https://doi.org/10.51408/issi2025_069

Guidance List for Reporting Bibliometric Analyses (GLOBAL): A Two-Round Modified Delphi Study

Jeremy Y. Ng[1], Henry Liu[1], Mehvish Masood[1], Niveen Syed[1], Ludo Waltman[2], Stefanie Haustein[3,4,5], Michel Sabé[6,7], Marco Solmi[8,9,10,11,12], Dimity Stephen[13]✉, Alexander Schniedermann[13], Simon Willemin[14], Marianne Gauffriau[15], Jens Peter Andersen[16], Lutz Bornmann[17], Rodrigo Costas[2], Wolfgang Glänzel[18], Sybille Hinze[19], Nicolas Robinson-Garcia[20], Gunnar Sivertsen[21], Stephan Stahlschmidt[13], Thed van Leeuwen[2], Erija Yan[22], Cameron Neylon[23], Verena Weimer[24], Alesia Zuccala[25], David Moher [1,26]

[1] Centre for Journalology, Ottawa Methods Centre, Ottawa Hospital Research Institute, Ottawa (Canada)
[2] Centre for Science and Technology Studies, Leiden University, Leiden (The Netherlands)
[3] School of Information Studies, University of Ottawa, Ottawa (Canada)
[4] Scholarly Communications Lab, Ottawa (Canada)
[5] Centre Interuniversitaire de Recherche sur la Science et la Technologie, Université du Québec à Montréal, Montreal (Canada)
[6] Division of Adult Psychiatry, Department of Psychiatry, University Hospitals of Geneva, Thonex (Switzerland)
[7] Faculty of Medicine, University of Geneva, Geneva (Switzerland)
[8] Department of Psychiatry, University of Ottawa, Ottawa (Canada)
[9] Department of Mental Health, The Ottawa Hospital, Ottawa (Canada)
[10] Clinical Epidemiology Program, Ottawa Hospital Research Institute, University of Ottawa, Ottawa (Canada)
[11] School of Epidemiology and Public Health, Faculty of Medicine, University of Ottawa, Ottawa (Canada)
[12] Department of Child and Adolescent Psychiatry, Charité Universitätsmedizin, Berlin (Germany)
[13] German Centre for Higher Education Research and Science Studies (DZHW), Berlin (Germany)
[14] ETH Zurich, Zurich (Switzerland)
[15] IT University of Copenhagen, Copenhagen (Denmark)
[16] Danish Centre for Studies in Research and Research Policy, Aarhus University, Aarhus (Denmark)
[17] Administrative Headquarter of the Max Planck Society, Munich (Germany)
[18] KU Leuven, Leuven (Belgium)
[19] Center for Open and Responsible Research, Berlin University Alliance, Berlin (Germany)
[20] University of Granada, Granada (Spain)
[21] Nordic Institute for Studies in Innovation, Research and Education, Oslo (Norway)
[22] Drexel University, Philadelphia (United States of America)
[23] Curtin University, Perth (Australia)
[24] DIPF | Leibniz Institute for Research and Information in Education, Frankfurt am Main (Germany)
[25] University of Copenhagen, Copenhagen (Denmark)
[26] Institute of Health Policy, Management & Evaluation, Dalla Lana School of Public Health, University of Toronto, Toronto (Canada)

Abstract

Background: Despite the growth of bibliometric analyses in the scholarly literature, few studies offer guidance on how to report them, resulting in a lack of transparency and completeness in research. To address this gap in thorough reporting practices, in accordance with existing best practice for establishing reporting guidelines, we developed the Guidance List for the repOrting of Bibliometric AnaLyses (GLOBAL), a reporting guideline aimed at promoting high-quality reporting of bibliometric analyses. Methods: An initial list of items for the GLOBAL was generated through a scoping review and further refined through a two-round Delphi, as outlined by the EQUATOR Network's methodological framework on creating reporting guidelines. Participants, including international bibliometric experts, were recruited for the Delphi via personalized emails and open invitations. Consensus was achieved when at least 80% of participants agreed on the inclusion or exclusion of items in the GLOBAL checklist. Items that did not reach consensus were excluded. Round 1, conducted through an international online survey, used a 9-point Likert scale to assess how essential an item was for reporting bibliometric analyses. A content analysis was performed on participant feedback from Round 1, including comments on each item and responses to the open-ended questions. Round 2 consisted of an in-person meeting to discuss and vote on items that were new or did not reach consensus in Round 1. Results: In Round 1, 24 of 32 items reached consensus and content analysis resulted in one new item. This item and the eight items that did not reach consensus were discussed in Round 2. During the meeting, one item was split into two, totalling ten items. Nine out of ten items reached consensus, five for inclusion and four for exclusion, while 1 item was also excluded because it did not reach consensus. Conclusions: The finalized 29-item GLOBAL checklist provides users with guidance to report bibliometric analyses. Its international adoption is aimed at improving the reporting practices of bibliometric analyses for research purposes.

Introduction

Bibliometrics is a social science discipline historically based on three developments: (1) the positivist-functionalist philosophy (of science) of being able to examine social facts objectively; (2) the development of citation indices and analysis to measure research performance; and (3) the discovery of mathematical laws that enabled the use of indicators in science evaluation (De Bellis, 2014). Here, we follow a pragmatic definition of bibliometrics based on common usage in the literature. We define bibliometric analyses as any study that quantitatively studies academic research based on at least one of two basic elements: (1) publications (e.g., journal articles, conference proceedings papers, books and book chapters, preprints, peer review reports, grey literature) to represent scholarly outputs; and (2) citations (i.e., formal references to a publication in the reference lists of other publications) to reflect connections between and the impact of publications. These units of measurement can be applied to various levels of aggregation, for instance: micro-level (e.g., authors, documents), meso-level (e.g., institutions, departments, journals), and macro-level (e.g., countries, disciplines).

