Knowledge synthesis research: a bibliometric analysis

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Abstract

Objectives: The purpose of this article is to describe the volume and attributes of original research available in PubMed on emerging knowledge synthesis methods (excluding traditional systematic reviews) published by researchers.

Study Design and Setting: Bibliometric analysis.

Results: Six-hundred eight studies related to the topic of knowledge synthesis methods were analyzed. Although there has been a steady increase in publications on knowledge synthesis methods since 2003, studies are dispersed among a large number of journals. Similarly, a large number of authors are publishing on these methods but in limited numbers for any individual. Relevant Medical Subject Headings that were applied most often to these studies included qualitative research, research design, meta-analysis as topic, and review literature as topic.

Conclusion: There is no prevailing journal or author that is a leader in reporting on knowledge synthesis methods. Relevant Medical Subject Headings were either not applied to most records or not available for the synthesis method being examined. This may lend itself to inconsistencies and variations in methods making it challenging for researchers and research users to locate and appraise these articles.   © 2016 Elsevier Inc. All rights reserved.

Keywords: Review literature as topic; Bibliometrics; Medical subject headings

1. Introduction

Many different knowledge synthesis methods exist across disciplines that go beyond traditional systematic reviews and realist reviews, including metanarratives, meta-ethnography, and qualitative reviews among others [1]. Although there are numerous strategies to synthesize knowledge, currently available summaries lack rigor and exhaustiveness [2,3]. As well, a comprehensive manual for all the different synthesis methods (quantitative, qualitative, or mixed), how they are related, and how to decide which methodology is the most appropriate for a particular topic does not exist. To address this gap, our research team completed a scoping review of synthesis methods across multidisciplinary fields, and the results are presented in an earlier article in this series [4].

Bibliometric research uses mathematical and statistical methods to analyze and measure the quantity of publications [5]. The purpose of this article is to describe the volume and attributes of original research available in PubMed on emerging knowledge synthesis methods (excluding traditional systematic reviews) published by researchers. This analysis was done alongside the scoping review of synthesis methods, described in a previous article in this series.

2. Materials and methods

2.1. Literature search

An information specialist (L.P.) developed the literature search strategy for the scoping review of synthesis methods described as reported previously in this series (including

What is new?

Key findings
- The bibliometric study highlights a lack of subject headings that help researchers and research users to identify articles that describe and explain specific synthesis methods.

What this adds to what was known?
- Our study includes an article published in 1909, which indicates an enduring interest in the methodologies of synthesizing evidence. This bibliometric study provides a quantitative analysis of the knowledge synthesis literature and identifies a broad range of journals and authors reporting on methods as well as an absence of subject headings used for indexing.

What is the implication and what should change now?
- Subject headings that identify distinct methods would provide clarity and assist researchers or research users in locating literature offering guidance on the methodologies of conducting syntheses of evidence.

the MEDLINE search strategy) [4], and this was peer reviewed by another information specialist using Peer Review of Electronic Search Strategies [6]. Search terms included combinations of terms such as review, overview, synthesis, evidence, methodologic, quantitative, and qualitative. Nine literature databases were searched (Appendix A) from inception to December 5, 2011, and retrieved 28,369 records. After removing duplicates, 17,962 records were screened by two reviewers independently to determine potential relevance.

2.2. Study selection

Studies were identified as relevant if they fulfilled the following criteria: (1) all study designs including qualitative and quantitative methods; (2) synthesis methods above and beyond traditional systematic reviews, excluding methods on economic analysis, or clinical practice guidelines; and (3) disciplines of health or philosophy. These were selected because many of the knowledge synthesis methods originated from these disciplines (e.g., systematic review methods rooted in education and psychology; realist reviews based on philosophy) [7]. Two people (L.P., D.L.) independently checked if each of the included records were held in PubMed [8]. PubMed is a service of the United States National Library of Medicine and provides free access to a literature database of "indexed citations and abstracts to medical, nursing, dental, veterinary, health care, and

preclinical sciences journal articles" [9]. If the record was found, a PMID (PubMed Identification) number was retrieved and recorded. A PMID is the unique identifier assigned to a record when it enters PubMed [10]. Discrepancies were resolved by rechecking records and discussion. A final list of 608 records was identified as being available in PubMed and having a PMID number (Fig. 1).

