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The influence of complexity: A bibliometric analysis of complexity science in healthcare

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The influence of complexity:
A bibliometric analysis of complexity science in healthcare

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ABSTRACT

Objectives

To analyse trends in the academic literature applying complexity science to healthcare, focusing specifically on bibliometric characteristics and indicators of influence.

Design

This study reports a bibliometric analysis via a systematic search of the academic literature applying complexity science to healthcare.

Method

A search of four academic databases was performed. Articles details were downloaded and screened against inclusion criteria (peer-reviewed journal articles applying complexity science to healthcare). Publication and content data were then collected from included articles, with analysis focusing on trends over time in the types and topics of articles, and where they are published. We also analysed the influence of this body of work through citation and network analyses.

Results

Articles on complexity science in healthcare were published in 268 journals, though a much smaller subset were responsible for a substantial proportion of this literature. The United States contributed the largest number of articles, followed by the United Kingdom, Canada, and Australia. Over time, there were increases in the number of empirical and review articles published, relative to non-empirical contributions. However, in general, non-empirical literature were more influential, with a series of introductory conceptual papers being the most influential based on both overall citations and their use as index references within a citation network. The most common topics of focus were health systems and organisations generally, and education, with recent uptake in research, policy, and change and improvement.

Conclusions

This study identified changes in the types of articles on complexity science in healthcare published over time, and their content. There was evidence to suggest a shift from conceptual work to the application of concrete improvement strategies and increasingly in-depth examination of complex healthcare systems. We also identified variation in the influence of this literature at article-level, and to a lesser extent by topic of focus.

Key words

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Complexity science, Healthcare, Bibliometrics, Review, Complex adaptive systems, Health care

ARTICLE SUMMARY

Strengths and limitations of this study

- Use of an inclusive search strategy based on previously published reviews and including non-empirical and non-English language articles.
- Articles coded by multiple coders into topic themes to determine popular and emerging areas of interest for complexity science in healthcare.
- A focus on citations and index references as a proxy for influence; citation analysis tends to prioritise older contributions that have had more time to accumulate cites.
- Inclusion of only peer-reviewed articles, minimizing the potential influence of some prominent non-peer-reviewed contributions.

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The influence of complexity: A bibliometric analysis of complexity science in healthcare

BACKGROUND

Complexity science provides a way of understanding nonlinearity, in which causation is problematic and multi-faceted, and emergent behaviours are the norm.[1] It developed out of diverse academic traditions, including computer science, physics, sociology, anthropology, economics and mathematics. Different systems can be understood using the complexity paradigm—it finds commonalities and patterns in the behaviour of systems comprised of very different agents (ants, cells, humans, societies, species, bacteria), often labelled via a convenient phrase: complex adaptive systems (CASs).[2] Such systems were initially recognised for displaying "weird", chaotic and dynamic behaviours; thus, chaos theory was developed to explain such phenomenon. However, a focus only on chaos failed to account for why complex systems also often exhibit degrees of homeostasis—that is, they are somehow balanced between the chaotic and unpredictable on the one hand, and the orderly and predictable on the other—for the most part, most of the time.[3] Complexity science provides an understanding of systems that are between phase transitions and are often found just "at the edge of chaos".[1, 3]

The study of complexity challenges traditional approaches to science that favour a controlled view of the world, where variables are held constant and where outcomes are predictable because causes and effects are related, and construed as linear arrangements.[4] CASs are not well-explained through studies that aim for such reduction, decomposition and cause-effect logic, breaking problems down into manageable parts and studying these components individually in an attempt to understand the whole.[5] In short, CASs are *different from*, and *more than* the sum of their parts.

Complexity science has pervaded many disciplines, making its way, for example, into the social sciences and the study of human systems and organisations.[1, 6] The adoption of complexity science principles has been particularly notable in health-related fields, with healthcare systems worldwide recognised as excellent examples of CASs because of the diverse array of agents involved (doctors, patients, nurses, consumer groups, politicians, non-government organisations) and the enormous number of interactions among them.[7, 8] This work gained momentum at the beginning of this century, with the publication of a number of conceptual contributions discussing the application of complexity science principles in areas of healthcare like clinical practice,[9] education,[10] and

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healthcare management.[11, 12] Since this time, the potential of complexity science in understanding and tackling some of the otherwise intractable challenges of delivering healthcare—including patient safety,[13] interprofessional collaboration,[14] sustained improvement,[15] and managing uncertainty [16]—has been considered. Empirical studies applying the principles of complexity science to healthcare have also proliferated. Almost two decades ago, Anderson and McDaniel [17] used complexity theory to understand nurses' decision-making in nursing homes in the United States. Much more recently, Barasa, Molyneux [18] examined hospitals as CASs in their case study of financing decisions in Kenya.

There are signs that literature on complexity science in healthcare is approaching maturity, with literature reviews of the empirical research now being undertaken,[19] especially in the context of health services interventions,[20] as well as publication of a systematic review of empirical and non-empirical complexity ideas.[21] As a complement to these contributions, now is an appropriate time to examine the influence and spread of this literature in greater prevision. Towards this end, bibliometrics is an approach that looks at publication patterns in an area of research literature, including trends over time and globally, and the influence of articles, and the authors and journals publishing such works, indicated by citations.

Aim

This study aimed to analyse trends in the academic literature on applying complexity science to healthcare, focusing specifically on bibliometric characteristics. We also analysed the influence of this body of work through citation and network analyses.

METHOD

Systematic search of the literature

Databases

In April 2018, the Cochrane Database of Systematic Reviews, CINAHL, EMBASE, and all databases of Web of Science, which includes MEDLINE, were searched using keywords documented below. The general search strategy was based on that taken by Thompson et al.,[19] with a range of search terms associated with complexity theory used to account for broad indexing. This included "chaos theory", because complexity is often described as developing out of,[1] as well as encompassing the more

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specific concept of, chaos.[22] Keywords related to healthcare and health systems were also searched. No date restrictions were used.

Keywords

1. "Complexity theory" OR "complexity science" OR "complex adaptive system" OR "complexity thinking" OR "complex responsive process theory" OR "chaos theory"
2. healthcare OR "health care" OR "health-care" OR hospital OR "health facilit*" OR "acute care" OR "health organi*" OR "health system" OR "primary care" OR "general practice" OR "aged care" OR "nurs* home OR medic* OR clinic* OR nurs* OR health

Citations returned from these searches were downloaded into the reference management software Endnote, and duplicates were removed. References were then exported to a Microsoft Excel spreadsheet for screening. Articles were reviewed against inclusion criteria and exclusion criteria. References meeting inclusion criteria were classified for bibliometric analysis.

Inclusion and exclusion criteria

Because we were looking at influence, empirical and non-empirical papers (e.g., commentaries, conceptual papers and reviews) published in peer-reviewed academic journals and applying complexity science to healthcare were included in the analysis. We defined healthcare broadly to include not only the professionals involved (e.g., nurses, doctors, administrators) and sites of healthcare delivery (e.g., hospitals, nursing homes), but also education, policy, processes and ethical or research issues related to healthcare. Health promotion and public health articles were initially retained for full-text screening. However, they were ultimately only included if they discussed healthcare sites, professions or aspects of care delivery, rather than, for example, population-based health promotion interventions and issues.

Letters to the editor and editorial papers that only described the contents of an issue were excluded, because they were not thought to sufficiently contribute to the spread of complexity ideas within healthcare. Books, book chapters and conference proceedings were also excluded because bibliometric data is often not available or incomplete for such publications. Articles that were not originally published in English but provided an English-language abstract were included in the bibliometric review if, based on this information, they were found to meet all of the inclusion criteria and none of the exclusion criteria.

Bibliometric analysis

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Stage one: Review of article publication data

First bibliometric data on the article, including the year of publication, the journal in which it was published, the corresponding author and their country of residence, were captured from the full-text, or the journal or indexing database where full-text was unavailable (either inaccessible to the authors or not available in English).

Stage two: Review of article content

Articles were then classified in greater detail according to their content, including type of article and focus. This involved classifying articles as empirical or non-empirical. The empirical papers were further categorized according to their use of complexity science (e.g., the covered aspects of prediction, conceptual framework, data analysis, or interpretation of findings) following the schema of Thompson et al.[19] Non-empirical papers were classified as: commentaries and editorials, conceptual discussions, conceptual case studies, and protocols. Reviews were also included and classified.

Two of the authors (KC and CP) performed a content analysis on the main focus(es) of all the included articles. This involved inductive descriptive coding of each paper, then comparisons, modifications and expansions of codes to identify the most common topic themes in the literature applying complexity science to healthcare. Generally, details in the abstract and title, in addition to database indexing information, were sufficient to classify whether an article was empirical or non-empirical, and also its main focus. However, some articles did not have an abstract, or the abstract detail was insufficient. Full-text review was conducted during this stage (where full-text was available in English) to ensure the most accurate classification.

Stage three: Analysis of influence

The number of citations an article had received over time was used to calculate influence, with citations collected from Google Scholar in July 2018. We also examined influence by identifying one or more "index" reference(s) for each of the full-text articles reviewed.[1] An index was defined as the most influential, prominent or leading reference(s) cited by an included article that also focused on complexity science within healthcare (as compared with complexity science in biology, management or generally). However, unlike papers in this review, an index reference need not be a peer-reviewed

[1] Where full-text was available (n=377)

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publication; this criterion allowed us to consider influence from other sorts of academic outputs. Where possible, we identified an index reference based on attribution by the authors of that paper, for example, a statement like: "In his appendix to *Crossing the Quality Chasm*,[12] Plsek[13] suggests that, rather than using the principles of mechanical systems to try to improve health care, innovators should employ the principles of complex adaptive systems".[23, p. 17] However, in the absence of an explicit statement to this effect, we took the first reference(s) cited when introducing the notion of complexity science applied to healthcare. Some articles included did not have index references, and others were unable to be searched (i.e., full-text not available).