Bibliometric analyses may introduce, adapt, and/or apply various types of bibliometric indicators – ranging from absolute numbers of publications and citation rates (e.g., journal impact factor, field-normalized citation rate), citation percentiles, or collaboration strength – to measure, compare and benchmark (AlRyalat et al., 2019; Donthu et al., 2021; Sugimoto & Larivière, 2018). Researchers and organizations conduct bibliometric analyses for a variety of purposes, such as to explore the intellectual structure of an existing field and to identify publication-related characteristics, trends, and patterns specific to a journal, article, book, author,

institution, and/or topic of study. The value of this method is that it enables researchers to discover patterns and "make sense" of a high volume of different characteristics taken from hundreds, thousands, or even millions of publications. The findings of bibliometric analyses can therefore serve to advance a field by providing a comprehensive overview of the research conducted, understanding how research has evolved over time, identifying knowledge gaps, and inspiring novel ideas for investigation in that particular area (Donthu et al., 2021).

Recently, a number of articles have been published describing how to report or conduct a bibliometric analysis (Donthu et al., 2021; Linnenluecke et al., 2020). However, most of these articles have not framed their work in the format of a reporting guideline (Jappe, 2020). The current lack of evidence-based guidance on how to report a bibliometric analysis can be problematic for several reasons. If authors fail to provide readers with enough information about how and when their study was conducted, including e.g., the database from which the bibliographic data were retrieved, readers will only have a partial understanding of what was done. Consequently, insufficient reporting may hinder the reproducibility of a study and further inhibit researchers from evaluating the accuracy of its findings (Bornmann et al., 2021). Furthermore, editors and peer reviewers have no guidelines against which to compare the reporting quality of a study under their consideration. Moral and ethical justifications also exist for providing accurate research reporting (Moher, 2007). Ethical research promotes knowledge, truth, and the avoidance of error, which are values that are essential to both collaborative work and accountability to the public (Resnik, 2015).

As a first step to address this knowledge gap, we opted to develop a reporting guideline for bibliometric analyses, known as the Guidance List for the repOrting of Bibliometric AnaLyses (GLOBAL). A reporting guideline is defined as "a checklist, flow diagram, or explicit text to guide authors in reporting a specific type of research, developed using explicit methodology" (Moher et al., 2010 p. 1). This work stems from our understanding that "bibliometrics" is generally regarded as the most commonly used term, which captures the entire field of research and application that deals with the quantitative analysis of scholarly outputs and their influence.

As bibliometric analyses are increasingly adopted, establishing reporting guidelines for these studies is crucial to strengthening their reliability and accuracy. Such guidelines enhance reporting quality by enabling researchers to ensure their published papers are complete and transparent, thereby positively influencing how researchers plan, execute, and report their work (Donthu et al., 2021; Gagnier et al., 2013; Moher et al., 2010). The GLOBAL has the potential to benefit many stakeholders. As a reporting guideline, the GLOBAL aims to assist researchers in reporting and peer reviewers in evaluating bibliometric analyses. Thorough reporting, supported by adherence to reporting guidelines, allows readers to evaluate the usefulness of a study's methods and, consequently, the reliability and robustness of its conclusions. High-quality reporting may help to ensure new research is efficiently used, less research waste is produced, and may also facilitate easier replication and potential review updates (Moher et al., 2010).

Methods

Study design

The following section briefly outlines the study design, while detailed explanations are provided in the subsequent sections. The GLOBAL was developed in accordance with the EQUATOR Network's methodological framework (EQUATOR Network, n.d.; Moher et al., 2010). A scoping review was conducted to identify relevant reporting guidance for bibliometric analyses and generate a preliminary list of candidate items for the GLOBAL checklist. This scoping review has since been posted as a preprint (Ng et al., 2024). The preliminary list of GLOBAL candidate items was further developed using a two-round modified Delphi that was conducted on a global scale. The Delphi modification came from generating a preliminary list of items through a scoping review and discussions with the GLOBAL steering committee, rather than deriving original ideas from the Delphi panel, although participants could suggest new items during these rounds.

Round 1 of the Delphi involved individuals completing an online survey using Welphi (*Welphi*, n.d.), a web-based platform that is specifically designed to host surveys employing the Delphi method. Round 2 consisted of an in-person consensus group meeting with participants who completed the previous round and were interested and able to attend this meeting. The GLOBAL steering group, which supervised and provided input to the GLOBAL's development, consisted of five international researchers, four with expertise in bibliometrics (LW, MSabé, MSolmi, and SH) and one with expertise in reporting guidelines (DM).

Open science statement

The GLOBAL is registered on the EQUATOR Network Library of Reporting Guidelines (EQUATOR Network, n.d.a). The protocol was registered on January 12, 2023, on the Open Science Framework (OSF) (Ng et al., 2023). Anonymized, aggregate voting data and participant responses from Rounds 1 and 2 were also shared publicly using OSF. Participants in both Delphi survey rounds provided consent to participate in this study. We followed the Accurate Consensus Reporting Document checklist (Gattrell et al., 2024) in reporting our findings.

Scoping review and candidate item generation

An initial list of candidate items for the GLOBAL checklist was generated through a scoping review (Peters et al., 2020) of peer-reviewed literature, articles on preprint servers, and grey literature that aimed to identify and categorize bibliometric reporting recommendations (Ng et al., 2024). Twenty-three studies met the inclusion criteria following screening. Consensus on the inclusion, the section the item belongs to (i.e., 'title', 'abstract', 'introduction', 'methods', 'results', 'discussion', or 'other' sections of the reporting guideline), and the phrasing of candidate items for the GLOBAL were decided after multiple discussions with the steering committee and research team (JYN, HL, MM, NS, LW, MSabé, MSolmi, SH, DS, DM). The steering committee also had the opportunity to add items that seemed necessary to increase the quality of bibliometric reporting but were not addressed by the included

studies (Ng et al., 2024). This process resulted in a 32-item preliminary checklist; 31 items being created based on recommendations from the literature and one item arising from expert opinion of the GLOBAL steering committee.