2.3. Validation of Synthesi.sr: bibliometric

Two online tools, GoPubMed [11] and PubMed PubReMiner [12] were identified as using PMIDs to generate relevant data for a bibliometric analysis. Ten percent (62) of the included records were randomly selected for the validation exercise. The random sample was obtained by using R software and the sample() function [13]. Before obtaining output from GoPubMed [11] and PubReMiner [12], the following data were manually retrieved from PubMed and tabulated independently by two investigators (L.P., D.L.) for each of these records: first author, journal name, year of publication, publication type, and MeSH. MeSH are Medical Subject Headings used by the United States National Library of Medicine and are the controlled vocabulary used for indexing articles in PubMed [14]. Discrepancies were resolved by rechecking records independently and discussion so that a final master list was created. The PMIDs were then processed separately by GoPubMed [11] and PubReMiner [12]; however, the data generated were inconsistent with the data on the master list of 62 records, with differences on MeSH for GoPubMed, and MeSH and publication types for PubReMiner. As a result, neither of these tools could be used for the bibliometric analysis. Our Knowledge Synthesis Center has developed proprietary online software for conducting systematic reviews called *Synthesi.sr*. This tool was further developed to query PubMed by using PMIDs to collect data associated with each record that could be used for a bibliometric analyses. The PMIDs for the records were entered into *Synthesi.sr: bibliometric*, and the data generated were reviewed manually by two people (L.P., D.L.) who independently compared each piece of information (such as journal name) and their reported frequencies against the master list for accuracy. The records generated from *Synthesi.sr: bibliometric* were identical to the master list that had been tabulated manually (Appendix B). We calculated sensitivity and considered this operating characteristic to be a measure of performance for *Synthesi.sr: bibliometric*. Sensitivity is defined as the proportion of relevant items (i.e., the desired PMID content) including publication year, journal name, first author name, publication type, language, and MeSH that are retrieved, and 100% was achieved. Formulae for calculating the sensitivity is shown in Appendix C.

2.4. Analysis of studies

After the validation exercise, the complete set of all PMIDs were entered into *Synthesi.sr: bibliometric* which