Index references and their citing articles were used in a network analysis, visually constructed in Gephi, version 0.9.2. Network analysis uses graph theory to map and measure relationships among nodes.[24] In this case, the nodes in the network were the articles in the review as well as any index reference(s) they cited, while relationships were directional tie(s) to an index reference (e.g. articles X cited article Y as an index reference). Articles that did not cite an index reference, and were not themselves used as an index reference for another article (i.e., an isolate), were removed from the network analysis, on the basis that they did not contribute to understanding influence. In visualizing the network, the main topic theme of the research output was used to differentiate different categories of articles and identify any possible clustering, as well as distinguish influential index references that were not captured by our review strategy. The most influential academic outputs in the network were assessed using in-degree calculation (the number of inward directed ties to a node i.e., the number of times an index reference was cited by other articles).

RESULTS

A total of 2,505 articles were returned from searches across the four databases and downloaded into Endnote X8. Following removal of duplicates, citation details (n=2,382) were exported to Microsoft Excel for screening of their titles and abstracts against inclusion criteria. Five-hundred and forty-seven references were retained, though a further 93 were excluded at stages one and two of data analysis because, upon review, they did not meet inclusion criteria (reasons documented in Table 1). This left 454 articles that were subjected to the bibliometric analysis. Figure 1 presents the search strategy.

INSERT FIGURE 1 HERE

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Table 1. Reasons for exclusion at full text stage.

Reason for exclusion	Number of articles
Not about complexity science	12
Not in healthcare	31
Not a peer-reviewed academic journal article	49
Article information unable to be found[1]	1
Total	93

[1] Rouse, W. B. (2000). Managing complexity: disease control as a complex adaptive system. Information Knowledge Systems Management, 2(2), 143-165 was published in a now discontinued journal. Citation data unavailable in Google Scholar, precluding bibliometric analysis.

Of the 454 articles considered eligible for inclusion, the research team was able to access full-text in English for 379 articles, permitting a more detailed and accurate classification of content. The remaining 75 articles included in the bibliometric analysis were comprised of 49 articles in English-language journals where full-text was inaccessible, and 26 where full-text was not available in English. See Appendix 1 for summary of data extraction.

Stage one results: Article publication data

Publishing of articles on complexity science applied to healthcare

The 454 included articles came from 268 different journals, which were primarily health-focused, but varied in scope. Table 2 displays the journals publishing the highest number of articles in the field. The journal publishing the most articles on complexity science applied to healthcare was the *Journal of Evaluation in Clinical Practice* (n=24), followed by *Health Care Management Review* (n=18), and *Social Science & Medicine* (n=11).

Table 2. Top 13 journals publishing articles on complexity science applied to healthcare

Top journals publishing on complexity science in healthcare	Number of articles
Journal of Evaluation in Clinical Practice	24
Health Care Management Review	18
Social Science & Medicine	11
BMC Health Services Research	8
Implementation Science	8
Journal of Advanced Nursing	8

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Medical Education	8
Annals of Family Medicine	6
Academic Medicine	5
BMJ	5
International Journal of Integrated Care	5
Journal of Interprofessional Care	5
Journal of Nursing Administration	5

Using the corresponding author's affiliation as an indicator, we determined that articles applying complexity science principles to healthcare came from 33 countries. The United States of America (n=199, 43.8%), the United Kingdom (n=82, 18.1%), Canada (n=49, 10.8%) and Australia (n=23, 5.1%) accounted for nearly three-quarters of the included papers, as can be seen from Figure 2. Other countries contributing substantially were the Netherlands (n=12, 2.6%) and Brazil (n=17, 3.7%); for Brazil, this included 11 (2.4%) papers published in non-English language journals. Despite the concentration of articles among only a few countries, there was evidence for increasing globalisation over time; prior to 2003, the only countries publishing literature on complexity science applied to healthcare were the UK, USA, Canada and Australia, while in 2017 alone articles came from 17 different countries.

INSERT FIGURE 2 HERE

Stage two results: Article content

Types of articles published

The majority of the literature (n=277, 62.8%)[2] applying complexity science to healthcare has been non-empirical, mostly conceptual discussions (n=178), followed by conceptual case-studies (n=39), methodological and practical articles (n=23), commentaries and editorials (n=18), unstructured and narrative reviews (n=12), and protocol papers (n=7). However, the publication of empirical papers (n=149, 33.9%) increased, especially over the last five years; these articles predominantly employed complexity science as a conceptual framework (n=109), or to a lesser extent, for data collection (n=4) or analysis (n=12), or the interpretation of findings (n=22).[3] Publication of structured and systematic

[2] N=13 unable to be classified because full-text was inaccessible and there was insufficient information in the abstract. Percentage calculated on the 441 articles able to be classified.
[3] Full-text unavailable for two empirical articles. There was not enough detail in the title and abstract to determine the use of complexity science.

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reviews (n=15, 3.4%) that either explicitly reviewed complexity science in healthcare [e.g., 19, 20, 25] or used these principles as a lens or framework for their review [e.g., 26, 27] also increased over the last decade. These trends are captured in Figure 3.

INSERT FIGURE 3 HERE

Content of articles published

Delving deeper into the content of these articles, we coded the main focus(es) of each of the articles included in the review, then developed broader categories representing common topic themes for complexity science applied to healthcare. Multiple topic themes were often evident in a single article, so themes are not mutually exclusive. These topic themes are displayed in Table 3. The most common topic themes involved a focus on *healthcare settings* (especially *primary care* and *hospitals*), followed by *health systems and organisations generally*, *healthcare professionals* (particularly *nursing* and *medicine*), and *education*. Furthermore, while *healthcare professionals*, and *education* were early topics for complexity science in healthcare, it was not until 2006 that these principles were taken up in articles focused on *change, improvement and implementation*, *research* and *policy* (see Figure 4).

Table 3. Topic themes for articles on complexity science applied to healthcare.

Topic themes	Number of articles[1]	Citations per year
Management and leadership	49	4.0
Education	59	5.9
Teamwork, collaboration and care coordination	31	4.8
Health systems and organisations generally	76	6.0
Public health and health promotion	31	4.4
Safety, quality and performance	22	2.4
Change, improvement and implementation	39	5.1
Research	14	4.7
Healthcare policy	10	2.3
Health settings	146	3.4
- *aged and nursing care*	*21*	*5.7*
- *ambulatory care*	*2*	*0.8*
- *chronic care*	*9*	*4.3*
- *hospital*	*53*	*2.7*
- *mental health*	*6*	*1.9*
- *paediatrics*	*3*	*3.9*

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- *palliative care*	*4*	*1.3*
- *primary care*	*48*	*6.4*
Healthcare professionals	71	3.6
- *allied health*	*2*	*0.3*
- *medicine*	*19*	*7.3*
- *nursing and midwifery*	*44*	*2.7*
- *general*	*6*	*4.0*
Other	33	3.5

[1] Topic themes are not mutually exclusive, except within subthemes of health settings and healthcare professionals.

INSERT FIGURE 4 HERE

Stage three results: Examination of influence

Citation analysis

Influence was calculated using the number of citations each article received averaged by the number of years elapsed since publication. For the field, this amounted to an overall average of 4.9 citations a year per article, although there was high degree of skewedness (Mdn= 2.5, Min=0, Max=110.1).[4] At article-level, influence was considered separately for empirical and non-empirical contributions, which included structured reviews. As can be seen in Table 4, generally, non-empirical articles were more influential than empirical ones. The most influential article by a substantial margin was the conceptual discussion by Plsek and Greenhalgh,[5] published in 2001 in the BMJ, to introduce a series of papers on complexity in healthcare, many of which in this series also featured in the top 10. A brief description of the main focus of each paper, which was used as the basis for developing topic themes, is present in Table 4. For non-empirical articles, the focus tended to be broader and there were a number of common themes, including discussion of application of complexity science to healthcare generally,[5] clinical practice,[9, 28] and education.[29] The empirical articles were however more varied and specific in focus, though nursing homes and primary care were common areas of interest. Influence was also examined according to the topic themes identified in stage two; based on this analysis, we found that articles focusing on complexity science specifically in relation to medical professionals were most influential, followed by articles in the primary care setting and considering health systems and organisations generally (Table 3).

[4] Articles published in 2018 not included in calculation.

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Network analysis of index references

The influence of included articles and other research outputs on complexity science applied to healthcare was further investigated in the network analysis of index references, depicted in the sociogram in Figure 5. The network consisted of 514 nodes (i.e., academic outputs) and 657 directional ties (which output cited another output as an index reference). Of these nodes, 276 (53.7%) were used as an index reference by at least one other research output in this network (indegree >0). The nodes with the highest in-degree are listed in Table 5. The most influential node in the network was the article by Plsek and Greenhalgh,[5] which was cited as an index reference for complexity science in healthcare by 71 other articles in the review. Visualisation revealed an absence of clustering by topic theme; that is, rather than seeing index referencing only between research outputs that explore similar ideas (e.g. management only uses other management outputs as index references), there were connections among the different topic themes. Finally, there were 183 outputs (35.6%) used as index references that had not been included in our review.