Recruitment of Delphi Participants

Participants were recruited from a diverse group of international stakeholders with bibliometric experience (e.g., bibliometricians, librarians, journal editors, policy and research analysts, and researchers) through purposeful sampling. Steering committee members did not serve as participants in either Delphi round. Recruitment was conducted through two methods. First, the steering committee compiled a list of experts from the bibliometric community and sent personalized email invitations and reminders to these potential participants through the Welphi platform (*Welphi*, n.d.). Second, an advertisement and recruitment script with a general universal link to the Welphi survey was disseminated to members of the International Society for Scientometrics and Informetrics (ISSI) through their mailing list, an ISSI website blog post on 26 July 2024 and promoted via social media (Twitter, LinkedIn). Information on the GLOBAL Delphi was also listed on the website for the 2024 International Science, Technology and Innovation Indicators (STI) conference website (GLOBAL Delphi Survey, n.d.). The ISSI and STI are communities of researchers and professionals involved in the fields of scientometrics, informetrics, and webometrics. The survey link for both methods (i.e., the personalized recruitment email and the universal link) led participants to a page that provided more information about the study, including data privacy/storage information. By completing the survey, participants provided consent to take part in the study. Participants were not provided financial compensation for taking part in the study. Those who participated in Round 2 of the Delphi were invited to co-author the present paper.

Round 1

In Round 1, participants completed an online Delphi survey that was administered in English on the Welphi platform (*Welphi*, n.d.). The survey was open from 10 July 2024 to 16 August 2024, with reminder emails sent to participants who received personalized email invitations one, two, and four weeks following the initial email. Prior to administration, the survey was pilot tested from 29 June 2024 to 4 July 2024 by four researchers (DS and three external research assistants). Pilot testers did not participate in the Delphi. This pilot test was conducted to check for issues in survey design, technology, and the clarity/phrasing of the survey questions.

The survey included 41 questions that addressed the following: (1) demographic variables (seven close-ended questions); (2) preferences for GLOBAL candidate checklist items (32 questions); and (3) other comments (i.e., suggestions for new items that were not addressed in the GLOBAL and additional comments in general; two open-ended questions). All survey questions were optional to complete, with the exception of rating preferences for the candidate items. Participants were required to complete all the questions on a page to move to the next, but their responses were submitted even if the survey was not fully completed. For the ‘preferences for

GLOBAL candidate items' section, participants were asked to rate each item of the preliminary 32-item GLOBAL checklist that was generated from the scoping review (Ng et al., 2024) using the following Likert scale scoring system (Jebb et al., 2021): essential (1-3), preferable (4-6), and non-essential (7-9). It was determined a priori that items that garnered 80% of responses in the top range (7-9) or bottom range (1-3) on the 9-point scale were considered to have achieved consensus for inclusion or exclusion. This 80% threshold was selected based on general agreement within the literature, which commonly uses 75% as a threshold to define consensus (Diamond et al., 2014). Items that met consensus were excluded from consideration in the subsequent round. Each candidate GLOBAL item in this section also had an open-ended comment box for respondents to provide further feedback. At the end of the survey, participants were provided with information regarding the Round 2 in-person consensus meeting and a linked form to express their interest in attending.

Round 2

A one-day consensus meeting was held on 21 September 2024 in Berlin, Germany, to discuss and vote on new items and those that did not reach consensus in Round 1. The date and location of the meeting were chosen to take advantage of many members of the bibliometric community attending the STI 2024 conference in Berlin from 18 to 20 September 2024. Stakeholders were invited by the steering committee via email from the list of Round 1 Delphi participants who fully completed the survey and expressed interest in participating in Round 2. A total of 32 participants were invited to participate. Efforts were made to ensure varied representation from all stakeholder groups.

The in-person consensus meeting was moderated by three steering committee members (JYN, SH, and LW), who did not vote or participate in discussion but aimed to stay neutral during the meeting. Two researchers (DS and one external research assistant) took notes and recorded votes during this process. During the meeting, all items that did not reach consensus from the initial literature review and all new items proposed by participants in Round 1 were discussed. The consensus group participants were presented with each item along with its score from the first Delphi exercise, in addition to any remarks made by Round 1 participants on that item. This information was provided six days in advance of the meeting on 15 September 2024 as part of a handbook and during the meeting itself on 21 September 2024. At the consensus meeting participants were asked to comment on the significance of each item and whether it should be included in the GLOBAL. After an open discussion of a particular item, participants were given the option to rephrase items if the majority agreed upon its change. After discussions for each given item, an anonymous electronic vote was held using Mentimeter (*Interactive Presentation Software - Mentimeter*, n.d.) with the option to 'include in checklist', 'exclude from checklist', and 'abstain from voting'. After voting for an item was completed, final results were presented quantitatively. Similar to Round 1, the inclusion and exclusion threshold of 80% served to represent majority consensus (Diamond et al., 2014). Participants also had the chance to suggest new items for the GLOBAL during the consensus meeting, and these were subsequently voted on. Participants were not required to

stay for the complete Delphi process given this was a day-long event involving international stakeholders, although this was encouraged. In addition to the notes taken, the meeting was recorded and transcribed using MacWhisper (*MacWhisper*, n.d.).

Analysis

Frequencies and percentages were used to record the number of participants that completed each round of the Delphi and their basic demographic characteristics. For Round 1, qualitative data (open-ended responses) underwent content analysis (Joffe & Yardley, 2003). There were three categories of open-ended responses from the Round 1 survey: 1) item-specific responses (32 questions); 2) suggestions for new items that were not addressed in the GLOBAL (one question); and 3) additional comments in general (one question). Coding to identify common themes in participant responses was conducted independently and in duplicate by two researchers (MM and NS), before meeting to resolve discrepancies in coding. Following this, MM and NS met to iteratively generate and discuss themes and subthemes until consensus was reached. All 'item-specific responses' were reviewed and discussed, but only items deemed to have sufficient data, as determined by team discussion (JYN, HL, MM, NS), were analyzed (e.g., items that had less than three dissimilar comments were determined to have insufficient data). Item-specific responses were coded with the purpose of identifying ways to rephrase items on the GLOBAL for the Round 2 consensus meeting and to capture any concerns regarding GLOBAL items. Responses for 'suggestions for new items that were not addressed in the GLOBAL' were coded with the intention to identify new items to add to the GLOBAL checklist. Newly proposed items were subsequently presented to the research team and steering committee for further refinement. Through iterative team discussions, new items reached consensus for inclusion to vote on during Round 2. Responses from 'additional comments in general' were used to generate general themes regarding participant preferences on the GLOBAL's format and usage and were subsequently presented to participants taking part in the Round 2 Delphi.