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┌─────────────────────────────────┐
│ Records identified through database │
│            searching             │
│           n = 28,369            │
└─────────────────────────────────┘
                │
                ▼
┌─────────────────────────────────┐
│ Records after duplicates removed │
│           n = 17,962            │
└─────────────────────────────────┘
                │
                ▼
┌──────────────────┐       ┌──────────────────┐
│ Records screened │──────▶│ Records excluded │
│   n = 17,962     │       │   n = 16,952     │
└──────────────────┘       └──────────────────┘
                │
                ▼
┌──────────────────┐       ┌──────────────────────────┐
│ Eligible articles│──────▶│   Articles excluded      │
│   n = 1,010      │       │        n = 402           │
└──────────────────┘       │                          │
                │          │  Reason for exclusion:   │
                │          │ 397 = no PMID available  │
                │          │ 5 = methods not described│
                ▼          └──────────────────────────┘
┌──────────────────┐
│ Studies included in │
│ bibliometric analysis │
│      n = 608      │
└──────────────────┘
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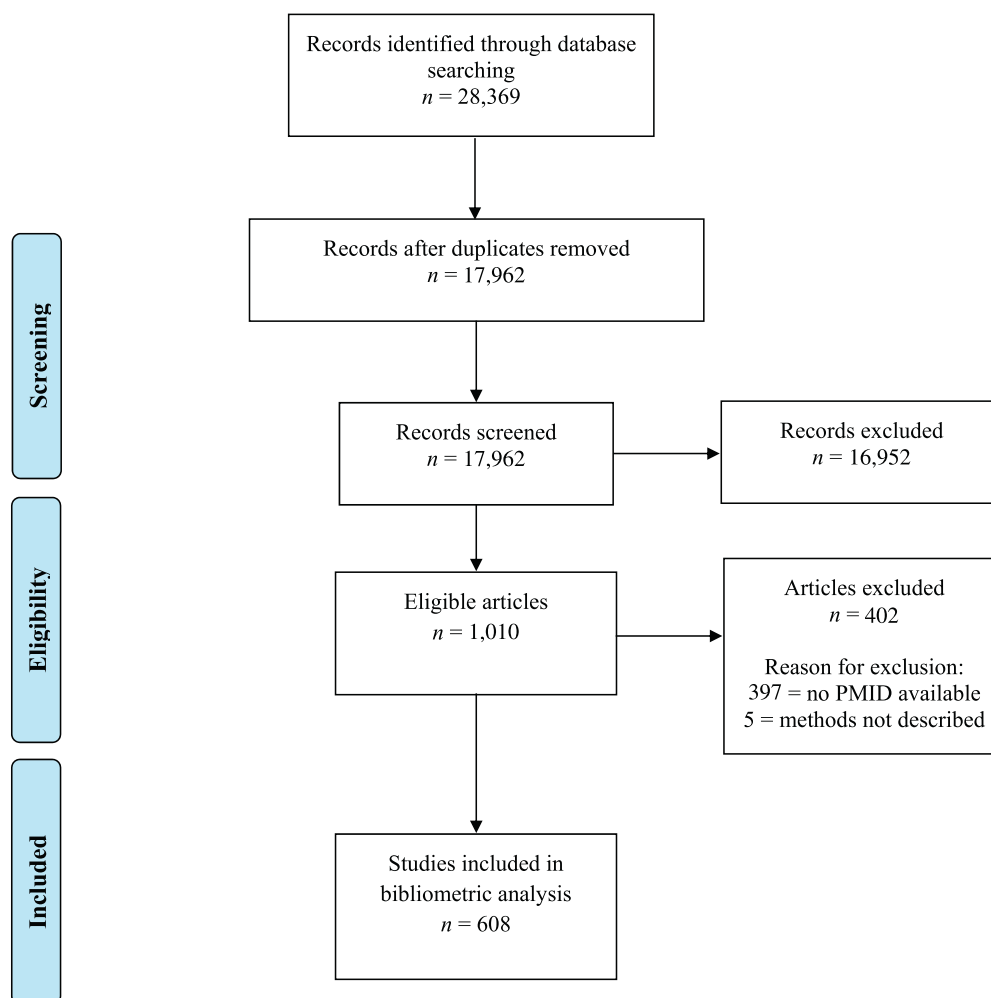
Screening

Eligibility

Included

Fig. 1. Flow diagram to identify eligible studies for bibliometric analysis.

queried PubMed and provided tabulations on first authors, journal names, publication dates, publication types, language of publication, and all MeSH assigned to each record. Several MeSH can be assigned to one article, and frequencies were tabulated to identify the MeSH that were used most often. We also analyzed the distribution of studies over time, frequencies by journal, and frequencies by first authors. The most frequently assigned MeSH were checked to identify if they appeared in the publications produced by the most productive authors (i.e., first authors with the highest number of publications). *Journal Citation Reports*, an annual publication that provides information about academic journals including impact factors [15] and categorization (i.e., a science or social science focus) was used to assess the 10 most productive journals (i.e., journals with the highest number of publications). All records were assessed independently by 2 reviewers to identify the synthesis method described in the study based on those identified in the scoping review of synthesis methods presented in an earlier article in this series [4]. This information was plotted by year to present a visualization of the data.