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Table 4. Most influential empirical and non-empirical articles on complexity science applied to healthcare.

Empirical article	Citations per year	Main focus description	Non-empirical and review articles	Citations per year	Main focus description
Anderson, Issel [30]	29.4	nursing home	Plsek and Greenhalgh [5]	110.1	healthcare - general
O'Sullivan, Kuziemsky [31]	22.6	public health - health promotion in disaster	Fraser and Greenhalgh [10]	50.6	education
Hanseth, Jacucci [32]	21.8	hospital – EHR/IT	Plsek and Wilson [12]	41.4	leadership
Monrouxe, Rees [33]	18.4	education - medicine	Best, Greenhalgh [27]	40.7	healthcare system - transformation
Oyeleye, Hanson [34]	16.8	nursing - workplace bullying	Goldberger [35]	39.6	clinical practice
Anderson, Corazzini [36]	15.9	nursing homes - job satisfaction	Braa, Hanseth [37]	35.6	EHR/IT - developing countries
Ssengooba, McPake [38]	15.5	performance targets - health systems	Wilson, Holt [9]	28.1	clinical - general
Miller, McDaniel [39]	14.8	primary care	Frye and Hemmer [40]	28.0	education
Boustani, Sachs [41]	14.5	primary care - dementia care	Bleakley [42]	25. 7	education
Provost, Lanham [13]	14.0	collaboration and teamwork - safety	Anderson, Crabtree [43]	25.1	healthcare organisations

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INSERT FIGURE 5 HERE

Table 5. In-Degree

	Most popular index references in network	In-degree	Topic theme of complexity
1	Plsek, P. E. and T. Greenhalgh (2001)	71	Health systems and organisations
2	IOM and P. E. Plsek [44]	25	Not in review
2*	Plsek, P. E. and T. Wilson [12]	25	Management/leadership
3	Wilson, T., T. Holt and T. Greenhalgh Wilson, Holt [9]	19	Healthcare setting
3*	Zimmerman, B., C. Lindberg, and P. Plsek Zimmerman, Lindberg [45]	19	Not in review
4	Fraser, S. W. and T. Greenhalgh [10]	18	Education

* indicates equal levels of in-degree.

DISCUSSION

Complexity science has brought a radical shift in how we think about many of the dynamic relationships and systems present in our world, with healthcare being no exception. This bibliometric review of complexity science in healthcare has identified a number of trends in the types of articles published over time, and the influence of this body of work. It has documented increasing use of a complex systems lens to describe, understand and study aspects of healthcare over the past two and a half decades, with literature emanating from numerous countries and being published in many journals. While there has been considerable concentration, with only a few countries (the USA, UK, Canada and Australia) and journals responsible for a disproportionately high number of contributions, there is also evidence of increasing globalisation of complexity science in healthcare literature over the years.

Our findings indicate recent increases in empirical research and reviews, relative to non-empirical contributions, suggesting a move from the conceptual to the concrete with regard to understanding complexity in healthcare. A recent review by Thompson, Fazio [19] though, indicates that empirical work in health services research is often inconsistent and lacks sophistication in the use of complexity science methods; similarly, Brainard and Hunter [20] reviewed complexity-informed interventions and noted that there is often a poor operationalisation of complexity science principles. In this regard, our

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own analysis of non-empirical research has identified a preponderance of broad conceptual discussions, rather than practical or methods articles of *how* to apply complexity science in healthcare.

This bibliometric review further demonstrated that complexity science has permeated diverse contexts and topic areas within healthcare, being particularly prominent in articles on management, education, primary care and hospitals. Interest in research as well as change, improvement and implementation have emerged more recently. In regards to the former, the evolving trend for publishing articles about researching complexity in healthcare suggests increasing awareness of the need to operationalise complexity concepts. Meanwhile, for the latter, a nascent focus on change and improvement mirrors the formalisation of implementation science as a field.[e.g., 46] It is plausible that these will become more prominent target areas in the future for attention by complexity scientists.

Although there was variation in the degree of influence these topics had, based on average citations, our network analysis demonstrated limited clustering according to theme, which suggests cross-fertilisation of ideas across the broader body of work on complexity science in healthcare. At the same time, a number of early contributions on complexity science in healthcare have become widely-recognised in the field as the most influential both in terms of their total citations and their consistent status as index references for other articles.[e.g., 5, 9, 10, 12]

Strengths and limitations

The search strategy for this bibliometric analysis was based on that of a published review.[19] Furthermore, our inclusion criteria were designed to be as inclusive as possible, such as in recognising non-English language publications. Peer-reviewed journal articles are best suited to bibliometric and particularly citation analyses, rather than other academic outputs such as books, book chapters and reports, hence this being a requirement for inclusion in our review.[47, 48] While well-justified, our network analysis demonstrates the limits of this approach in that a substantial portion of index references identified were not included in our review, particularly a prominent book by Zimmerman, Lindberg [45] and Plsek's appendix to an Institute of Medicine Report.[44] Despite this limitation, these contributions were included to some extent through our identification of index references.

Furthermore, the citation analysis, as well as our focus on index references, has arguably better illustrated long-term impact than the emerging influence of new and up-and-coming work on

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complexity science in healthcare, because the publication process can be lengthy, creating delays in the accumulation of citations.[49] Hence, more recent articles, which we have found influential in guiding our own research, such as those by Leykum, Lanham and their colleagues [e.g., 50, 51] may be revealed as more influential in the coming years. The use of "altmetrics" (e.g., social media mentions) in future bibliometric reviews could facilitate assessment of more immediate impact.[52] Lastly, some contributions influential in the field have straddled public health and social care, such as the work of Hawe [53] and Sterman,[54] and so were not included based on our search strategy and inclusion criteria.

CONCLUSION

This study conducted a bibliometric analysis of the peer-reviewed literature in the evolving academic field of complexity science applied to healthcare. We identified a number of trends in where this work has been conducted and published. There were also clear shifts in the types of articles published over time, and their content. As a field, the application of complexity science to healthcare appears to be increasingly focused on *doing* complexity-informed research, rather than discussions of its conceptual and theoretical contours. Finally, we found substantial variation in the influence of this literature at article-level, and to a lesser extent by topic of focus.

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Author Contributions

KC had the original idea for the article and devised the search strategy with support from LAE, JCL and JB. KC oversaw the search, and conducted the title/abstract review and analysis with assistance from CP. CP performed the network analysis of influence. KC drafted the manuscript. CP, LAE, JCL and JB critically revised the manuscript. All authors agreed upon the final version of the manuscript.

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Competing Interests

None declared.

Abbreviations

CASs Complex Adaptive Systems

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FIGURE LEGENDS

Figure 1. PRISMA flow diagram of search strategy

Figure 2. Global trends for publishing articles on complexity science applied to healthcare.

Figure 3. Trends over time in the types of articles published on complexity science applied to healthcare.
Note data collected mid-2018.

Figure 4. Trend over time in the publications of complexity science applied to healthcare by topic theme.

Figure 5. Sociogram of index references for complexity science applied to healthcare.
Each circle (node) is representative of a research output. The size of node is indicative of in-degree (larger nodes indicate a higher number of references towards the output as an index). Colour of node is indicative of the topic theme. * indicates equal levels of in-degree for corresponding rank.

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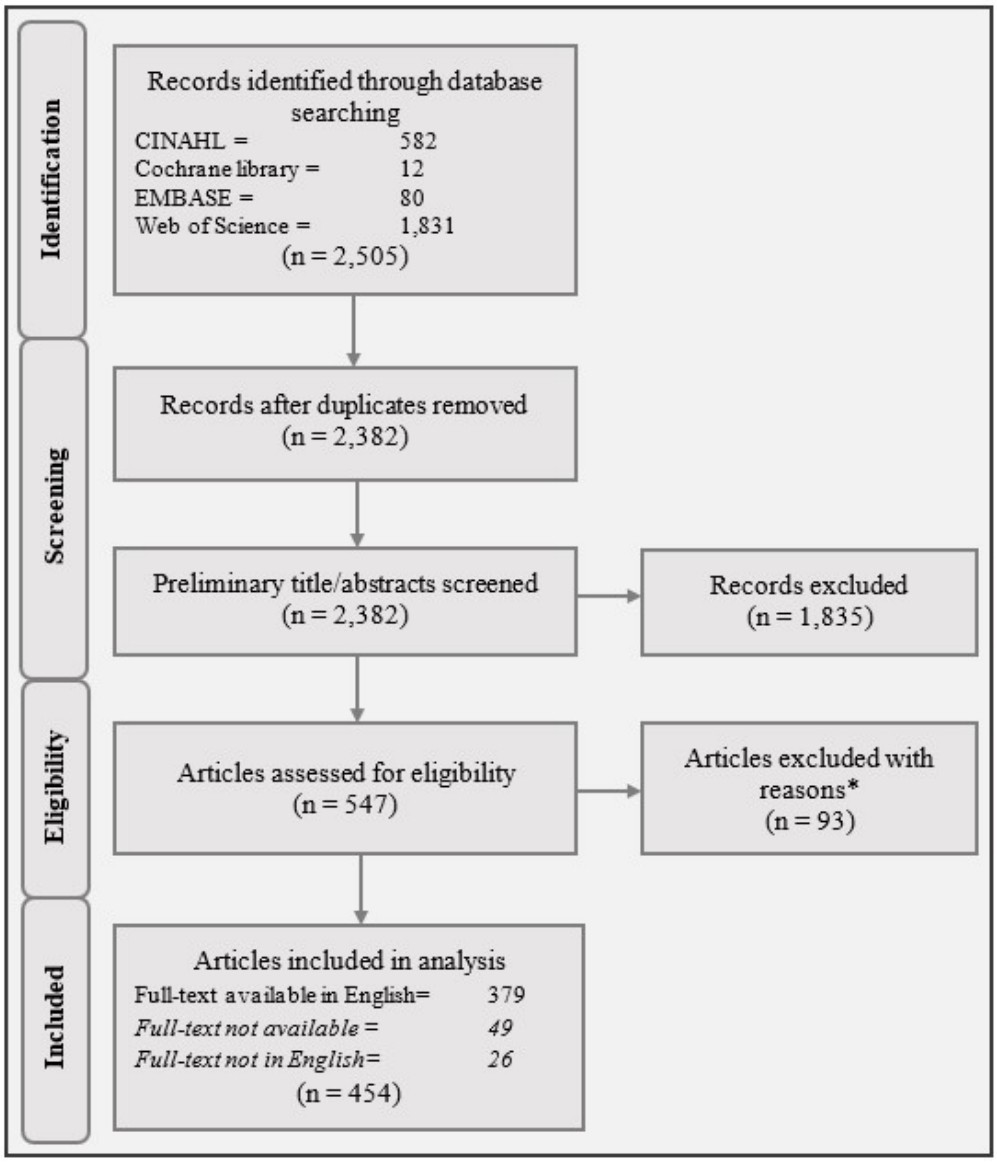