Results

The results of each stage of the process of developing the GLOBAL are summarized in Figure 1 and described in more detail in the subsequent sections.

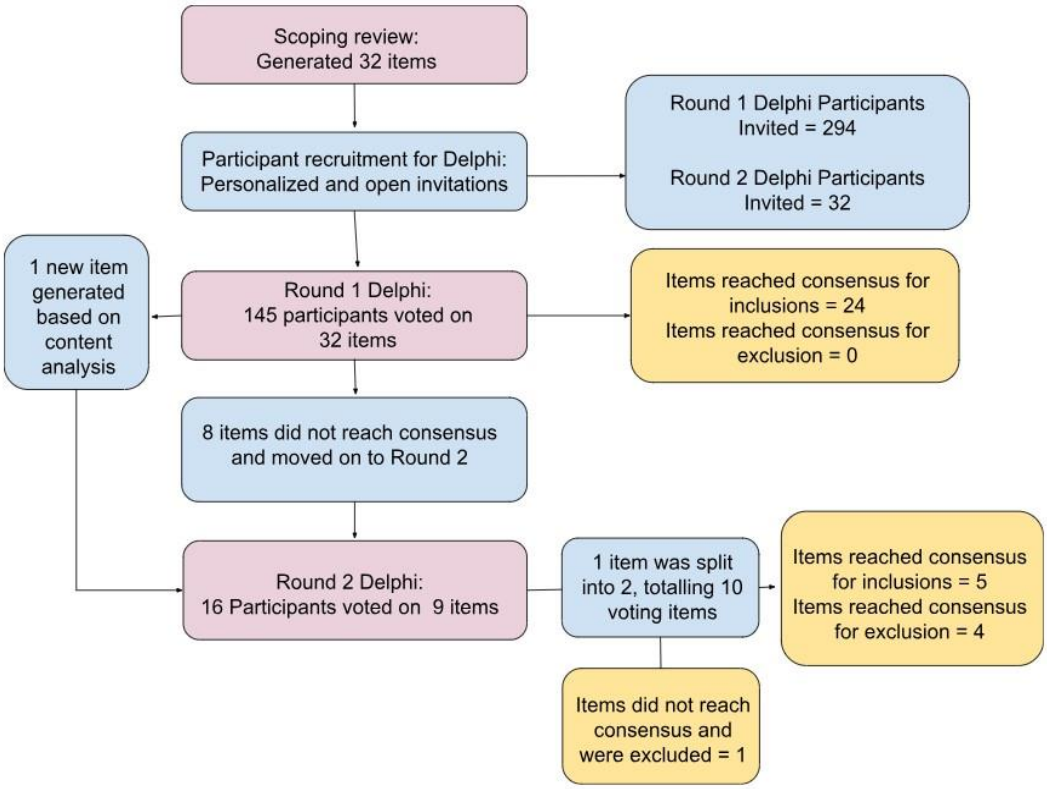

Figure 1. Summary of the methods and results of the GLOBAL development process.

Deviance from the protocol

Time and resource constraints led to three deviations from the protocol. First, the three-round Delphi process was reduced to two rounds as items reached consensus within the two rounds. Second, although Round 2 was initially planned to be an online survey, it was conducted as an in-person consensus meeting instead. While this deviation limited the number of participants who could attend Round 2, it also promoted a productive and detailed discussion for each item. Third, Welphi (*Welphi*, n.d.) was used to create and distribute the Round 1 Delphi survey instead of SurveyLet (*Calibrum*, n.d) since Welphi was designed to implement the Delphi method and ensure data accuracy.

Round 1

Participants

A total of 145 participants, representing 111 institutions, took part in Round 1 by rating at least one GLOBAL item. Table 1 provides a summary of participant demographics. Only two (1.4%) participants did not fully complete the survey. Most respondents were men (n = 91, 62.8%) and between the ages of 35 and 44 (n = 56, 41.4%). Respondents worked in various countries, including the United States (n = 19, 16.0%), Canada (n = 15, 12.6%), Germany (n = 9, 7.6%), the United Kingdom (n = 9, 7.6%), and the Netherlands (n = 8, 6.7%). The top five roles reported by the

participants who completed the survey were: 'bibliometrician' (n = 48, 22.6%), 'librarian/information specialist' (n = 36, 17.0%), 'associate professor' (n = 18, 8.5%), 'full professor' (n = 17, 8.0%), and 'research coordinator' (n = 13, 6.1%). More than half of respondents had more than ten years of experience in their respective careers (n = 70, 57.9%), a quarter had five to ten years of experience (n = 31, 25.6%), and 14.1% had less than five years (n = 17).

Table 1. Round 1 and 2 participant demographic characteristics.

Demographic	*Participant characteristics*	*Responses (n, %)*	
		Round 1	*Round 2*
Gender	Male	91 (62.8%)	11 (68.6%)
	Female	47 (28.9%)	4 (25.0%)
	Prefer not to say	7 (4.8%)	1 (6.2%)
		N=145	N=16
Age	25-29	2 (1.5%)	0 (0.0%)
	30-34	12 (8.9%)	3 (18.8%)
	35-39	28 (20.7%)	2 (12.5%)
	40-44	28 (20.7%)	2 (12.5%)
	45-49	16 (11.8%)	1 (6.2%)
	50-54	15 (11.1%)	2 (12.5%)
	55-59	13 (9.6%)	3 (18.8%)
	60-64	8 (5.9%)	1 (6.2%)
	65-69	6 (4.4%)	2 (12.5%)
	70+	6 (4.4%)	0 (0.0%)
	Prefer not to say	1 (0.7%)	0 (0.0%)
		N=135	N=16
Country of work	Canada	15 (12.6%)	0 (0.0%)
	Germany	9 (7.6%)	4 (28.6%)
	Netherlands	8 (6.7%)	2 (14.3%)
	United Kingdom	9 (7.6%)	0 (0.0%)
	United States	19 (16.0%)	1 (7.1%)
	Other	56 (47.1%)	7 (50.0%)
	Prefer not to say	3 (2.5%)	0 (0.0%)
		N=119	N=14
Career stage	Early (≤5 yrs)	17 (14.1%)	1 (7.1%)
	Mid (5-10 yrs)	31 (25.6%)	3 (21.4%)
	Senior (10+ yrs)	70 (57.9%)	10 (71.4%)
	Prefer not to say	3 (2.5%)	0 (0.0%)
		N=121	N=14
Role	Bibliometrician	48 (22.6%)	7 (26.9%)
	Librarian/ Information specialist	36 (17.0%)	3 (11.5%)
	Research coordinator	13 (6.1%)	2 (7.7%)
	Associate Prof.	18 (8.5%)	3 (11.5%)
	Full Professor	17 (8.0%)	2 (7.7%)
	Other	80 (37.7%)	9 (32.6%)
		N=212[a]	N=26[a]

[a] Participants chose more than one option.