3. Results

After titles and abstracts were reviewed, a total of 1,010 records fulfilled this criteria and were eligible for inclusion in our bibliometric study. Five of these studies were excluded as they offered no description of the methods of the synthesis method. A final list of 608 records was analyzed related to the topic of knowledge synthesis methods using our validated bibliometric tool, *Synthesi.sr: bibliometric* on May 27, 2014. Overall, 97.5% (593 records) of these were published between 1991 and 2011. Since 2003, there was a steady increase in publication of articles with the highest number (105 studies) published in 2011 (Fig. 2). Most studies were published in English (96.3% or 586 studies).

3.1. Most common journals where knowledge syntheses methods articles were published

Studies were published in 330 different journals and journals that published more than 10 knowledge syntheses
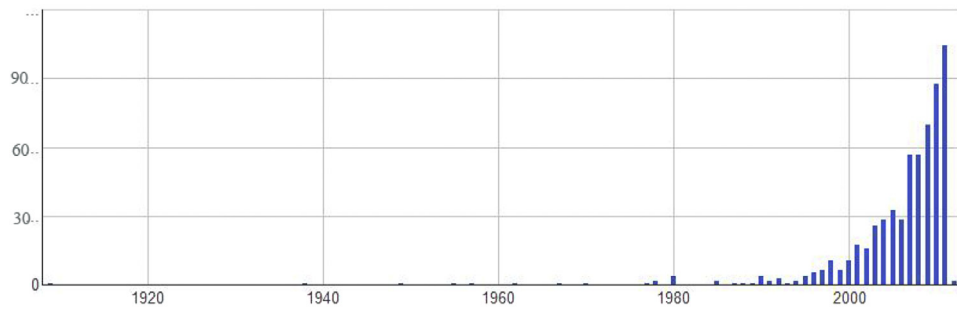
Fig. 2. Publications by year.

methods articles included *Journal of Advanced Nursing* (44 studies), *Journal of Clinical Nursing* (24 studies), *Qualitative Health Research* (12 studies), *Journal of Health Services Research & Policy* (11 studies), and *Patient Education and Counseling* (11 studies). These five journals had a median impact factor of 1.620 in 2012. Using *Journal Citation Reports* [15] to take a broader look at the 10 journals that published most often about knowledge syntheses methods, seven were categorized as science journals and three were social science journals. Journals are assigned to at least one subject category that indicates a general area of science or social science. Each journal was included in only one category with four falling into the Nursing category, two in Health Care Sciences and Services, two in Health Policy and Services, and one each in Interdisciplinary Social Sciences and Public, Environmental and Occupational Health (Table 1). Just under half (46.8% or 285) of the journals had published only one or two studies in our analysis.

3.2. Most productive authors

Most of the 558 first authors (98.7% or 551 studies) had published only one or two studies. The most productive first author, Margarete Sandelowski published 11 articles,

focusing on qualitative methods with a concentration on the methods of metasynthesis and metasummary. Five applied synthesis methods to maternal HIV infection (one metastudy, one metasynthesis, one metasummary, and two metasynthesis/metasummary). Six articles focused on methods, specifically, three on qualitative research synthesis methods, two on meta-summary methods, and one on meta-synthesis methods [16–26]. The next most productive first author was Deborah Finfgeld-Connett with seven articles. Two focused on meta-synthesis methods [27,28], and five applied synthesis methods to specific topics (one applied to caring [metasynthesis] [29], one applied to homelessness [metasynthesis] [30], one applied to aggression [metasynthesis] [31], one applied to social support [metasynthesis] [32], and one applied to courage [metainterpretation] [33]). Trisha Greenhalgh followed with six articles, five of these applied synthesis methods to health topics (two applied to therapeutic relationships [metanarrative] [34,35], one applied to school feeding [realist review] [36], one applied to patient records [metanarrative] [37], and one applied to diffusion of innovations [metanarrative] [38]. One article reported on realist review or meta-narrative methods [39]). All subsequent first authors had published three or fewer studies. For these three most productive authors, all studies were published in English

