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Methods for data extraction and data transformation in convergent integrated mixed methods systematic reviews.

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## **Methods for Data Extraction and Data Transformation in Convergent Integrated Mixed Methods Systematic Reviews**

Abstract:

Objective:

To describe what is, when, and how to undertake data transformation involving qualitization and to clarify how this process aligns with data extraction in order to expand on the current guidance for JBI convergent integrated mixed methods systematic reviews (MMSRs).

Introduction:

The convergent integrated approach to MMSRs involves combining extracted data from both quantitative studies (including the quantitative components of mixed methods studies) and qualitative studies (including the qualitative components of mixed methods studies). This process requires data transformation, which can occur either by converting qualitative data into quantitative data (i.e., *quantitizing*) or converting quantitative data into qualitative data (i.e., *qualitizing*). Data transformation involving qualitization is poorly understood in the context of MMSRs and there appears to be confusion regarding how to undertake this process, with much of the literature specific to primary mixed methods studies. There is a need to expand current guidance and provide more practical advice to reviewers on how to undertake this process.

Methods:

The JBI MMSR Methodology Group took a multi-pronged approach to update its guidance. First, a structured search of the literature was conducted to determine what is known about data transformation followed by analysis of a sample of systematic reviews that claimed to use the JBI convergent integrated approach to MMSRs. Approaches were summarized and used to inform the development of draft guidance. This guidance was iteratively revised following a series of online meetings, as well as presented to evidence synthesis experts at an international conference. Finally, the guidance was submitted to the JBI International Scientific Committee for discussion, feedback, and ratification.

Results:

There is uncertainty in the literature regarding the process of data transformation within the context of MMSRs, with ill-defined approaches provided and variation in practice. In JBI convergent integrated MMSRs, it is recommended that data extraction from quantitative studies (or mixed method studies reporting quantitative findings) stays as close as possible to the data reported in the

primary studies. Where data are absent or insufficient to meet the needs of the MMSR, systematic reviewers may need to construct the narrative representation using relevant data from the primary studies. Following data extraction, the process of qualitization occurs where extracted data (both quantitative and qualitative) are assembled and reviewers are required to conduct detailed examination across data to identify likenesses and thus create categories based on similarities in meaning.

Conclusion:

To our knowledge, this is the most comprehensive guidance currently available for data extraction and qualitization for MMSRs. However, it is important to acknowledge the inherent variability in MMSRs and our methodology may need tailoring for certain situations. Further work will focus on examining how certainty and confidence in findings can be assessed within the framework of MMSRs.

Keywords: convergent integrated mixed methods systematic review, data transformation, data extraction, mixed methods systematic review, qualitization

Introduction

Mixed methods systematic reviews (MMSRs) are an important development in the field of evidence-based healthcare as they allow a broader and deeper understanding of a phenomenon of interest than that offered by single method reviews.<sup>1-4</sup> While MMSRs share the same transparent and rigorous methodological steps as other types of systematic reviews, they have distinct features for synthesis and integration, combining data across quantitative, qualitative, and mixed methods studies.<sup>4,5</sup> This distinction, leads to unique challenges largely related to how (and when) these data can be integrated. The JBI approach to MMSRs recommends that reviewers take either a convergent segregated or convergent integrated approach to synthesis, with the approach dictated by the nature of the question(s) posed.<sup>6</sup> The convergent segregated approach involves independent syntheses of quantitative data and qualitative data, which are subsequently integrated. On the other hand, the convergent integrated approach relies on data transformation to ensure compatibility between quantitative and qualitative data. While the convergent segregated approach appears to be more commonly used and has more established methods (for the independent syntheses component), methods describing data transformation in the convergent integrated approach are less well described. Data transformation can occur either by converting qualitative data into quantitative data (i.e., *quantitizing*) or by converting quantitative data into qualitative data (i.e.,

*qualitizing*). The JBI approach calls for 'qualitizing' quantitative data for a convergent integrated MMSR as codifying quantitative data is less error-prone than attributing numerical values to qualitative data.<sup>7</sup> The JBI guidance for MMSRs describes qualitizing as a process that involves extracting data from quantitative studies and then translating or converting them into 'textual descriptions' to allow integration with qualitative data.<sup>6</sup>

Qualitization is poorly understood in the context of systematic reviews and there appears to be confusion regarding how to undertake this process and how it relates to the data extraction process. There is a need for JBI to expand on its current guidance and provide more practical advice to reviewers on how to undertake this process.