GLOBAL item preferences

A total of 24 out of 32 items reached the 80% consensus threshold for inclusion in the GLOBAL reporting guideline in Round 1. Content analysis of participant feedback resulted in one novel candidate item for inclusion in the GLOBAL: "Provide a clear study materials and data sharing statement (e.g., if datasets, data sources, codes used for the analysis, software, and/or calculations are provided or not)". This item was voted on in Round 2. In the open-ended survey responses, participants suggested two further themes: 1) expanding the GLOBAL objective by adapting it to different audiences and/or types of records that use bibliometric analyses; and 2) reformatting the GLOBAL checklist to reduce redundancy, include examples, or rephrase existing items. A summary of these themes is provided in Table 2. The first theme is discussed and encouraged in the 'Future Directions' section, while the second theme could not be implemented as participants were only allowed to vote on the necessity of the items rather than modify their content.

Table 2. Round 1 Delphi online consensus group themes.

Theme	*Codes*	*Quotes*
GLOBAL objectives	Clarify purpose	"Why is this needed at this time?" (P15) "The meaning of 'reporting bibliometric studies' could be broad. It is unclear whether it specifically apply to reports, [...] research articles, or any document based on a bibliometric analysis." (P77)
	Adapt to audience	"I wonder if the reporting needs to be adapted to the audience" (P156) "I sometimes found it difficult to answer the questions because I produce different types of analysis for very different audiences" (P122)
	Extensions	"How about other types of reporting, e.g. benchmarking reports that institutions and governments use" (P342)
GLOBAL formatting and structure	Redundant / generic requirements	"Some of the items seem to be overlapping in meaning, causing unnecessary redundancy" (P241) "Many of these items seem not particular to bibliometric studies but rather standard elements of journal articles" (P378)
	Include examples	"It would be nice to see some "recipes" (representative examples)." (P320)
	Item editing / suggestions	"[...] the question of data availability and the conflict of interest [...] should be better defined." (P25) "By making all this mandatory one runs the risk of making papers heavy and impenetrable" (P360)

Round 2

Participants

A total of 16 participants took part in Round 2. Demographic characteristics were collected from Round 1, anonymized, and aggregated. Participants were mostly men (n = 11, 68.8%), 'White' (n = 13, 81.3%), and all participants were between 30 and 59 years of age (n = 16, 100%). Most respondents worked in Germany (n = 4, 25.0%),

Denmark (n = 3, 18.8%), and the Netherlands (n = 2, 12.5%). Common roles included 'bibliometrician' (n = 7, 25%), 'journal editor' (n = 3, 10.7%), 'librarian/information specialist' (n = 3, 10.7%), and 'associate professor' (n = 3, 10.7%). Most participants had more than ten years (n = 10, 62.5%), and few with between five and ten (n = 3, 18.8%) and less than five years (n = 1, 6.4%) of work experience. Summarized participant demographics are provided in Table 1.

GLOBAL item preferences

Participants voted on ten items during the in-person consensus meeting. Initially, there were nine items from Round 1 that required further discussion, eight of which did not reach consensus and one that was introduced after content analysis of participant feedback. However, one item was split into two during Round 2, resulting in ten items. The phrasing of seven items was altered. Five out of ten items reached the 80% consensus threshold for inclusion following Round 2, with all five undergoing rephrasing. The other five items were excluded, with four of them reaching consensus for exclusion. The remaining item did not reach the consensus threshold and was therefore excluded. Participants did not suggest any new items for the GLOBAL. In total, 29 out of 34 items reached consensus for inclusion in the GLOBAL following the completion of both Delphi rounds. A summary of the original items included and their results via the two Delphi rounds is provided in the Appendix.

Guidelines finalization process

The final GLOBAL checklist is comprised of 29 items, with the following in each section: 'abstract' (one item), 'introduction' (four items), 'methods' (13 items), 'results' (four items), 'discussion' (three items), and 'other' (four items). The finalized GLOBAL checklist is presented in Table 3.

Table 3. The final 29-items GLOBAL guideline for the reporting of bibliometric analyses.

	Reporting item
Abstract	
1.1	Abstract should be reflective of the bibliometric analysis, including scope, data collection, analysis, and results.
Introduction	
2.1	Situate the bibliometric analysis within the context of relevant pre-existing literature, identifying the gap in literature.
2.2	Define the aim, scope, rationale, and/or objective of the bibliometric analysis.
2.3	Define the research question.
2.4	Explicitly specify relevant terms, concepts, and theoretical frameworks used in the study.
Methods	
3.1	Describe the bibliometric methods used.
3.2	Define the units of analysis that are analysed (i.e., micro-, meso-, and macro-level) in the bibliometric analysis (e.g., countries, institutions, authors).

3.3	Describe the bibliometric data collection methods, including any limitations.
3.4	Describe the databases and data sources used, including any limitations.
3.5	Present the full search strategies for all databases used, including any filters and limits that were applied.
3.6	Describe the data collection time frame.
3.7	Describe the search results and selection processes (e.g., inclusion/exclusion). If applicable, use a flow diagram.
3.8	Describe the data cleaning methods, including any limitations.
3.9	Describe the bibliometric data analysis methods used.
3.10	Specify the analytical software used and the parameter settings selected.
3.11	Describe the bibliometric indicators used.
3.12	If applicable, define the calculations/formulas used for indicators in the bibliometric analysis.
3.13	Provide sufficient detail in the bibliometric analysis manuscript to ensure full replicability/transparency of methods.
Results	
4.1	Describe the results and key findings.
4.2	Describe the results of bibliometric analysis techniques used.
4.3	Ensure figures, tables and visualizations clarify and/or facilitate the interpretation of the results without misleading.
4.4	If appropriate, report the uncertainty/dispersion/heterogeneity depending on the type of data and analysis, and error values of bibliometric indicators.
Discussion	
5.1	Summarize and discuss study findings.
5.2	Provide context for and situate the study findings in the literature.
5.3	Discuss the strengths, limitations, and potential biases of the bibliometric analysis.
Other	
6.1	Disclose any existing or potential conflicts of interest and/or sources of financial or non-financial support.
6.2	Describe the availability and accessibility of data.
6.3	Use references and citations to support statements and methods used.
6.4	Provide a statement about whether study materials, data and/or code are shared and if so, where and how it can be accessed.