Figure 1. PRISMA flow diagram of search strategy

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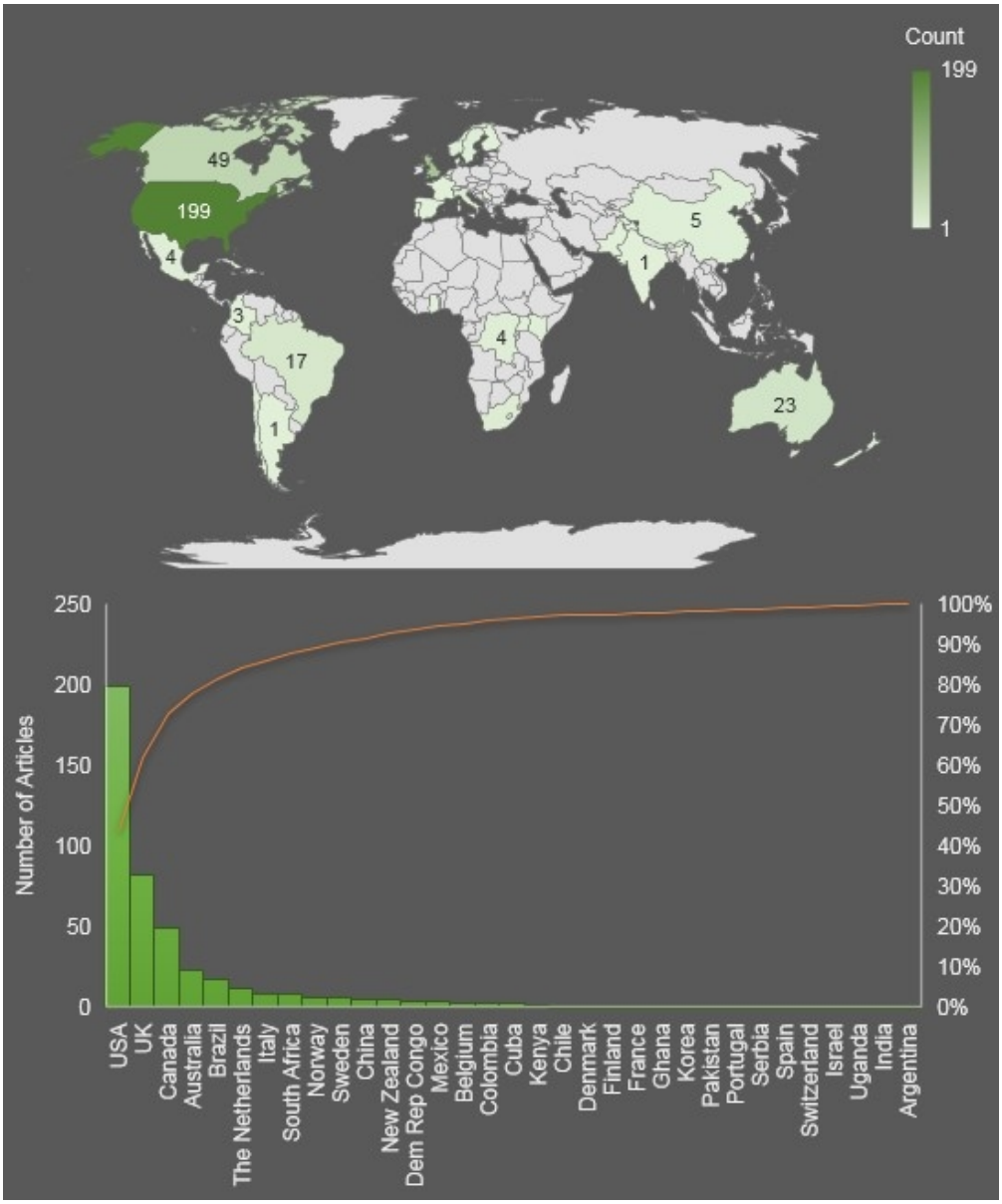

Figure 2. Global trends for publishing articles on complexity science applied to healthcare.

144x172mm (96 x 96 DPI)

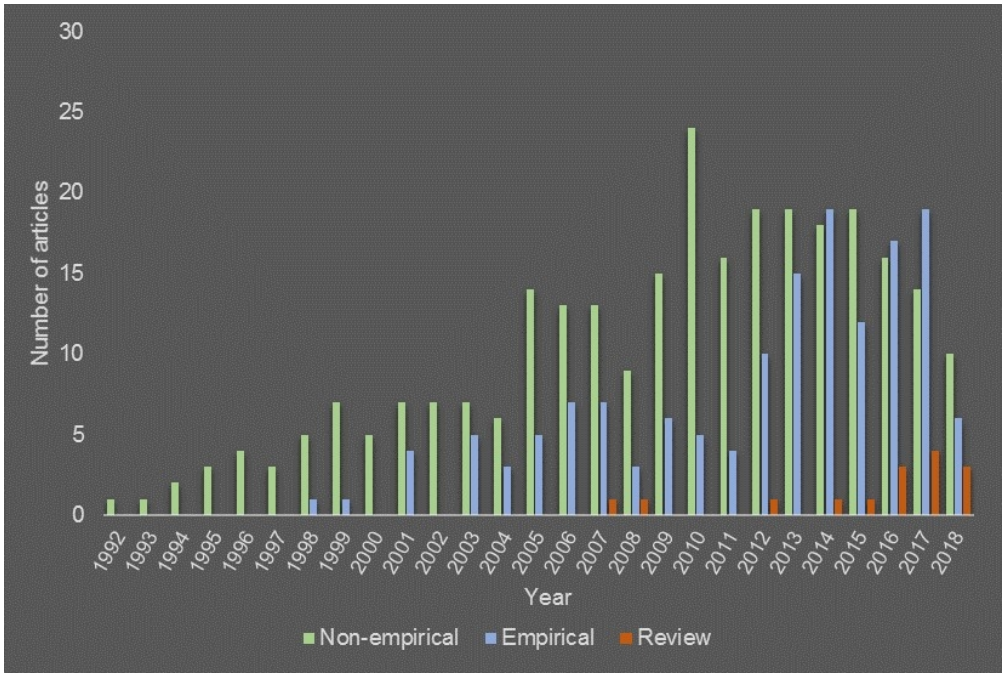

Figure 3. Trends over time in the types of articles published on complexity science applied to healthcare. Note data collected mid-2018.

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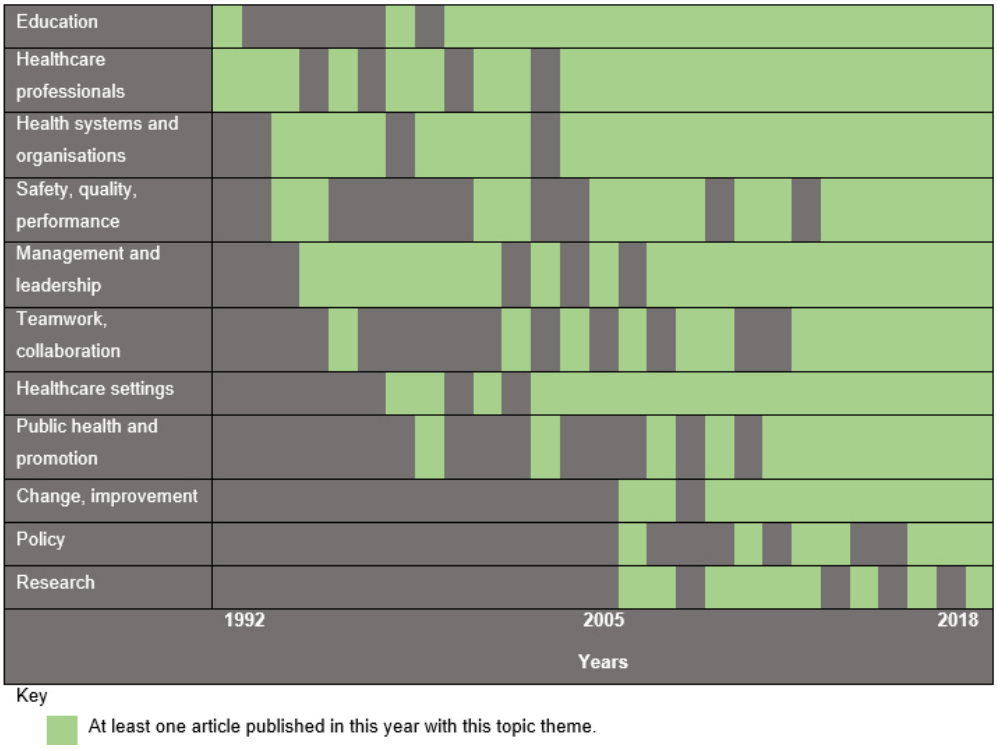

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Appendix 1.