Table 1. Most common journals where knowledge syntheses were published

Journal name	Count	2012 Impact factor	Category	Rank by category	Edition
Journal of Advanced Nursing	44	1.527	Nursing	16th of 106 journals	Science
Journal of Clinical Nursing	24	1.316	Nursing	25th of 106 journals	Science
Qualitative Health Research	12	2.181	Health Policy and Services	17th of 67 journals	Social Sciences
Patient Education & Counseling	11	2.372	Interdisciplinary Social Sciences/Public, Environmental and Occupational Health	*Social Sciences:* 3rd of 92 journals; *Science:* 43rd of 161 journals	Social Sciences/Science (listed in both)
Journal of Health Services Research & Policy	11	1.620	Health Policy and Services	30th of 67 journals	Social Sciences
Journal of Nursing Scholarship	10	1.612	Nursing	13th of 106 journals	Science
Social Science & Medicine	10	2.733	Public, Environmental and Occupational Health	*Social Sciences:* 14th of 139 journals; *Science:* 33rd of 161 journals	Social Sciences/Science (listed in both)
BMC Medical Research Methodology	9	2.211	Health Care Sciences and Services	25th of 83 journals	Science
International Journal of Nursing Studies	9	2.075	Nursing	5th of 106 journals	Science
Implementation Science	7	2.372	Health Care Sciences and Services	20th of 83 journals	Science

and in total had 10 articles (of 24 total articles) in the 10 most common journals identified in this bibliometric analysis.

3.3. Patterns of indexing

The most commonly assigned MeSH are humans (527 times), female (144 times), qualitative research (104 times), research design (94 times), and male (84 times). Eliminating MeSH based on population characteristics, such as species, sex, or age groups (e.g., humans, male, female, adult), and focusing on MeSH oriented toward the subject matter of the study, the most commonly assigned were qualitative research (104 times), research design (94 times), meta-analysis as topic (72 times), evidence-based medicine (55 times), and review literature as topic (47 times). The publications for the three most productive authors were checked to identify if these five most frequently assigned MeSH focusing on subject matter of the study appeared in their publications. All were present in at least one article among the articles by Sandelowski (11 studies) and Finfgeld-Connett (7 studies), but only three appeared in at least one article in the set of publications by Greenhalgh (6 studies; Table 2). A total of 1,395 different MeSH were applied to the 608 studies. Two-thirds of these (67.3% or 939 MeSH) only appeared once or twice in any record. Table 3 lists the 25 most frequently assigned MeSH with the number of times each appeared in the 608 records assessed for the bibliometric analysis. With regard to publication types, 364 (58.8%) of the articles were classified as a review, 19.0% or 116 studies as meta-analysis, 25 studies as comparative study, 5 studies as case report, and 4 studies as comment.

3.4. Visualization of data

In Figure 3, the 10 most commonly reported knowledge synthesis methods are highlighted. Twelve methods are represented in the visualization as there was a tie in the number of studies published for integrative review and meta ethnography (52 studies each), and meta-narrative review and mixed methods review (21 studies each). Among

the original 608 research documents, critical interpretive synthesis was the most commonly reported method with 87 studies and is the only knowledge synthesis method with publications before 1990. From 2000 to 2011, knowledge synthesis methods follow the general trend of showing an increase in publications over time. Although realist review did not have publications until 2004, by 2011 this method had the most publications (14 studies), right after integrative review (15 studies).

4. Discussion

Although we identified 608 studies reporting different knowledge syntheses methods, the journal with the most publications is 44 studies, suggesting that the literature is widely dispersed throughout a variety of journals. Nursing journals were among the 10 most common journals containing studies on knowledge synthesis methods; however, this is still a small proportion of the total (4 of the 10 most common journals) suggesting that this literature is scattered among many disciplines and fields. Although there was a large quantity of studies, most authors (98.7%) had two or less articles, and the most productive author had 11 articles published. This diversity in authors and journals creates the potential for inconsistent guidance on methods and enhances the challenge of finding these articles for researchers or research users. Further challenges to finding these articles are due to the inconsistency of MeSH indexing. Although review and meta-analysis are assigned most often as a publication type for these studies, five articles were classified as case reports, which would appear to be inconsistent with the reporting of synthesis methods. Several of the MeSH that were assigned most often to studies were harmonious with the subject matter including qualitative research, review literature as topic, and research design. Overall, none of these MeSH were applied to a large proportion of records with qualitative research used most often on 104 records. Some of this inconsistency could be attributed to the possible lack of MeSH related to the methods of conducting research