Discussion

The GLOBAL serves as the first guideline developed for the reporting of bibliometric analyses in the scholarly literature through international multi-stakeholder and multi-sector consensus. Through an iterative, multi-step process, we have developed a 29-item reporting guideline that is intended to enable more thorough, accurate, and transparent reporting of bibliometric analyses. It is important to note that these are minimum standards. Authors should not feel discouraged from including additional information that might enhance the quality of reporting of their bibliometric analysis.

Scope of GLOBAL

The goal of the GLOBAL is to provide the minimum essential guidance for the reporting of bibliometric analyses for research purposes. The intent of the GLOBAL is not to provide methodological design guidance for researchers and specialists conducting bibliometric analyses, nor does it assess the suitability of particular methods in specific contexts. However, while our work does not directly address the quality of bibliometric analyses, we anticipate that this reporting guideline will set the stage for future work in this area. The complete reporting of novel or more specialized types of bibliometric analyses may require additional guideline items and authors should not be deterred from reporting this information. The GLOBAL should nevertheless be considered as base guideline by such studies, until necessary specialized extensions are developed. The latter may also address the reporting of other "metrics" associated with bibliometrics (e.g., the reporting of altmetrics or other topics nestled within bibliometrics).

The GLOBAL is formatted to support the reporting process of manuscripts intended to be submitted to scholarly journals or preprint servers, and for peer-review. It incorporates the conventional sections of 'abstract', 'introduction', 'methods', 'results', and 'discussion,' along with an 'other' section, within its design. We aimed to ensure that this reporting guideline is clear and easy to follow, as recommended by the Consolidated Standards of Reporting Trials (CONSORT) (Altman, 1996): "[r]eaders should not have to infer what was probably done; they should be told explicitly." Although the GLOBAL aims to ensure the complete reproducibility of bibliometric analyses, we acknowledge that practical considerations (e.g., journal requirements or concision) may prevent researchers from providing the full scope of information needed to meet the ideal standards for reporting.

Implementation and dissemination

The GLOBAL is currently undergoing pilot testing with experts in the bibliometric community to assess the clarity of items' wording and any issues of redundancy or duplication of items when using the guidelines. Further, an Explanation and Elaboration (E&E) document of the GLOBAL is currently under development. The E&E document will facilitate use of the GLOBAL by providing concrete examples from the published bibliometric literature of suitable reporting, and additional information explaining the item and the rationale for its inclusion in the GLOBAL. Once the pilot testing and E&E document are completed, we plan on disseminating our publication(s) to multiple sources, including but not limited to the following: 1) the core bibliometrics and reporting guidelines communities via conferences and/or mailing lists associated with ISSI and STI, the International Network of Research Management Societies, the Directorate for Science, Technology and Innovation, the European Network of Indicator Designers, and the International Congress on Peer Review and Scientific Publication; 2) editors and editorial board members of scholarly journals; 3) researchers from disciplines that use bibliometrics and/or reporting guidelines to evaluate their own fields; 4) scholarly communication librarians and research managers that conduct bibliometric analyses to support researchers; 5) publishers and publishing-related organizations/associations that

publish bibliometric analyses or bibliometric-related studies; 6) websites and blogs that feature bibliometric-related content, such as The Scholarly Kitchen and Leiden Madtrics; 7) developers of applications and software that assist researchers unfamiliar with bibliometric analyses in conducting and reporting them, such as Bibliometrix (*Bibliometrix*, n.d.); and summer schools offering bibliometric-related programs, such as European Summer School for Scientometrics (ESSS) (european summer school for scientometrics, n.d.) and Centre for Science and Technology Studies (CWTS) (CWTS, n.d.).

Future directions

Future studies may include GLOBAL extensions that address the reporting of other "metrics" associated with bibliometrics, such as webometrics and altmetrics. Additionally, while the current focus is on reporting in the scholarly literature, such as in journal articles, it would also be valuable to develop reporting guidelines for other types of bibliometric analyses, such as analyses performed for research institutions, research funders, governments, and other stakeholders, for instance in a research assessment context. Thus, in the future, extensions of the GLOBAL could be developed that would support authors in reporting bibliometric analyses for the purposes of policy reports, institutional benchmarking, funding evaluations, and other applications. Future research could also explore the development of reporting guidelines for studies that use bibliometrics along with other methodological approaches, such as systematic reviews.

Further research may also examine the facilitators and barriers to the use of the GLOBAL by authors, editors, and peer reviewers, and develop interventions to overcome identified barriers and evaluate those interventions. Moreover, conducting think-aloud studies to understand how items are interpreted and reliability studies to identify where items can be differently interpreted would be beneficial to inform potential revisions to the guideline (Charters, 2003).

Multiple translations of the reporting guideline will improve the accessibility of the GLOBAL. We encourage journal editors and publishers to promote the GLOBAL (for instance, by mentioning it in their journal's "Instructions to Authors" page), endorse its usage, advise editors and peer reviewers to assess submitted bibliometric analyses against the GLOBAL, and adjust journal policies to take into account the new reporting recommendations.

Strengths and limitations

This study has several strengths. First, the development of the GLOBAL adheres to recommendations present within the EQUATOR toolkit and other established guidelines for developing a reporting guideline (EQUATOR Network, n.d.; Moher et al., 2010), thereby increasing its robustness. Second, the development process is evidence-based, supported by a comprehensive scoping review (Ng et al., 2024) of recommendations in the literature. Third, involving diverse stakeholders from the international community (e.g., researchers with varying years of experience with bibliometrics) in the selection process strengthens the study's credibility and relevance as it considers a wide range of perspectives. Fourth, the recruitment of

participants through two methods, sending personalized emails and issuing an open invitation through public advertisement, helped to minimize the potential for bias that could arise from selecting individual participants or relying on a single sampling method.