#### Aims

- To describe what is, when, and how to undertake data transformation involving qualitization and to clarify how this process aligns with data extraction in order to expand on the current guidance for JBI convergent integrated MMSRs to provide more practical advice to reviewers.

#### Methods

The JBI MMSR Methodology group, composed of an international panel of academic and clinical researchers, is responsible for providing methodological guidance on how to conduct MMSRs to the JBI Collaboration (an international group of self-governing entities that advocate the synthesis, transfer and utilization of evidence to improve healthcare outcomes).<sup>8</sup> The group released its updated guidance on the conduct of MMSR in 2020<sup>6</sup>, and since then it has become a popular methodology among mixed methods systematic reviewers. Given its widespread adoption in the systematic review community, the group continuously evaluates its guidance and collects feedback from users to ensure its relevance and appropriateness. One of the most common comments received by the group is the challenge associated with data transformation for a convergent integrated approach to MMSR.

To address this challenge, the group undertook a multi-pronged approach that encompassed: a structured literature search to determine what is known about the topic within the context of evidence synthesis, identification and analysis of a sample of systematic reviews which cited the JBI approach for convergent integrated MMSRs, development of draft guidance and external validation and refinement.

#### *Literature search*

To address the challenges associated with data transformation, the group performed a structured search of the literature in PubMed (NLM), CINAHL (EBSCOhost), and Google Scholar in May 2023. The objective of this search was to identify existing knowledge and methodologies related to data transformation, particularly qualitzation, in MMSRs.

The search employed broad terms to capture a wide range of relevant literature, ensuring that we identified both foundational and recent advancements in data transformation methodologies. Search terms were a combination of index headings and key terms (title and abstract fields searched) and included: mixed methods, data transformation, qualitzation, evidence synthesis, and systematic review. No limits were placed on date, language or publication type. The inclusion criteria focused on articles that discussed data transformation within the context of MMSRs or provided relevant insights into data integration strategies. We excluded articles that did not specifically address data transformation or qualitzation or that were unrelated to systematic review methodologies.

#### *Identification and analysis of MMSRs citing a convergent integrated approach*

To further understand how data transformation is implemented in practice, a sample of systematic reviews that claimed to use the JBI convergent integrated approach to MMSR were analyzed. The goal was to examine how authors conducted data transformation and identify common practices and innovations. Using Google Scholar, two members of the methodology group identified the first 30 papers that cited the JBI MMSR methodology, sorted by relevance according to Google's ranking algorithm. This approach was chosen to prioritize impactful and highly cited works that referenced the JBI methodology, rather than focusing solely on the most recent publications. Papers that were not systematic reviews were excluded as were systematic reviews that did not follow a convergent integrated approach.

The selected reviews were examined to extract information on their qualitzation methods, where reported. We specifically examined how reviewers qualitized quantitative data, including the processes and techniques employed. For instances where qualitized data were described, the original primary studies were also retrieved to verify and understand how qualitzation occurred. This step ensured that our analysis was grounded in actual practices and that our findings accurately reflected the nuances of data transformation in MMSRs.

The methods used in different reviews were compared to identify similarities and differences in data transformation approaches. Common themes, innovative practices, and areas where guidance was

lacking or unclear were identified. This comparative analysis provided valuable insights into the current state of data transformation methodologies in MMSRs.

#### *Development of guidance*

Based on the findings from our analysis, a narrative summary was developed to encapsulate the key insights and challenges associated with quality in MMSRs. This summary served as the foundation for drafting new guidance, highlighting areas where existing methodologies could be strengthened or expanded.

The draft guidance was circulated to the wider JBI MMSR Methodology Group for review and feedback. The group engaged in a series of online meetings and discussions between July and October 2023, supplemented by regular email correspondence. This collaborative process ensured that diverse perspectives and expertise were incorporated into the final guidance. Online meetings provided a platform for real-time discussion and debate, allowing the group to address differing viewpoints and reach consensus. Regular email communication facilitated ongoing dialogue and allowed for the exchange of detailed feedback and suggestions.

#### *External validation and refinement*

In November 2023, the draft guidance was presented to an audience of evidence synthesis experts at the JBIiGNITE international conference. This presentation provided an opportunity for critique and feedback from a broader community of researchers and practitioners.