Source	Average citations per year	Country of corresponding author	Journal	Empirical	Healthcare context
Abbott, P. A., J. Foster, H. d. F. Marin and P. C. Dykes (2014)	10.75	USA	International journal of medical informatics	Empirical	IT implementation
Afek, A., A. Meilik and Z. Rotstein (2009)	0.22	Israel	Harefuah	Non-empirical	Management
Agyepong, I. A., A. Kodua, S. Adjei and T. Adam (2012)	8.83	Ghana	Health policy and planning	Empirical	Health system - policy
Aherne, M. and J. Pereira (2005)	1.17	Canada	Leadership in health services	Non-empirical	Health care policy - palliative care
Aita, V., H. McIlvain, E. Backer, K. McVea and B. Crabtree (2005)	5.92	USA	Patient education and counseling	Empirical	Primary care - patient-practitioner communication
Albanese, M., G. Mejicano, G. Xakellis and P. Kokotailo (2009)	2.11	USA	Academic medicine	Non-empirical	Health care systems
Allred, C. A., B. J. Burns and S. D. Phillips (2005)	1.69	USA	Administration and policy in mental health and mental health services research	Non-empirical	Community mental health care - assertive community treatment
Anderson, C. A. and A. L. Whall (2011)	0.71	USA	Journal of advanced nursing	Non-empirical	Nursing - research - agent based modelling
Anderson, R. A. and R. R. McDaniel (1999)	5.68	USA	Health care management review	Empirical	Nursing home - nursing - decision making
Anderson, R. A. and R. R. McDaniel Jr (2000)	18.33	USA	Health care management review	Non-empirical	Leadership and professionalism
Anderson, R. A., B. E. Crabtree, D. J. Steele and R. R. McDaniel (2005)	25.08	USA	Qualitative health research	Non-empirical	Health care organisations
Anderson, R. A., C. A. Allred and F. A. Sloan (2003)	1.47	USA	Health care management review	Empirical	Hospital - management practice changes in light of ownership conversion
Anderson, R. A., D. E. Bailey, B. Wu, K. Corazzini, E. S. McConnell, N. M. Thygeson and S. L. Docherty (2015)	5.67	USA	Advances in nursing science	Non-empirical	Leadership – chronic illness
Anderson, R. A., K. Corazzini, K. Porter, K. Daily, R. R. McDaniel and C. Colon-Emeric (2012)	7.33	USA	Implementation science	Non-empirical	Nursing homes
Anderson, R. A., K. N. Corazzini and R. R. McDaniel Jr (2004)	15.93	USA	The gerontologist	Empirical	Nursing homes - job satisfaction

Anderson, R. A., L. M. Issel and R. R. McDaniel (2003)	29.40	USA	Nursing research	Empirical	Nursing home
Anthony, M. K., J. Kloos, P. Beam and K. Vidal (2018)	0	USA	Journal of nursing care	Non-empirical	Hospital - nursing hand-off
Arndt, M. and B. Bigelow (2000)	4.11	USA	Health care management review	Non-empirical	Management
Arruda, C., S. G. R. Lopes, M. H. A. d. L. Koerich, D. R. Winck, B. H. S. Meirelles and A. L. S. F. d. Mello (2015)	2.00	Brazil	Escola anna nery	Non-empirical	Health care networks
Ashmos, D. P., J. W. Huonker and R. R. McDaniel (1998)	5.15	USA	Health care management review	Empirical	Hospital – leadership
Atun, R. A., I. Kyratsis, G. Jelic, D. Rados-Malicbegovic and I. Gurol-Urganci (2007)	7.73	United Kingdom	Health policy and planning	Empirical	Primary care – reform
Augustinsson, S. and P. Petersson (2015)	1.67	Sweden	Journal of research in nursing	Empirical	Hospital - nursing - discharge planning
Baghbanian, A. and G. Torkfar (2012)	1.33	Australia	Australian health review	Non-empirical	Health system - economics and policy
Bailey, D. E., S. L. Docherty, J. A. Adams, D. L. Carthron, K. Corazzini, J. R. Day, E. Neglia, M. Thygeson and R. A. Anderson (2012)	5.00	USA	Journal of healthcare leadership	Non-empirical	Leadership
Barasa, E. W., S. Molyneux, M. English and S. Cleary (2017)	12.00	Kenya	Social science & medicine	Empirical	Hospitals - priority setting
Baskin, K., J. Goldstein and C. Lindberg (2000)	0.89	USA	Physician executive	Non-empirical	Mergers
Beautement, P. and C. Broenner (2012)	0.29	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Health care practice
Bebber, R. and A. Liberman (2008)	0.20	USA	International journal of public policy	Non-empirical	Hospital – bioterrorism
Bedin, D. M., H. B. Kochenborger Scarparo, H. A. Martinez and I. B. Matos (2014)	0	Brazil	Saude e sociedade	Non-empirical	Management
Begun, J. W. and A. A. Kaissi (2005)	3.15	USA	Journal of healthcare management	Empirical	Healthcare planning - leadership/management
Bell, I. R., M. Koithan and D. Pincus (2012)	6.67	USA	Forschende komplementarmedizin	Non-empirical	Complementary medicine
Bennett, C. (2003)	0.13	Canada	Healthcare papers	Non-empirical	Health care system – hospital

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Best, A., T. Greenhalgh, S. Lewis, J. E. Saul, S. Carroll and J. Bitz (2012)	40.67	Canada	The milbank quarterly	Review	Health care system – transformation
Betancourt Betancourt, J. A. and R. M. Ramis Andalia (2010)	1.50	Cuba	Revista cubana de salud pública	Non-empirical	Health and healthcare generally
Betancourt Bethencourt, J. A., F. Martínez Álvarez, M. Álvarez Escoda and E. Nicolau Pestano (2016)	0	Cuba	Humanidades médicas	Non-empirical	Education
Betancourt Bethencourt, J. A., R. M. Ramis Andalia and M. Mirabal Nápoles (2014)	2.25	Cuba	Revista cubana de salud pública	Non-empirical	Primary care – translation
Bircher, J. and E. G. Hahn (2017)	3.00	Switzerland	Cureus	Non-empirical	Health and healthcare generally
Bleakley, A. (2006)	25.60	United Kingdom	Medical education	Non-empirical	Education
Bleakley, A. (2006)a	4.33	United Kingdom	Journal of medicine and philosophy	Non-empirical	Hospital - operating theatre, teamwork
Bleakley, A. (2010)	9.38	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Education
Bloom, L. A. and B. S. Bloom (1999)	0.316	USA	International journal of technology assessment in health care	Non-empirical	Decision making
Bogren, M. U., M. Berg, L. Edgren, E. van Teijlingen and H. Wigert (2016)	1.50	Sweden	Sexual and reproductive healthcare	Empirical	Professionalism – midwifery
Boustani, M. A., A. Frame, S. Munger, P. Healey, J. Westlund, M. Farlow, A. Hake, M. G. Austrom, P. Shepard, C. Bubp, J. Azar, A. Nazir, N. Adams, N. L. Campbell, A. Chehresa and P. Dexter (2012)	1.33	USA	Clinical interventions in aging	Empirical	Professional network - dementia care – improvement
Boustani, M. A., G. A. Sachs, C. A. Alder, S. Munger, C. C. Schubert, M. Guerriero Austrom, A. M. Hake, F. W. Unverzagt, M. Farlow, B. R. Matthews, A. J. Perkins, R. A. Beck and C. M. Callahan (2011)	14.50	USA	Aging & mental health	Empirical	Primary care - dementia care
Boustani, M. A., S. Munger, R. Gulati, M. Vogel, R. A. Beck and C. M. Callahan (2010)	5.63	USA	Clinical interventions in aging	Non-empirical	Implementation and system change
Boustani, M., C. Schubert and Y. Sennour (2007)	3.55	USA	Clinical interventions in aging	Non-empirical	Primary health care - dementia