Conversely, weaknesses of the study include a possible decrease in representativeness due to English-language restrictions, which limited participation by non-English speakers (Khanna et al., 2022). The in-person consensus meeting in Berlin is another limitation, as not all stakeholders were able to attend the meeting and provide feedback on the GLOBAL checklist items, thereby potentially restricting participant diversity. In future, for instance during the development of extensions of the GLOBAL, such meetings could be held in hybrid or virtual formats to facilitate broader participation.

Conclusions

The GLOBAL serves as a guide for high-quality reporting of bibliometric analysis. We anticipate that the GLOBAL checklist will be useful to bibliometricians, librarians, policy and research analysts, and researchers, as well as authors, editors, and peer reviewers of bibliometric analyses. Ultimately, the goal of the GLOBAL is to promote more thorough, accurate, and transparent reporting of bibliometric analyses.

Acknowledgements

We gratefully acknowledge Anton Ninkov, Chantal Ripp, and Marc-Andre Simard for pilot-testing the Welphi survey for Round 1 of the Delphi process. We greatly appreciate and acknowledge the efforts of the Round 1 participants who completed the survey. We also gratefully acknowledge Chantal Ripp for taking notes during Round 2 of the Delphi process. We gratefully acknowledge Stephan Gauch for providing technical equipment and organizing the meeting space and recording and transcription of Round 2. We further gratefully acknowledge Dalia Zubashev for her assistance in editing this submission.

Competing interests

The authors declare that they have no competing interests.

Funding

JYN’s postdoctoral fellowship was funded by a MITACS Elevate Award (Award #: IT36020), and co-funded by EBSCO Health. We also gratefully acknowledge funding provided by Cabells. Additionally, we thankfully acknowledge the Korean Institute of Oriental Medicine for their support. The funders played no role in the study design and conceptualization, data collection and analysis, decision to publish, or preparation of this research.

Research ethics approval and transparency practices

Ethics approval was obtained by the Ottawa Health Science Network Research Ethics Board (REB ID #20230527-01H).

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Appendix

Summary of Delphi voting rounds

Section	Checklist item [a]			Agreement [b] (n[%])		Final outcome
	Preliminary	Round 1	Round 2	Round 1[c]	Round 2[c]	
Title	In the title, identify the study as a bibliometric analysis and indicate the time period and key issues/topic.	In the title, identify the study as a bibliometric analysis and indicate the time period and key issues/topic.	In the title, identify the study as a bibliometric analysis and indicate the time period and key issues/topic.	Essential (1-3): 74 (51.03%) Neutral (4-6): 57 (39.31%) Non-Essential (7-9): 14 (9.66%)	Include: 3 (18.75%) **Exclude: 13 (81.25%)** Abstain: 0 (0%)	Excluded
Abstract	Abstract should be reflective of the bibliometric analysis, including scope, data collection, analysis, and results.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 120 (83.33%)** Neutral (4-6): 23 (15.97%) Non-Essential (7-9): 1 (0.69%)	Consensus reached in Round 1	Included
Introduction	Situate the bibliometric analysis within the context of relevant pre-existing literature, identifying the gap in literature.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 117 (81.25%)** Neutral (4-6): 22 (15.28%) Non-Essential (7-9): 5 (3.47%)	Consensus reached in Round 1	Included
Introduction	Define the aim, scope, rationale, and/or objective of the bibliometric analysis.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 137 (95.80%)** Neutral (4-6): 6 (4.20%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included

Introduction	Define the research question.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 131 (91.61%)** Neutral (4-6): 12 (8.39%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Introduction	Clearly define all relevant terms and definitions used within the bibliometric analysis.	Clearly define all relevant terms and definitions used within the bibliometric analysis.	Explicitly specify relevant terms, concepts, and theoretical frameworks used in the study.	Essential (1-3): 104 (72.73%) Neutral (4-6): 35 (24.48%) Non-Essential (7-9): 4 (2.80%)	**Include: 16 (100%)** Exclude: 13 (81.25%) Abstain: 0 (0%)	Included
Introduction	Describe the intended target audience of the bibliometric analysis (e.g., researchers, public, media, etc.). Describe the ways in which the information included in the report may be used for the target audience.	Describe the intended target audience of the bibliometric analysis (e.g., researchers, public, media, etc.). Describe the ways in which the information included in the report may be used for the target audience.	[Rephrased into two items] Item #1: Describe the intended target audience of the bibliometric analysis (e.g. researchers, public, media, etc).	Essential (1-3): 56 (39.16%) Neutral (4-6): 76 (53.15%) Non-Essential (7-9): 11 (7.63%)	Include: 1 (6.25%) **Exclude: 15 (93.75%)** Abstain: 0 (0%)	Excluded
			[Rephrased into two items] Item #2: Describe the ways in which the information included in the report is expected to be of relevance or intended to be used.		Include: 3 (6.25%) **Exclude: 10 (93.75%)** Abstain: 3 (0%)	
Methods	Describe the bibliometric methods used.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 137 (95.74%)** Neutral (4-6): 6 (4.26%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included

Methods	Define the units of analysis that are analysed (i.e., micro-, meso-, and macro-level) in the bibliometric analysis (e.g., countries, institutions, authors).	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 126 (90.00%)** Neutral (4-6): 14 (10.00%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Methods	Describe the bibliometric data collection methods, including any limitations.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 137 (97.86%)** Neutral (4-6): 3 (2.14%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Methods	Describe the databases and data sources used, including any limitations.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 137 (97.86%)** Neutral (4-6): 2 (1.43%) Non-Essential (7-9): 1 (0.71%)	Consensus reached in Round 1	Included
Methods	Present the full search strategies for all databases used, including any filters and limits that were applied.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 124 (88.57%)** Neutral (4-6): 16 (11.43%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Methods	Describe the data collection time frame.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 126 (90.00%)** Neutral (4-6): 14 (10.00%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included