Based on the comments received during this event, refinements were made to the guidance to ensure it met the needs and expectations of the wider research community. This iterative process of feedback and refinement was crucial in enhancing the guidance's clarity, applicability, and impact.

#### *Final review and approval*

The finalized guidance underwent a final review by the JBI MMSR Methodology Group before submission to the JBI International Scientific Committee in January 2024. On March 19, 2024, the guidance was presented to the Committee for discussion and debate. After addressing minor feedback from the Committee, the guidance was resubmitted and subsequently ratified on June 25, 2024. This approval process ensured that the guidance was rigorously evaluated and endorsed by leading experts in the field.

## Results

The structured search of the literature resulted in 208 papers that mentioned either 'data transformation' or 'quality'. It became apparent that most of the literature focused on data

transformation for primary mixed methods studies with very scarce information available for secondary studies or systematic reviews. The papers that did refer to systematic reviews<sup>9, 10, 11, 3, 12</sup> provided definitions or descriptions of data transformation and agreed it is a necessary step in facilitating the integration of quantitative and qualitative data from primary studies. However, none offered comprehensive guidance on the procedural aspects of this process in a systematic review.

Eleven reviews that cited the JBI methodology and followed the JBI convergent integrated approach were examined.<sup>13-23</sup> Upon evaluating the methods employed for data transformation across these reviews, three distinct approaches were identified (as shown below). Approach one was observed in one systematic review<sup>19</sup>, while approach two was utilized in three reviews.<sup>13, 14, 18</sup> Notably, approach three emerged as the most prevalent, being applied in seven reviews.<sup>15-17, 20-23</sup> To illustrate these approaches and provide concrete examples, we selected five systematic reviews for demonstration. These reviews were chosen over others due to their ability to effectively illustrate the specific methods employed in a more explicit manner.

*Approach 1:* Reviewers extract verbatim data from the included primary quantitative studies (or mixed methods studies), which includes both the numeric results and the narrative representation of the primary research authors (Example A, Table 1).<sup>19</sup> The review authors considered these verbatim data as '*qualitized statements*' (given the inclusion of *textual* descriptions) that can then be combined with the qualitative data from the included qualitative primary studies. All qualitized statements and qualitative data are coded to facilitate integration; codes are grouped into subthemes and further into themes to answer the review question(s).

*Approach 2:* Reviewers extract numeric data and/or narrative text from the primary quantitative studies (or mixed methods studies) but they are not verbatim. Reviewers 'tweak' the data to include contextual information (Example B1, Table 1)<sup>13</sup> or rephrase the narrative text from the primary study to improve clarity and alignment with the review objectives (Example B2, Table 1).<sup>18</sup> As with Approach 1, the textual descriptions or narrative representations of the quantitative results by the primary authors are considered as qualitized data. All qualitized data and qualitative data are first coded, then grouped into subthemes and further into themes to answer the review question(s).

*Approach 3:* Reviewers extract data from the primary quantitative studies (or primary mixed methods studies) first, and then undertake qualitization as the next step. In some reviews, qualitization involves numeric data being replaced with text descriptors, such as *majority, more than half, some, significantly higher, most, etc.*, based on the interpretation of the review authors (Example C, Table 1).<sup>16</sup> In other reviews, qualitization involves assigning a descriptive label or textual statement to the extracted quantitative data (Example D, Table 1).<sup>17</sup> After the process of

qualitization, the text descriptors/textual statements (qualitized data) and qualitative data are coded, then grouped into subthemes and further into themes to answer the review question(s).