Table 2. Most productive authors

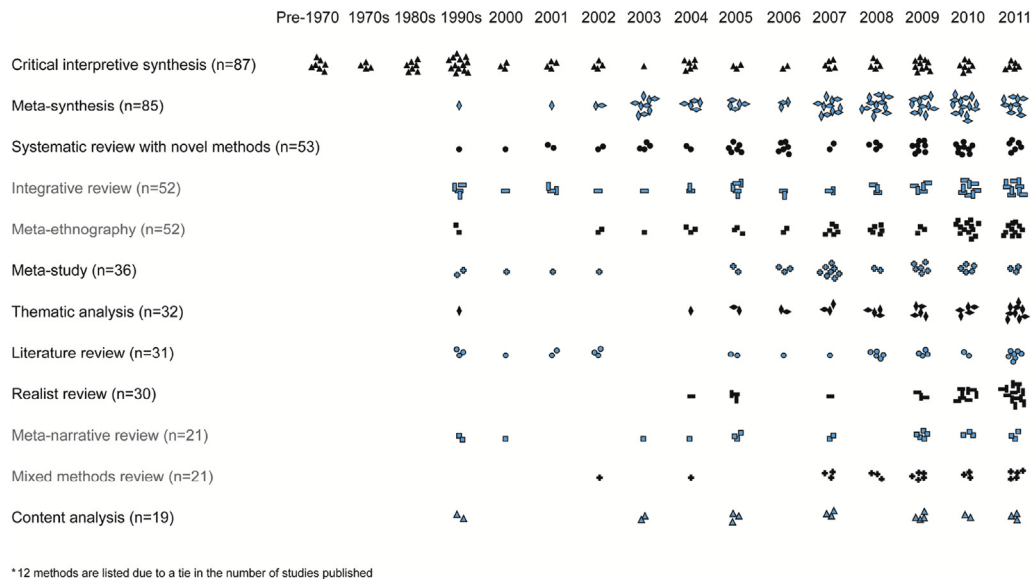| Author name	Number of studies	Synthesis method	No. of studies in 10 most common journals	No. of studies with 5 most commonly assigned MeSH	Language
Sandelowski, Margarete	11	• Metastudy • Metasummary	3	Qualitative research: 7 Research design: 5 Meta-analysis as topic: 5 Evidence-based medicine: 2 Review literature ast: 3	English
Finfgeld-Connett, Deborah	7	• Metasynthesis • Metainterpretation	5	Qualitative research: 4 Research design: 1 Meta-analysis as topic: 3 Evidence-based medicine: 2 Review literature as topic: 1	English
Greenhalgh, Trisha	6	• Metanarrative • Realist review	2	Qualitative research: 0 Research design: 1 Meta-analysis as topic: 1 Evidence-based medicine: 0 Review literature as topic: 1	English

Table 3. Most commonly assigned MeSH

MeSH	Number of times assigned
Humans	527
Female	144
Qualitative research	104
Research design	94
Male	84
Meta-analysis as topic	72
Adult	62
Evidence-based medicine	55
Review literature as topic	47
Child	45
United States	44
Adaptation, psychological	42
Health knowledge, attitudes, practice	42
Aged	41
Nursing methodology research	41
Attitude to health	40
Health services research	40
Nursing research	40
Adolescent	39
Attitude of health personnel	38
Great Britain	38
Middle aged	38
Randomized controlled trials as topic	31
Nurse's role	30
Risk factors	29