Methods	Describe the search results and selection processes (e.g., inclusion/exclusion). If applicable, use a flow diagram.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 114 (81.43%)** Neutral (4-6): 26 (18.57%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Methods	Describe the data cleaning methods, including any limitations.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 120 (85.71%)** Neutral (4-6): 19 (13.57%) Non-Essential (7-9): 1 (0.71%)	Consensus reached in Round 1	Included
Methods	Describe the bibliometric data analysis methods used.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 134 (95.71%)** Neutral (4-6): 6 (4.29%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Methods	Specify the analytical software used and the parameter settings selected.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 116 (82.86%)** Neutral (4-6): 24 (17.14%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Methods	Describe the bibliometric indicators used.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 128 (91.43%)** Neutral (4-6): 12 (8.57%)	Consensus reached in Round 1	Included

				Non-Essential (7-9): 0 (0.00%)		
Methods	If applicable, define the calculations/formulas used for indicators in the bibliometric analysis.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 115 (82.14%)** Neutral (4-6): 25 (17.86%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Methods	Provide sufficient detail in the bibliometric analysis manuscript to ensure full replicability / transparency of methods.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 118 (84.29%)** Neutral (4-6): 22 (15.71%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Results	Describe the results and key findings.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 136 (97.14%)** Neutral (4-6): 4 (2.86%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Results	Describe the results of bibliometric analysis techniques used.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3): 123 (87.86%)** Neutral (4-6): 15 (10.71%) Non-Essential (7-9): 2 (1.43%)	Consensus reached in Round 1	Included
Results	Visualize the results through the use of figures, graphs,	Visualize the results through the use of figures, graphs, and/or tables. Ensure the	Ensure figures, tables and visualizations clarify and/or	Essential (1-3): 102 (72.86%) Neutral (4-6):	**Include: 13 (86.67%)** Exclude:	Included

	and/or tables. Ensure the visualizations are simple and easy to interpret. Aesthetic bibliometric visualization should not replace a rigorous bibliometric analysis.	visualizations are simple and easy to interpret. Aesthetic bibliometric visualization should not replace a rigorous bibliometric analysis.	facilitate the interpretation of the results without misleading.	33 (23.57%) Non-Essential (7-9): 5 (3.57%)	0 (0%) Abstain: 2 (13.33%)	
Results	If applicable, report the uncertainty / dispersion/heterogeneity depending on the type of analysis and error values of bibliometric indicators.	If applicable, report the uncertainty /dispersion/heterogeneity depending on the type of analysis and error values of bibliometric indicators.	If appropriate, report the uncertainty/ dispersion/heterogeneity depending on the type of data and analysis, and error values of bibliometric indicators	Essential (1-3): 97 (69.29%) Neutral (4-6): 43 (30.71%) Non-Essential (7-9): 0 (0.00%)	**Include:** **12 (80%)** Exclude: 2 (13.33%) Abstain: 1 (6.67%)	Included
Discussion	Summarize and discuss study findings.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3):** **129 (92.14%)** Neutral (4-6): 11 (7.86%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Discussion	Elaborate on the applicability and implications of study findings.	Elaborate on the applicability and implications of study findings.	Discuss the applicability and implications of study findings.	Essential (1-3): 105 (75.00%) Neutral (4-6): 34 (24.29%) Non-Essential (7-9): 1 (0.71%)	Include: 9 (60%) Exclude: 5 (33.33%) Abstain: 1 (6.67%)	Excluded[d]
Discussion	Provide context for the results of the bibliometric analysis and situate the study	Provide context for the results of the bibliometric analysis and situate the study findings in the existing literature.	Provide context for and situate the study findings in the literature.	Essential (1-3): 104 (74.29%) Neutral (4-6): 35 (25.00%)	**Include:** **13 (86.67%)** Exclude: 2 (13.33%)	Included

	findings in existing literature.			Non-Essential (7-9): 1 (0.71%)	Abstain: 0 (0%)	
Discussion	Discuss the strengths, limitations, and potential biases of the bibliometric analysis.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3):** **128 (90.00%)** Neutral (4-6): 13 (9.29%) Non-Essential (7-9): 1 (0.71%)	Consensus reached in Round 1	Included
Discussion	Identify future directions for research.	Identify future directions for research.	Identify future directions for research.	Essential (1-3): 54 (38.57%) Neutral (4-6): 79 (56.43%) Non-Essential (7-9): 7 (5.00%)	Include: 3 (20%) **Exclude:** **12 (80%)** Abstain: 0 (0%)	Excluded
Other	Disclose any existing or potential conflicts of interest and/or sources of financial or non-financial support.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3):** **112 (80.00%)** Neutral (4-6): 27 (19.29%) Non-Essential (7-9): 1 (0.71%)	Consensus reached in Round 1	Included
Other	Describe the availability and accessibility of data.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3):** **114 (81.43%)** Neutral (4-6): 26 (18.57%) Non-Essential (7-9): 0 (0.00%)	Consensus reached in Round 1	Included
Other	Use references and citations to support statements and methods used.	Consensus reached in Round 1	Consensus reached in Round 1	**Essential (1-3):** **125 (89.29%)** Neutral (4-6): 15 (10.71%)	Consensus reached in Round 1	Included

				Non-Essential (7-9): 0 (0.00%)		
Other	[Not Included in Round 1]	Provide a clear study materials and data sharing statements (e.g. if datasets, data sources, codes used for the analysis, software, and/or calculations are provided or not).	Provide a statement about whether study materials, data and/or code are shared and if so, where and how it can be accessed.	[Not Included in Round 1]	**Include:** **14 (100%)** Exclude: 0 (0%) Abstain: 0 (0%)	Included

a Underlining denotes text changes made between rounds.

b Bold indicates consensus.

c Round 1 items were scored on a 9-point Likert scale, where 1 to 3 points were categorized as 'essential',' 4 to 7 points were categorized as 'neutral,' and 7 to 9 points were categorized as 'non-essential' for inclusion within the tool. Round 2 items were scored using 'include in checklist', 'exclude from checklist', and 'abstain from voting' for inclusion within the tool.

d Item excluded because 80% threshold for consensus was not reached.