**Table 1: Examples of transformation approaches in sampled reviews**

Example	Systematic review objective	Quantitative data presented in the primary study	Data presented in results of systematic review
<p><b>Approach 1</b></p> <p>Example A<sup>19</sup></p>	<p>To explore whether risk stratification within population-based cancer screening programs is acceptable to health care professionals (HCP)</p>	<p>The majority of HCPs agreed that risk stratification for ovarian cancer would help identify those in most need of screening (89.8%, N=131). 63.7% (N=93) felt it would give patients a sense of control over their health. 71.9% (N=105) of HCPs felt patients would be reassured by being stratified into a low-risk group.”<sup>24</sup></p>	<p><u>Example of extracted data from the included primary study, reported as qualified statement in the review</u></p> <p>The majority of HCPs agreed that risk stratification for ovarian cancer would help identify those in most need of screening (89.8%, N=131). 63.7% (N=93) felt it would give patients a sense of control over their health. 71.9% (N=105) of HCPs felt patients would be reassured by being stratified into a low-risk group.</p>
<p><b>Approach 2</b></p> <p>Example B1<sup>13</sup></p>	<p>To explore the factors that influence engagement in physical activity during the first three months following coronary artery bypass graft surgery</p>	<p>Forty-one percent of the women stated that they spent more than 3hours per day on household activities in contrast to 14% of the men (p &lt; .001).<sup>25</sup></p>	<p><u>Example of extracted data from the included primary study</u></p> <p>41% of females spent more than 3 hours/day on household activities in contrast to 14% of males (p&lt;0.001) at two months post-op.</p>
<p><b>Approach 2</b></p> <p>Example B2<sup>18</sup></p>	<p>To assess the influence of COVID-19 on body image, disordered eating behaviors, and eating disorder outcomes</p>	<p>When asked the effect of the lockdown on ED symptomatology 16 (42.1%) reported feeling an improvement, 14 (36.8%) reported no change and 8 (21.1%) reported that they felt their ED was worse. When patients were asked if the lockdown effected their access to ED related healthcare, 23.7% felt it often did. Beck Depression Inventory predicted 53.7% of the variance of ED behaviour. <sup>26</sup></p>	<p><u>Example of extracted data from the included primary study</u></p> <p>42% reported improved eating disorder (ED) symptomatology, 37% reported no change, 21% reported worse ED symptomatology from pre- to during lockdown; 24% reported that lockdown affected access to ED-related healthcare; depression score had the highest predictive value for ED behavior (r<sup>2</sup> = .537)</p>

<p><b>Approach 3</b></p> <p>Example C<sup>16</sup></p>	<p>To explore parents' self-reported experiences and information needs regarding recognition and management of pediatric anaphylaxis</p>	<p>Did not renew it because thought was no longer necessary n=12 (54.6%)<sup>27</sup></p> <p>Approximately 94% of mothers reported that they had a prescribed self-injectable epinephrine (EpiPen) for their child, 67% reported that they carry an EpiPen with them at all times, and 13% reported that they had used an EpiPen on their child at least once.<sup>28</sup></p>	<p><u>Example of qualitized data (review did not provide the actual extracted data)</u></p> <p>More than half of the parents who did not have a prescribed epinephrine injection believed the injection was no longer needed.</p> <p>Majority of mothers reported being ready to manage a reaction by carrying an epinephrine injection with them at all times.</p>
<p><b>Approach 3</b></p> <p>Example D<sup>17</sup></p>	<p>To determine the barriers and facilitators to the implementation of midwife-led care for childbearing women in low and middle income countries (LMICs) from the perspectives of care recipients, providers and wider stakeholders</p>	<p>Respondents living within 30 min of a health facility were 1.4 times more likely to use antenatal care services (OR = 1.44, 95% CI: 1.18-1.77) compared to those who had to walk more than 30 min.<sup>29</sup></p> <p>The main reasons that women did not seek skilled birth attendants (SBA) services included distance to a health facility (45%) and inadequate transportation (21%).<sup>29</sup></p>	<p><u>Example of a qualitized data (review did not provide the actual extracted data)</u></p> <p>Living less than 30 mins from health facility enhanced midwifery care</p> <p>Lack of transport hindered access for women in remote areas.</p>

These examples indicate a varied approach to what reviewers consider qualitization and when and how it takes place in MMSRs. Some reviews considered the numeric results and the accompanying textual descriptions or narrative representations from the primary authors as qualitized data already. In this instance, qualitization does not appear to be an additional process but rather occurs implicitly during data extraction. In other reviews, qualitization occurs as an additional process following data extraction and prior to integration by the review authors. In these reviews, qualitization involves replacing numerical results with descriptive text or statements. In either approach, review authors integrate findings by forming subthemes and themes that address the review question.

Our approach

Drawing insights from examining the above approaches and following a consensus-driven methodology, we present guidance for the qualitzation process. To ensure a clear and organized presentation of this guidance, we begin by describing the essential phase of data extraction, focusing specifically on quantitative studies (or the quantitative component of mixed methods studies). The extraction of data from qualitative studies will follow the standard process<sup>24</sup> and is not elaborated further in this guidance. Subsequent to the extraction of data from both quantitative and qualitative studies, qualitzation occurs as the integrative process undertaken by reviewers of analyzing all the extracted quantitative and qualitative data for perceptible patterns or areas of similarities. As these patterns/similarities emerge, categories are identified and further aggregated into integrated findings.

