back pain: a systematic review of qualitative and quantitative studies. *Spine*, 29 (20), 2309–2318.
- SMSR#17: Visser, A., Huizinga, G.A., van der Graaf, W.T., Hoekstra, H.J., Hoekstra-Weebers, J.E., 2004. The impact of parental cancer on children and the family: a review of the literature. *Cancer Treatment Review*, 30 (8), 683–694.
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A.2. Reproducible Mixed Studies Reviews (RMSRs)

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- RMSR#01: Badger, F., Werrett, J., 2005. Room for improvement? Reporting response rates and recruitment in nursing research in the past decade. *Journal of Advanced Nursing*, 51 (5), 502–510.
- RMSR#02: Brooker, D., 2005. Dementia care mapping: a review of the research literature. *Gerontologist*, 45 Spec. No. 1 (1), 11–18.
- RMSR#03: Button, L., Green, B., Tegnah, C., Johansson, I., Baker, C., 2005. The impact of international placements on nurses' personal and professional lives: literature review. *Journal of Advanced Nursing*, 50 (3), 315–324.
- RMSR#04: Caris-Verhallen, W., Timmermans, L., van Dulmen, S., 2004. Observation of nurse–patient interaction in oncology: review of assessment instruments. *Patient Education Counselling*, 54 (3), 307–320.
- RMSR#05: Crawford, M., Popp, D., 2003. Sexual double standards: a review and methodological critique of two decades of research. *The Journal of Sex Research*, 40 (1), 13–26.
- RMSR#06: Elder, N.C., Dovey, S.M., 2002. Classification of medical errors and preventable adverse events in primary care: a synthesis of the literature. *Journal of Family Practice*, 51 (11), 927–932.
- RMSR#07: Hawley, D.R., Bailey, C.E., Pennick, K.A., 2000. A content analysis of research in family therapy journals. *Journal of Marital and Family Therapy*, 26 (1), 9–16.
- RMSR#08: Humphreys, J., Parker, B., Campbell, J.C., 2001. Intimate partner violence against women. *Annual Review of Nursing Research*, 19, 275–306.
- RMSR#09: Im, E.O., Page, R., Lin, L.C., Tsai, H.M., Cheng, C.Y., 2004. Rigor in cross-cultural nursing research. *International Journal of Nursing Studies*, 41 (8), 891–899.
- RMSR#10: Mattick, K., Bligh, J., 2003. Interprofessional learning involving medical students or doctors. *Medical Education*, 37 (11), 1008–1011.
- RMSR#11: Mukoma, W., Flisher, A.J., 2004. Evaluations of health promoting schools: a review of nine studies. *Health Promotion International*, 19 (3), 357–368.
- RMSR#12: Mutchnick, I.S., Moyer, C.A., Stern, D.T., 2003. Expanding the boundaries of medical education: evidence for cross-cultural exchanges. *Academic Medicine*, 78 (10 Suppl.), S1–S5.
- RMSR#13: Noone, J., 2000. Cultural perspectives on contraception: a literature review. *Clinical Excellence for Nurse Practitioners*, 4 (6), 336–340.
- RMSR#14: Nystrom, K., Ohrling, K., 2004. Parenthood experiences during the child's first year: literature review. *Journal of Advanced Nursing*, 46 (3), 319–330.
- RMSR#15: Persoon, A., Heinen, M.M., van der Vleuten, C.J., de Rooij, M.J., van de Kerkhof, P.C., et al., 2004. Leg ulcers: a review of their impact on daily life. *Journal of Clinical Nursing*, 13 (3), 341–354.
- RMSR#16: Radyowijati, A., Haak, H., 2003. Improving antibiotic use in low-income countries: an overview of evidence on determinants. *Social Science and Medicine*, 57 (4), 733–744.
- RMSR#17: Robinson, A., McGrail, M.R., 2004. Disclosure of CAM use to medical practitioners: a review of qualitative and quantitative studies. *Complementary Therapies in Medicine*, 12 (2–3), 90–98.
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