because PubMed is focused on the therapy, diagnosis, etiology, and prognosis of the biomedicine and health literature [9]. MeSH are continuously being refined and added so that some indexing terms would not have been available for the entire time frame of the studies reported on in our analysis. For instance, qualitative research was introduced in 2003, meaning that any studies published before 2003 would not have the opportunity to be indexed with this MeSH. As well,

other study types have historically been poorly indexed but with increasing awareness, indexing has become greatly improved over time [40]. Despite these challenges in indexing, it is still possible to see a trend with the amount of research related to synthesis methods increasing at a steady rate. This trend suggests a growing interest in trying to develop and refine the methods of synthesizing literature in a rigorous manner, other than those used by traditional systematic reviews [41,42]. This increase in novel knowledge synthesis methods may be due to the limitations of traditional systematic reviews. The Cochrane Collaboration has recognized this and expanded their scope by creating a group that focuses on the methods and processes involved in the synthesis of qualitative evidence [43]. This bibliometric analysis puts the onus on authors to identify a knowledge synthesis method within their article, and of interest is one study published in 1909 that potentially provides insight on the methods of conducting a literature synthesis which suggests long-standing interest among researchers in the methodology of synthesizing evidence [44].

4.1. Limitations

The bibliometric analysis for the set of studies described in this article needs to be considered within the context of certain limitations. Not all records contain MeSH as evidenced in the 10% sample taken for the validation exercise of *Synthesi.sr: bibliometric*. In the random sample of 62 records, 7 records had no MeSH terms assigned although some had been published longer than 1 year. As well, 1,010 records were available for inclusion in the bibliometric analysis, but we were only able to locate 608 of these records in PubMed. Although there is overlap in the

*12 methods are listed due to a tie in the number of studies published

Fig. 3. Visualization of the 10 most reported knowledge synthesis methods by year*. In this figure, we demonstrate the visualization of the 10 most reported knowledge synthesis methods by year. Each point represents one original research document. There was a tie in the number of studies published for ''integrative review'' and ''meta-ethnography'' (both with 52 studies), and ''meta-narrative review'' and ''mixed methods review'' (both with 21 studies) so that 12 methods are represented in the visualization.

journals covered by PubMed and other literature databases, unique journals can be found in databases such as EM-BASE [45], and these were not included in this analysis. Despite this, 608 records is a large quantity sufficient to provide a summary of the research activity in this area. Although it would have been interesting to know what country the research originated from, identifying this was problematic. An attempt was made to build this reporting into *Synthesi.sr: bibliometric* by retrieving this information from the PubMed records, but it could not be validated as country is reported in several different fields including corresponding author, affiliated institution, journal, and grant information. As an example, the country associated with the affiliated institution may not be the same country as where the data were collected, making it challenging to declare the originating country of the research.

Despite these limitations, our results are similar with the overall scoping review results for which 409 studies were included [4]. For example, the articles included in the scoping review were mostly from nursing, health care science and services, and health policy [4]. As well, critical interpretive synthesis and metasynthesis were common methods in the scoping review. The reason the bibliometric study includes more studies than the scoping review is because the former included all initial studies identified as relevant before being passed onto the second level of screening, and some of these methods were excluded during this second level of screening in the scoping review.

5. Conclusion

Effective indexing benefits users by leading them to subject matter quickly and efficiently. MeSH are controlled vocabulary used for indexing PubMed citations to systematically organize and aid in guiding users to pertinent subject matter. Relevant MeSH were not applied to most studies in our bibliometric analysis, making it challenging for those searching for literature on knowledge synthesis methods. As well, MeSH that identify specific knowledge synthesis methods, such as meta ethnography or critical interpretive synthesis, are not available. Given the number of knowledge synthesis methods available, subject headings that identify distinct methods would provide clarity and assist researchers or research users. There are a large number of authors and journals reporting on these methods with no definitive leadership coming from one source. This may lend itself to inconsistencies and variations in describing and reporting methods adding further challenges to users in finding these articles.

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Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jclinepi.2015.02.019.

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