The following sections expound on other important procedures of data extraction and integration involving qualitzation.

#### Data extraction

##### *The need to report what and how data were extracted*

It is important that reviewers provide information about how data for extraction were identified (e.g. what data were considered a factor or determinant?). Often for convergent integrated MMSRs, the review question focuses on identifying determinants or factors (e.g., barriers and enablers) and as such, reviewers should explicitly describe how the determinants or factors were identified from the quantitative studies (and qualitative studies). This is particularly important when percentages or statistical significance is presented in the primary studies. Included primary quantitative studies are often cross-sectional surveys that are either descriptive or analytic in nature. While some reviewers extract all relevant factors regardless of numeric results, other reviewers may decide not to extract factors based on an arbitrarily set percentage cut-off or statistical significance. We recommend that reviewers extract **all** relevant data, including statistical information, to provide a more holistic understanding of the determinants or factors under investigation. Excluding factors based on statistical significance or cut-offs may lead to an incomplete picture, overlooking potentially important variables that contribute to the overall understanding of the phenomenon of interest.

The JBI MMSR methodology group recommends that reviewers extract and use the original data from the primary studies (where they can) and therefore ***data extraction in convergent integrated MMSRs stays as close as possible to the data reported in the primary studies***. In other words, where numeric results are accompanied by accurate and reliable narrative representation, reviewers

should extract this information verbatim (i.e., numeric results plus narrative text, as shown in example A above). Verbatim extraction will be possible in most cases.

Where verbatim extraction is possible but lacks the contextual information to clearly align with the review aims/questions, reviewers are encouraged to add the relevant information (from the primary studies) to the extracted data. This is illustrated in example B1 above where the review authors indicated in their finding a time parameter (i.e., two months post-op) to align with their review objective. In essence, the reviewers should only be supplementing the extracted data with information provided in the primary study, for example, follow-up data, relevant statistical information and comparator information. Reviewers should not rewrite or reframe the extracted data.

Lastly, there may be situations where there is no narrative for the results of interest and only numerical results are presented in a table or figure. When there is no narrative, we recommend reviewers develop the narrative representation of the results. They should attempt to follow the style and format that the primary authors used to narrate other results. For example:

*Review aim: To determine barriers and enablers to the participation or engagement of health professionals in quality improvement (QI) activities in the hospital setting.*

Scenario 1: The primary study presents a bar graph illustrating different barriers to QI participation. The graph shows the percentage of respondents (nurse executives) who identified each item as a major or moderate barrier. These items include physician resistance to change, insufficient data-related expertise, insufficient data collection resources, other staff resistance to change, insufficient implementation training for staff, lack of nurses, lack of other staff, not knowing the best measures or improvements, and inadequate institutional leadership. The accompanying text in the study states: *“Physician resistance to changes developed through quality improvement initiatives was rated as a moderate to major barrier by 49% of nurse executives, while staff resistance was not quite as common. Data again appeared to be a problem with insufficient staff expertise to analyze data and prepare reports and resources to collect data rated as moderate to major obstacles.”*

In this example, the authors of the primary study did not include the other barriers (i.e. insufficient implementation training for staff, lack of nurses, lack of other staff, not knowing best measures or improvements, and inadequate institutional leadership) in their narrative. An example narrative for these could be:

- 13% of nurse executives in the rural hospitals rated inadequate institutional leadership as a moderate to major barrier to QI participation.

- 20% of nurse executives in the rural hospitals indicated that not knowing which improvements or measures of improvement were best as a moderate to major barrier to QI participation.
- Lack of nurses was identified as a moderate to major barrier by 24% of nurse executives, while a smaller percentage (21%) identified lack of other staff as a moderate to major barrier.

Scenario 2: The primary study presents a table (Figure 1) of the different variables associated with QI participation. The table (Figure 1) presents the statistical results to show whether the variables are associated with QI participation. The accompanying text for the task domain in the study states: *“Two task-domain variables, job role, and quantitative workload were associated with QI participation. Specifically, advanced practice nurses (APNs) and managers reported greater QI participation compared to staff nurses. Higher level of quantitative workload was associated with greater frequency of QI participation.”*

<<<Figure 1 about here>>>

Figure 1: Variables Associated With Nurse-Reported Participation in Quality Improvement: Adapted with permission from Djukic et al 2020<sup>25</sup>

In this example, the authors of the primary study reported a narrative only for those variables where a statistically significant finding was found. An example narrative for the other non-significant variables could be:

- Patient load was not significantly associated with QI participation ( $p=0.881$ ).
- Variety in the job was not significantly associated with QI participation ( $p=0.762$ ).
- Autonomy at work was not significantly associated with QI participation ( $p=0.803$ ).