Braa, J., O. Hanseth, A. Heywood, W. Mohammed and V. Shaw (2007)	35.64	Norway	Mis quarterly	Non-empirical	Information systems implementation in developing countries
Bradley, E. H., L. A. Curry, L. A. Taylor, S. W. Pallas, K. Talbert-Slagle, C. Yuan, A. Fox, D. Minhas, D. K. Ciccone, D. Berg and R. Perez-Escamilla (2012)	5.17	USA	Bmj open	Empirical	Community/ family health -LMIC
Brainard, J. and P. R. Hunter (2016)	7.50	United Kingdom	Implementation science	Review	Research -diverse
Brand, S. L., L. E. Fleming and K. M. Wyatt (2015)	0.33	United Kingdom	The scientific world journal	Non-empirical	Health care organisations - workplace wellbeing
Brannon, S. D., P. Kemper and T. Barry (2009)	1.00	USA	Health care management review	Empirical	Management - health organisations
Brennan, C. (2016)	0	USA	Plastic surgical nursing	Non-empirical	Leadership
Breton, J. J. (1999)	0.37	Canada	Canadian journal of psychiatry	Non-empirical	Mental health - health promotion
Bro, F. and J. Kragstrup (2003)	0.20	Denmark	Scandinavian journal of primary health care	Non-empirical	Primary health care
Brooks, E. and R. Geyer (2012)	1.00	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Health system policy - drug advertising to consumers
Brown, C. A. (2006)	4.50	United Kingdom	Disability and rehabilitation	Non-empirical	Rehabilitation - professionalism
Brown, C. A. and C. Richardson (2006)	3.67	United Kingdom	European journal of pain	Empirical	MDT – pain
Browne, A. J., C. Varcoe, M. Ford-Gilboe, C. N. Wathen and E. R. Team (2015)	5.33	Canada	International journal for equity in health	Non-empirical	Primary care – equity
Bujak, J. S. (1999)	0.63	USA	Physician executive	Non-empirical	Leadership - culture - medicine
Bujak, J. S. (2003)	2.47	USA	Frontiers of health service management	Non-empirical	Leadership
Bullas, S. and J. Bryant (2007)	0.82	United Kingdom	Studies in health information technology and informatics	Non-empirical	IT implementation
Bungay, V. and J. Stevenson (2013)	0.40	Canada	Policy, politics, & nursing practice	Empirical	Nurse leaders - reform
Burke, J. P. and S. L. Pestotnik (1999)	0.74	USA	Current opinion in infectious diseases	Non-empirical	Resistance

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Burman, C. J., M. Aphane and P. Delobelle (2015)	3.33	South Africa	African journal of aids research	Non-empirical	Public health and health promotion - AIDS
Burman, C. J., M. Aphane, O. Mtapuri and P. Delobelle (2015)	2.33	South Africa	Sahara-j: journal of social aspects of hiv/aids	Non-empirical	Health promotion - HIV prevention
Burns, J. P. (2001)	4.18	USA	Journal of nursing administration	Non-empirical	Leadership
Butt, G., M. Markle-Reid and G. Browne (2008)	5.80	Canada	International journal of integrated care	Review	Integrated care - health and social service partnership
Buttigieg, S. C., V. Cassar and J. W. Scully (2013)	1.20	United Kingdom	Journal of health organization and management	Empirical	Hospital, leadership, integrated care
Caffrey, L., C. Wolfe and C. McKevitt (2016)	4.00	United Kingdom	Health research policy and systems	Empirical	Health system - implementation and working with research
Callahan, C. M., M. A. Boustani, M. Weiner, R. A. Beck, L. R. Livin, J. J. Kellams, D. R. Willis and H. C. Hendrie (2011)	9.13	USA	Aging & mental health	Non-empirical	Primary care - dementia
Canals L, M. and R. Solís (2005)	0.85	Chile	Revista médica de chile	Non-empirical	Medicine
Carlos, D. M., E. M. M. de Padua, L. M. P. da Silva, M. A. I. Silva, W. E. U. Marques, M. N. D. Leitao and M. D. C. Ferriani (2017)	1.00	Brazil	Journal of clinical nursing	Empirical	Primary health care - family violence
Carney, T. J. and C. M. Shea (2017)	4.00	USA	Computational and mathematical methods in medicine	Non-empirical	Public health - informatics
Chadwick, M. M. (2010)	3.88	USA	Aorn journal	Non-empirical	Leadership - nursing
Chaffee, M. W. and M. M. McNeill (2007)	8.64	USA	Nursing outlook	Non-empirical	Nursing
Chan, M. K., D. D. Meschino, D. Dath, J. Busari, J. D. Bohnen, L. M. Samson, A. Matlow and M. Sanchez-Mendiola (2016)	5.50	Canada	Leadership in health services	Non-empirical	Education - medical - leadership
Chandler, J., J. Rycroft-Malone, C. Hawkes and J. Noyes (2016)	10.67	United Kingdom	Journal of advanced nursing	Empirical	Health system - improvement and implementation
Checkland, K., I. McDermott, A. Coleman, L. Warwick-Giles, D. Bramwell, P. Allen and S. Peckham (2018)	0	United Kingdom	Public money & management	Empirical	Primary care - oversight, planning, management
Chen, D. T., P. H. Werhane and A. E. Mills (2007)	1.73	USA	Critical care medicine	Non-empirical	Hospital - ICU/critical care medicine

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Chinnis, A. and K. R. White (1999)	1.26	USA	Journal of emergency medicine	Non-empirical	Hospital - emergency department
Chou, S.-M. (2004)	0.07	China	Hu li za zhi the journal of nursing	Non-empirical	Nursing
Christian, C. S. and N. Crisp (2012)	1.00	South Africa	Development southern africa	Empirical	Public health
Chughtai, S. and K. Blanchet (2017)	5.00	Pakistan	Health policy and planning	Review	Public health
Ciemins, E. L., J. Brant, D. Kersten, E. Mullette and D. Dickerson (2016)	2.50	USA	Journal of palliative medicine	Empirical	Palliative care - interdisciplinary team work
Clancy, T. R. (2014)	1.00	USA	Journal of nursing administration	Non-empirical	Nursing - workflow
Clancy, T. R., C. White Delaney, B. Morrison and J. K. Gunn (2006)	3.50	USA	Journal of nursing administration	Non-empirical	Nursing - documentation
Clarke, J. R. (2005)	1.62	USA	Journal of the american college of surgeons	Non-empirical	Hospital - surgery - patient safety
Cloninger, C. R. (2013)	3.40	USA	International journal of person centred medicine	Non-empirical	Health promotion - chronic disease - person-centred care
Cockings, J. G., D. A. Cook and R. K. Iqbal (2006)	2.42	United Kingdom	Critical care	Empirical	Hospital - quality and surveillance
Colon-Emeric, C. S., D. Lekan-Rutledge, Q. Utley-Smith, N. Ammarell, D. Bailey, M. L. Piven, K. Corazzini and R. A. Anderson (2006)	3.25	USA	Health care management review	Empirical	Nursing homes
Colon-Emeric, C. S., K. Corazzini, E. S. McConnell, W. Pan, M. Toles, R. Hall, M. P. Cary, M. Batchelor-Murphy, T. Yap, A. L. Anderson, A. Burd, S. Amarasekara and R. A. Anderson (2017)	2.00	USA	Jama internal medicine	Empirical	Nursing homes
Colon-Emeric, C. S., N. Ammarell, C. Bailey, C. Kirsten, D. Lekan-Rutledge, M. Piven and R. Anderson (2005)	0.08	USA	Journal of the american geriatrics society	Unable to classify	Nursing
Colon-Emeric, C. S., N. Ammarell, D. Bailey, K. Corazzini, D. Lekan-Rutledge, M. L. Piven, Q. Utley-Smith and R. A. Anderson (2006)	6.58	USA	Qualitative health research	Empirical	Nursing home - communication between medicine-nursing
Cooper, A. and B. Wren (2012)	1.33	United Kingdom	Psychoanalytic psychotherapy	Non-empirical	Mental health

Cooper, H. and E. Spencer-Dawe (2006)	7.75	United Kingdom	Journal of integrated care	Empirical	Education - interprofessional
Cooper, H. and R. Geyer (2008)	3.30	United Kingdom	Social science & medicine	Non-empirical	Education
Cooper, H. and R. Geyer (2009)	2.33	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Chronic disease management – diabetes
Cooper, H., E. Spencer-Dawe and E. McLean (2005)	10.15	United Kingdom	Journal of interprofessional care	Empirical	Education - medicine, nursing, physiotherapy, OT undergraduates
Copelli, F. H. d. S., R. J. T. d. Oliveira, C. M. S. d. Oliveira, B. H. S. Meirelles, A. L. S. F. d. Mello and A. L. P. Magalhães (2016)	1.50	Brazil	Aquichan	Review	Nursing - leadership
Copnell, B. (1998)	1.00	Australia	Journal of advanced nursing	Non-empirical	Nursing - nursing knowledge
Coppa, D. F. (1993)	1.84	USA	Journal of advanced nursing	Non-empirical	Nursing
Cornforth, A. (2013)	1.60	United Kingdom	British journal of nursing	Non-empirical	Primary care - self-management – COPD
Crabtree, B. F. (2003)	3.13	USA	Health care management review	Non-empirical	Primary care
Crabtree, B. F., P. A. Nutting, W. L. Miller, R. R. McDaniel, K. C. Stange, C. R. Jaen and E. Stewart (2011)	17.57	USA	Medical care	Non-empirical	Primary care - change/improvement
Crabtree, B. F., W. L. Miller and K. C. Stange (2001)	9.53	USA	Journal of family practice	Empirical	Primary care
Cruz, R. A., E. L. Araujo, N. M. Nascimento, R. J. Lima, J. R. Franca and J. D. Oliveira (2017)	1.00	Brazil	Revista brasileira de enfermagem	Unable to classify	Nursing - education
Cucolo, D. F. and M. G. Perroca (2015)	3.67	Brazil	Acta paulista de enfermagem	Empirical	Nursing
Curtis, S. and M. Riva (2010)	8.63	United Kingdom	Progress in human geography	Non-empirical	Human geography and health systems
Curtis, S. and M. Riva (2010)a	4.63	United Kingdom	Progress in human geography	Non-empirical	Human geography and health systems and policy
Curtis, S., K. Oven, J. Wistow, C. Dunn and L. Dominelli (2018)	3.00	United Kingdom	Environment and planning c: politics and space	Empirical	Aged - health and social care
da Silva, A. L. and M. G. de Freitas (2010)	0.50	Brazil	Revista da escola de enfermagem da usp	Empirical	Education
D'Agata, A. L. and J. M. McGrath (2016)	2.50	USA	Advances in nursing science	Non-empirical	Hospital - neonatal ICU