While verbatim extraction is the ideal scenario to minimize the chance of misinterpretation by the reviewers, it will not always be possible and will depend on the studies included in the review. Reviewers may be required to use multiple approaches in one study depending on how the results are presented by the primary study authors. Reviewers will not know what they are dealing with until they have commenced extraction, and it is important that they outline what modifications (if any) have been undertaken. We recommend that reviewers outline all possible approaches to extraction in their protocol but report on those used in the final review.

#### *The need for checking data*

Regardless of the approach taken, and like any systematic review, reviewers should always cross-check the narratives in primary studies with the numerical results in primary studies. If there are any

discrepancies between the numerical results and the narrative, the reviewers should consult the supplementary data (if available) and attempt to contact the authors for clarification. If this is not possible, we recommend utilizing the numerical results and noting any discrepancies in the review. Two hypothetical examples are provided in Table 2.

**Table 2: Hypothetical examples where numerical results and narrative statements are discrepant and advice for systematic reviewers**

Numerical results presented in primary study	Narrative statement presented in the primary study	Advice for systematic reviewers
<p>Study 1 From data table: Education: Odds ratio (OR) -1.18 (95% Confidence Intervals (CI) -1.71 to -0.67) P &lt; 0.001</p>	<p>No significant effect was found for level of education or increasing age.</p>	<ul style="list-style-type: none"> <li>• Is supplementary data available to investigate further?</li> <li>• Are the authors able to be contacted?</li> <li>• If no to either of the above, suggest using the numeric data instead of the narrative but commenting on this discrepancy in the review</li> </ul> <p>Example narrative commentary: The numerical results did not align or correlate with the authors' narrative description of the findings. Efforts were made to resolve this discrepancy by checking supplementary data that might clarify the authors' interpretations. Unfortunately, no such supplementary data were available. Moreover, attempts to contact the corresponding authors for clarification were unsuccessful, as we did not receive a response. Given the lack of clarification and additional information, we made the decision to prioritize the numerical data over the narrative descriptions provided by the authors. Therefore, in our analysis and synthesis of the findings, we have used the numerical data reported in the results section and have disregarded the contradictory narrative interpretations. This decision was based on the premise that numerical data are generally less subject to interpretive bias and provide a more objective basis for analysis.</p>

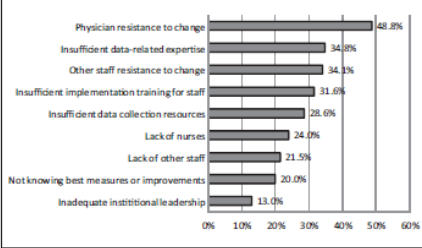
Reviewers should be wary about misinterpretations of numerical or statistical results and therefore should apply strategies to ensure narrative representations are accurate and reliable. These strategies include the review team having at least one member who is experienced in quantitative research or statistical analyses, and, double data extraction (with one experienced quantitative

researcher) or independent validation of extracted data by a person experienced in quantitative research.

*The need for transparency*

As with any scientific research, transparency is a core principle of systematic reviews and helps build trust not only among scholars but also consumers of research. It is in this regard that we recommend reviewers undertaking JBI convergent integrated MMSRs include a detailed extraction table in their published manuscript (as supplementary material or in the appendix). The table should clearly distinguish data obtained verbatim from the primary studies from those where modifications were made. See example in Table 3.

**Table 3: Exemplar data extraction table with verbatim data from the primary study**

Example VERBATIM data from the primary study	Was modification needed? Y/N	Outcome data																				
<p>The majority of <b>health care professionals</b> (HCPs) agreed that risk stratification for ovarian cancer would help identify those in most need of screening (89.8%, N=131). 63.7% (N=93) felt it would give patients a sense of control over their health. 71.9% (N=105) of HCPs felt patients would be reassured by being stratified into a low-risk group. Hann et al 2017<sup>27</sup></p>	N	<p>The majority of HCPs agreed that risk stratification for ovarian cancer would help identify those in most need of screening (89.8%, N=131). 63.7% (N=93) felt it would give patients a sense of control over their health. 71.9% (N=105) of HCPs felt patients would be reassured by being stratified into a low-risk group.</p>																				
<p>Forty-one percent of the women stated that they spent more than 3 hours per day on household activities in contrast to 14% of the men (<math>p &lt; .001</math>). (Kendel 2008)<sup>28</sup></p>	Y	<p>Forty-one percent of the women stated that they spent more than 3 hours per day on household activities in contrast to 14% of the men (<math>p &lt; .001</math>) at <b>two months post-op</b>.</p>																				
 <table border="1"> <caption>Barriers to Quality Improvement</caption> <thead> <tr> <th>Barrier</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Physician resistance to change</td> <td>49.8%</td> </tr> <tr> <td>Insufficient data-related expertise</td> <td>34.8%</td> </tr> <tr> <td>Other staff resistance to change</td> <td>34.3%</td> </tr> <tr> <td>Insufficient implementation training for staff</td> <td>31.6%</td> </tr> <tr> <td>Insufficient data collection resources</td> <td>28.6%</td> </tr> <tr> <td>Lack of nurses</td> <td>24.0%</td> </tr> <tr> <td>Lack of other staff</td> <td>21.5%</td> </tr> <tr> <td>Not knowing best measures or improvements</td> <td>20.0%</td> </tr> <tr> <td>Inadequate institutional leadership</td> <td>13.0%</td> </tr> </tbody> </table>	Barrier	Percentage	Physician resistance to change	49.8%	Insufficient data-related expertise	34.8%	Other staff resistance to change	34.3%	Insufficient implementation training for staff	31.6%	Insufficient data collection resources	28.6%	Lack of nurses	24.0%	Lack of other staff	21.5%	Not knowing best measures or improvements	20.0%	Inadequate institutional leadership	13.0%	N	<p>Physician resistance to changes developed through quality improvement initiatives was rated as a moderate to major barrier by 49% of nurse executives, while staff resistance was not quite as common. Data again appeared to be a problem with insufficient staff expertise to analyze data and prepare reports and resources to collect data rated as moderate to major obstacles.</p>
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<p>Physician resistance to changes developed through quality improvement (QI) initiatives was rated as a moderate to major barrier by 49% of nurse executives, while staff resistance was not quite as common.</p>	Y	<p>13% of nurse executives in the rural hospitals rated inadequate</p>																				

<p><i>Data again appeared to be a problem with insufficient staff expertise to analyze data and prepare reports and resources to collect data rated as moderate to major obstacles. (Paez et al 2013)<sup>25</sup></i></p>	<p>Y</p>	<p>institutional leadership as a moderate to major barrier to QI participation.</p> <p>20.0% of nurse executives in the rural hospitals indicated that not knowing which improvements or measures of improvement were best as a moderate to major barrier to QI participation.</p>
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The methods section of the review should further clarify the extraction table and provide explanation on whether only verbatim data were extracted and integrated with the qualitative data or where this is not the case, the reason/s for modification (e.g., to add contextual information or greater clarity) and how this process was undertaken. Decisions made by the reviewers (as outlined previously), for example, if they disagree with the narrative representation made by the primary authors, should be made explicit in the review. Should any of these pose a potential limitation to the review, the reviewers should acknowledge this in the discussion section.

#### Data integration involving qualitization

Following data extraction, the process of integration occurs. In this step, extracted data (both quantitative and qualitative) are assembled and reviewers are required to conduct detailed examination across data to identify likenesses and thus create categories based on similarities in meaning. The process of grouping or coding data into categories represents data transformation through qualitization, which specifically applies when the extracted data being grouped involve a mix of quantitative and qualitative data, or when only quantitative data are being categorized. In Figure 2 below, categories 1, 2 and 3 emerge through the process of qualitization, while the development of category 4 does not require qualitization. We therefore provide this definition of qualitization in JBI convergent integrated MMSR as:

*The integrative process in which extracted quantitative and qualitative data from primary studies are analyzed for identifiable patterns and systematically grouped into descriptive categories developed from mixed evidence sources. This process also applies where only quantitative data are grouped into categories.*

Categories are then aggregated to produce the overall integrated finding/s.