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Dattee, B. and J. Barlow (2010)	4.50	United Kingdom	Journal of health services research and policy	Empirical	Whole system change
Dattee, B. and J. Barlow (2017)	1.00	France	Organization science	Empirical	Healthcare system
Davis, B. and D. Sumara (2010)	9.25	Canada	Journal of evaluation in clinical practice	Non-empirical	Research - education
de Bock, B. A., D. L. Willems and H. C. Weinstein (2018)	1.00	The Netherlands	Journal of evaluation in clinical practice	Empirical	Hospital - ICU, decision making
De Simone, J. (2006)	2.33	Italy	Journal of evaluation in clinical practice	Non-empirical	Evidence-based medicine
De Vito, E. L. (2016)	0	Argentina	Medicina	Non-empirical	Medicine
de Zulueta, P. C. (2016)	9.50	United Kingdom	Journal of healthcare leadership	Non-empirical	Leadership - compassionate leadership
deMattos, P. C., D. M. Miller and E. H. Park (2012)	2.83	USA	Management decision	Non-empirical	Hospital - trauma- decision making
Deutsch, E. S., Y. Dong, L. P. Halamek, M. A. Rosen, J. M. Taekman and J. Rice (2016)	2.50	USA	Human factors	Non-empirical	Education
Doebbeling, B. N. and M. E. Flanagan (2011)	1.86	USA	Medical care	Non-empirical	Healthcare systems
Doll, W. E. and D. Trueit (2010)	5.88	USA	Journal of evaluation in clinical practice	Non-empirical	Healthcare professionals broadly
Donaldson, A., E. Lank and J. Maher (2005)	1.85	United Kingdom	Journal of change management	Non-empirical	Education and learning - communities of practice in cancer
Donini, L. M., R. D. Grave, A. Caretto, L. Lucchin, N. Melchionda, E. Nisoli, P. Sbraccia, A. Lenzi and M. Cuzzolaro (2014)	1.75	Italy	Eating and weight disorders	Non-empirical	Health condition and its management - obesity
Donnelly, F. and R. Wiechula (2012)	2.17	Australia	Nurse education today	Non-empirical	Education - nurse placement
Dreher, M. C., P. Clinton and A. Sperhac (2014)	2.50	USA	Journal of professional nursing	Non-empirical	Education
Dunn, K. S. and C. K. Riley-Doucet (2017)	0	USA	Nurse educator	Unable to classify	Nursing
Durie, R. and K. Wyatt (2007)	3.18	United Kingdom	Social science & medicine	Empirical	Health geography
Durie, R. and K. Wyatt (2013)	4.20	United Kingdom	Critical public health	Empirical	Community and public health
Dyck, L. R., A. Caron and D. Aron (2006)	1.58	USA	Journal of management development	Non-empirical	Change/improvement
Edgren, L. (2008)	10.10	Sweden	International journal of integrated care	Non-empirical	Integrated care

Edgren, L. and K. Barnard (2012)	8.33	Sweden	Leadership in health services	Non-empirical	Health and social care integration
Eika, M., B. Dale, G. A. Espnes and S. Hvalvik (2015)	3.67	Norway	Bmc health services research	Empirical	Nursing homes - nursing - care transitions
Ellis, B. (2010)	4.13	United Kingdom	Informatics in primary care	Empirical	Primary care
Ellis, B. and S. I. Herbert (2011)	6.43	United Kingdom	Informatics in primary care	Non-empirical	Primary care - clinical governance
Ellis, L. A., K. Churruca and J. Braithwaite (2017)	2.00	Australia	International journal of mental health systems	Non-empirical	Mental health services
Ellsbury, D. L. (2010)	0.88	USA	Clinics in perinatology	Non-empirical	Hospital - neonatal medicine
Erdek, M. A. and P. J. Pronovost (2004)	7.50	USA	International journal for quality in health care	Empirical	Hospital - pain assessment
Erdmann, A. L., K. C. d. Nascimento, G. Marcelino and J. A. Ribeiro (2005)	1.85	Brazil	Fascicles of escola anna nery revista de enfermagema	Empirical	Education - graduate nurses
Essen, A. and S. Lindblad (2013)	7.33	Sweden	Social science & medicine	Empirical	Rheumatology
Fajardo Ortiz, G. (2013)	0	Mexico	Ludus vitalis	Non-empirical	Medicine
Fajardo-Ortiz, G., M. A. Fernandez-Ortega, A. Ortiz-Montalvo and R. A. Olivares-Santos (2015)	0.67	Mexico	Cirugía y cirujanos (english edition)	Non-empirical	Health systems
Farmer, E. A., J. D. Beard, W. D. Dauphinee, T. LaDuca and K. V. Mann (2002)	2.19	Australia	Medical education	Non-empirical	Medical performance assessment
Favaretti, C. (2013)	0.40	Italy	Recenti progressi in medicina	Non-empirical	Health care organisations generally
Fennell, M. L. and C. M. Adams (2011)	2.43	USA	Annual review of sociology	Non-empirical	Health care organisations generally
Fenwick, T. (2012)	6.83	United Kingdom	Journal of education and work	Non-empirical	Education - learning for collaboration
Fenwick, T. and M. A. Dahlgren (2015)	16.33	United Kingdom	Medical education	Non-empirical	Education
Fernandez, A., J. Sturmberg, S. Lukersmith, R. Madden, G. Torkfar, R. Colagiuri and L. Salvador-Carulla (2015)	10.67	Australia	Health research policy and systems	Non-empirical	Evidence-based medicine movement history
Florczak, K., M. Poradzisz and S. Hampson (2012)	1.00	USA	Nursing science quarterly	Non-empirical	Nursing profession
Fontanesi, J., A. Martinez, T. O. Boyo and R. Gish (2015)	0.33	USA	The journal of medical practice management: mpm	Empirical	Quality improvement

Forbes-Thompson, S., T. Leiker and M. R. Bleich (2007)	4.91	USA	Health care management review	Empirical	Nursing homes
Ford, R. (2009)	5.56	USA	Health services management research	Empirical	Leadership
Frame, A., M. LaMantia, B. B. Reddy Bynagari, P. Dexter and M. Boustani (2013)	2.20	USA	Egems	Empirical	Primary care - EHR – improvement
Fraser, S. W. and T. Greenhalgh (2001)	50.59	United Kingdom	Bmj open	Non-empirical	Education
Frasso, R., A. Golinkoff, H. Klusaritz, K. Kellom, H. Kollar-McArthur, M. Miller-Day, R. Gabbay and P. F. Cronholm (2017)	1.00	USA	Applied nursing research	Empirical	Primary care - nurse-led practices
Freddi, G. and J. L. Roman-Pumar (2011)	2.00	Italy	Annali dell istituto superiore di sanita	Non-empirical	Evidence-based medicine
Freed, D. H. (1995)	0	USA	Hospital material management quarterly	Non-empirical	Health care generally - quality
Friel, S., L. Hattersley and R. Townsend (2015)	9.33	Australia	Annual review of public health	Non-empirical	Public health - trade
Frye, A. W. and P. A. Hemmer (2012)	28.00	USA	Medical teacher	Non-empirical	Education
Gardam, M., L. Gitterman, L. Rykert and E. Vicencio (2017)	0	Canada	Healthcare papers	Non-empirical	Health care delivery - safety
Gary, J. C. (2014)	1.25	USA	Dimensions of critical care nursing	Empirical	Improving patient-centred care - nursing - ICU
Gatrell, A. C. (2005)	13.54	United Kingdom	Social science & medicine	Non-empirical	Health geography
Gear, C., J. Koziol-McLain, D. Wilson and F. Clark (2016)	1.00	New Zealand	Bmc family practice	Empirical	Primary care - family violence
Geary, C. R. and K. L. Schumacher (2012)	7.17	USA	Advances in nursing science	Non-empirical	Care transitions
Ghazzawi, A., C. Kuziemsky and T. O'Sullivan (2016)	3.50	Canada	Bmc health services research	Empirical	Stroke - rehabilitation - carers
Glenn, L. A., J. Stocker-Schnieder, R. McCune, M. McClelland and D. King (2014)	2.00	USA	Journal of advanced nursing	Empirical	Hospital - nursing maternity care during labour
Glynn, L. G. and R. Scully (2010)	1.00	United Kingdom	International journal of clinical practice	Non-empirical	Healthcare generally
Goldberger, A. L. (1996)	39.59	USA	The lancet	Non-empirical	Medical practice
Goldman, E., M. Plack, C. Roche, J. Smith and C. Turley (2009)	5.11	USA	Journal of workplace learning	Empirical	Hospital - emergency department/ learning