<<<Figure 2 about here>>>

Figure 2: JBI Convergent Integrated Approach to MMSR

## Discussion

In our previous guidance, we described qualitization as a process that involves converting 'quantities' (i.e. numerical results from quantitative or mixed methods studies) into declarative stand-alone sentences, in a way that answers the review question(s). However, the lack of clear guidance on how this process should be undertaken prompted our methodological investigation. In this updated guidance we provide reviewers with detailed methods not only for qualitization but also for data extraction, which is a critical step that facilitates the process of qualitization. We recommend that where possible, reviewers should utilize the primary studies' narrative representations to ensure congruency and alignment to the original data. The original numeric data and narrative statements are thus used and assembled with the qualitative data extracted from qualitative studies (or mixed methods studies). The ensuing integrative process that involves grouping the data into categories based on discernible patterns and similarities in meaning constitutes the process of qualitization. This approach aligns with the concept of qualitization as described by Sandelowski et al. (2006)<sup>3</sup> and Nzabonimpa (2018)<sup>26</sup> which revolves around identifying and imposing an underlying conceptual representation of the data through themes, typologies, or case profiles.

In this updated guidance, we emphasize the critical importance of accurate, thorough, and thoughtful data extraction. While accurate data extraction is fundamental to any systematic review, its meticulous application in MMSRs enhances the seamless integration of both quantitative and qualitative data. By utilizing the narrative developed by primary authors for their quantitative results, the need for further interpretation from reviewers is avoided. It is important to note, however, that this approach relies on the assumption that primary authors have accurately developed the narrative representations of the numerical results. As systematic reviewers, our role is not to replicate the narrative development process undertaken by primary authors but rather to ensure the precision of these representations. By elevating the extraction process, this guidance positions reviewers to integrate effectively while avoiding duplicating interpretive work likely already completed by the primary study authors. Data extraction in MMSRs should produce integration-ready datasets, not fragments requiring post-processing. Detailed instructions provided for extracting complete, narratively represented quantitative data thereby facilitates an efficient yet integrated MMSR.

In this guidance, we also underscore the importance of incorporating numerical results alongside narrative representations when analyzing extracted quantitative data for integration with qualitative

data. It is not uncommon for reviewers who conduct data transformation for MMSR to transform numerical results into statements or narratives, sometimes omitting the actual numeric outcomes or statistical results when combining them with qualitative data. This omission poses a risk of losing vital information during the process of data integration, especially in the context of JBI convergent integrated MMSRs. In convergent integrated MMSRs, findings are articulated as 'Integrated Findings,' representing patterns or recurring ideas/concepts derived from data during integration. Interestingly, these integrated findings rely on words or narratives, avoiding numerical values, even though such values contribute significantly to the overall findings. It is for this reason that our guidance emphasizes transparency, not only in detailing the processes and methods but also in presenting the extracted data from the included studies. This approach lets consumers of MMSRs effectively track and align the textual integrated findings with the underlying quantitative and qualitative evidence. In this way, no loss of granularity occurs when translating extracted statistical data into integrated findings.

## Conclusion

Our methodological investigation into the process of data transformation within MMSRs has shown there are diverse understandings of what it entails and how and when it should be undertaken. Our approach distinguishes data extraction from qualitization with qualitization occurring after the extraction process and forming part of the integration process. To our knowledge, this guidance puts forth the most comprehensive methodology currently available for data extraction and transformation via qualitization in systematic reviews, establishing a strong foundation for advancing knowledge. We have provided extensive guidance and worked examples in an area where methodology has been sparse and systematic reviewers have faced much confusion. The development of this guidance followed a robust methodology, leveraging the expertise of an international group of evidence synthesis experts and a gathering of international methodologists, with multiple quality checks. However, it is important to acknowledge the inherent variability in MMSRs, and we recognize that our methodology may not capture every possible scenario that can occur in this type of review. During our examination of MMSR examples to gain insights into the methods applied by systematic reviewers, and as we grouped them into the different approaches, we were unsure if we reached saturation. Uncertainty remains regarding whether these approaches truly represent the full spectrum utilized by systematic reviewers. Nonetheless, despite this limitation, we believe that the reviewed examples have provided us with sufficient insights to underpin the development of the methodology outlined in this guidance.

While our current work significantly addresses a crucial gap in MMSR methodology, there remains a need for further exploration and enhancement within the area of evidence synthesis. Our future endeavours will focus on delving deeper into the process of integration, examining how certainty and confidence in findings can be effectively assessed within the framework of MMSRs.

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