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Gonnering, R. S. (2010)	1.00	USA	Journal of surgical education	Non-empirical	Education - surgical
Gonzalez, M. G., K. N. Kelly, A. M. Dozier, F. Fleming, J. R. T. Monson, A. Z. Becerra, C. T. Aquina, C. P. Probst, B. J. Hensley, N. Sevdalis and K. Noyes (2017)	1.00	USA	Qualitative health research	Empirical	Hospital - surgical care – transitions
Gordon, L., C. Rees, J. Ker and J. Cleland (2017)	1.00	United Kingdom	Advances in health sciences education	Empirical	Leadership
Gormley, G. J. and T. Fenwick (2016)	3.00	United Kingdom	Perspectives on medical education	Empirical	Education - medical
Grady, C. M. (2016)	4.00	Canada	Leadership in health services	Empirical	Leadership - medical
Green, C. A., S. E. Estroff, B. J. H. Yarborough, M. Spofford, M. R. Solloway, R. S. Kitson and N. A. Perrin (2014)	5.75	USA	Schizophrenia bulletin	Non-empirical	Mental health care
Greene, R. A., E. Dasso, S. Ho and A. M. Genaidy (2014)	2.25	USA	Population health management	Non-empirical	Health care systems - person-centred care
Greenhalgh, T., P. Plsek, T. Wilson, S. Fraser and T. Holt (2010)	5.88	United Kingdom	Journal of health services research and policy	Non-empirical	Research
Griffiths, F. and D. Byrne (1998)	4.20	United Kingdom	British journal of general practice	Non-empirical	Primary care
Griffiths, F. and G. North American Primary Care Research (2007)	1.45	United Kingdom	Annals of family medicine	Non-empirical	Primary care
Grudniewicz, A., T. Tenbensel, J. M. Evans, C. Steele Gray, G. R. Baker and W. P. Wodchis (2018)	0	Canada	Social science & medicine	Empirical	Health policy - integrated care
Haffeld, J. (2012)	2.67	Norway	Global public health: an international journal for research, policy and practice	Non-empirical	Global health system
Haffeld, J. (2013)	1.40	USA	Reproductive health matters	Non-empirical	Health systems - governance
Haffeld, J. and H. Siem (2013)	1.00	Norway	Current pharmogenomics and personalized medicine	Unable to classify	Policy and governance international
Hafferty, F. W. and B. Castellani (2010)	13.50	USA	Academic medicine	Non-empirical	Medical professionalism
Hafferty, F. W. and D. Levinson (2008)	9.50	USA	Perspectives in biology and medicine	Non-empirical	Medicine - professionalism
Haigh, C. (2002)	3.81	United Kingdom	Journal of advanced nursing	Non-empirical	Nursing

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Haigh, C. A. (2008)	0.80	United Kingdom	Journal of nursing management	Empirical	Nursing - management
Hall, P., L. Weaver and P. A. Grassau (2013)	4.40	Canada	Journal of interprofessional care	Non-empirical	Integrated care - education
Hamilton, A. B., M. M. Farmer, T. Moin, E. P. Finley, A. J. Lang, S. M. Oishi, A. K. Huynh, J. Zuchowski, S. G. Haskell and B. Bean-Mayberry (2017)	1.00	USA	Implementation science	Non-empirical	Primary care - women's health
Hammerly, M. (2002)	0.44	USA	American journal of medical quality	Non-empirical	Collaborative medicine
Hanseth, O., E. Jacucci, M. Grisot and M. Aanestad (2006)	21.75	Norway	Mis quarterly	Empirical	Hospital – HER
Hast, A. S., A. M. DiGioia, D. Thompson and G. Wolf (2013)	3.00	USA	Journal of nursing administration	Unable to classify	Organisational change
Henriksen, E. and U. Rosenqvist (2003)	2.33	Sweden	Health & social care in the community	Empirical	Aged care
Hill, P. S. (2011)	11.13	Australia	Global public health: an international journal for research, policy and practice	Non-empirical	Governance - health care systems
Hilts, L., M. Howard, D. Price, C. Risdon, G. Agarwal and A. Childs (2013)	3.40	Canada	Family practice	Empirical	Primary care
Ho, S. and L. G. Sandy (2014)	1.75	USA	Journal of general internal medicine	Non-empirical	Health care system - economics and funding
Hoben, M., P. G. Norton, L. R. Ginsburg, R. A. Anderson, G. G. Cummings, H. J. Lanham, J. E. Squires, D. Taylor, A. S. Wagg and C. A. Estabrooks (2017)	5.00	Canada	Trials	Non-empirical	Nursing home - quality and improvement
Hodges, H. F. (2011)	7.43	USA	Journal of nursing education	Empirical	Education - nursing
Hoffman, E. (2000)	1.22	USA	Academic medicine	Non-empirical	Women's health - educating about
Holden, L. M. (2005)	14.46	USA	Journal of advanced nursing	Non-empirical	Nursing
Holder, R. and C. Ramagem (2012)	2.17	USA	World hospitals and health services: the official journal of the international hospital federation	Non-empirical	Leadership
Holmboe, E. S. (2018)	3.00	USA	Academic medicine	Non-empirical	Education - medicine

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Homa, L., J. Rose, P. S. Hovmand, S. T. Cherng, R. L. Riolo, A. Kraus, A. Biswas, K. Burgess, H. Aungst, K. C. Stange, K. Brown, M. Brooks-Terry, E. Dec, B. Jackson, J. Gilliam, G. E. Kikano, A. Reichsman, D. Schaadt, J. Hilfer, C. Ticknor, C. V. Tyler, A. Van der Meulen, H. Ways, R. F. Weinberger and C. Williams (2015)	5.00	USA	Annals of family medicine	Empirical	Primary care
Hopkinson, S. G. and D. L. Wiegand (2017)	0	USA	Journal of clinical nursing	Empirical	Nursing practice
Horvat, A. and J. Filipovic (2018)	5.00	Serbia	Journal of evaluation in clinical practice	Empirical	Leadership
Hunt, S. R., K. Corazzini and R. A. Anderson (2014)	4.50	USA	Journal of applied gerontology	Empirical	Nursing homes - management - care quality
Hutchison, D. (1994)	0.54	USA	Quality progress	Non-empirical	Quality management - health care organisation
Innes, A. D., P.D. Campion and F.E. Griffiths (2005)	8.15	United Kingdom	British journal of general practice	Non-empirical	Clinical consultation
Irimu, G. W., A. Greene, D. Gathara, H. Kihara, C. Maina, D. Mbori-Ngacha, D. Zurovac, M. Santau, J. Todd and M. English (2014)	1.50	Kenya	Bmc health services research	Empirical	Implementation of CPGs
Issel, L. M. and R. A. Anderson (2001)	0.88	USA	Research in nursing and health	Empirical	Community case managers - nursing - decision making
James, K. M. (2010)	3.38	USA	Creative nursing	Non-empirical	Education - nursing
Jana, M., L. Letsela, E. Scheepers and R. Weiner (2015)	1.00	South Africa	Journal of health communication	Non-empirical	Public health - health promotion/communication
Jolley, G. (2014)	9.00	Australia	Evaluation and program planning	Non-empirical	Health promotion - community care
Joly, B. M., M. Booth, P. Mittal and G. Shaler (2012)	3.17	USA	Evaluation & the health professions	Non-empirical	Quality improvement
Jorm, C. and C. Roberts (2018)	3.00	Australia	Academic medicine	Non-empirical	Education - evaluation
Jorm, C., G. Nisbet, C. Roberts, C. Gordon, S. Gentilcore and T. F. Chen (2016)	4.50	Australia	Bmc medical education	Empirical	Education - interprofessional learning
Joshi, R., D. Joshi and P. Cheriyath (2017)	5.00	USA	Patient preference and adherence	Empirical	Diabetes management - technology app

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Juarez, F. (2010)	0	Colombia	International journal of psychological research	Empirical	Health system - economic
Kaehne, A. (2016)	3.00	United Kingdom	Journal of integrated care	Non-empirical	Programme evaluation (integration programmes)
Kapp, J. M., E. J. Simoes, A. DeBiasi and S. J. Kravet (2017)	4.00	USA	Systems research and behavioural science	Non-empirical	Population health - improvement
Karam, E., M. C. Levesque, G. Jacquemin, A. Delure, I. Robidoux, M. T. Laramee, A. Odobescu, P. G. Harris and A. M. Danino (2014)	1.50	Canada	Annals of burns and fire disasters	Empirical	Multidisciplinary teams
Karemere, H. and J. Macq (2014)	0.50	Democratic Republic of Congo	Global health promotion	Empirical	Hospital
Karemere, H., J. B. Kahindo, N. Ribesse and J. Macq (2013)	0.40	Democratic Republic of Congo	Medecine et sante tropicales	Non-empirical	Hospital - governance
Karemere, H., N. Ribesse, B. Marchal and J. Macq (2015)	1.00	Democratic Republic of Congo	Conflict and health	Empirical	Hospital
Karemere, H., N. Ribesse, J.-B. Kahindo and J. Macq (2015)	1.00	Democratic Republic of Congo	The pan african medical journal	Empirical	Hospital
Katerndahl, D., R. Wood and C. R. Jaen (2017)	0	USA	Journal of evaluation in clinical practice	Empirical	Ambulatory care
Kernick, D. (2006)	7.75	United Kingdom	Family practice	Non-empirical	Health service generally
Kernick, D. and A. Mitchell (2010)	1.56	United Kingdom	Journal of interprofessional care	Non-empirical	Co-production - patient-centredness
Khan, B. A., S. Lasiter and M. A. Boustani (2015)	0	USA	The american journal of nursing	Non-empirical	Hospital - ICU
Khan, S., A. Vandermorris, J. Shepherd, J. W. Begun, H. J. Lanham, M. Uhl-Bien and W. Berta (2018)	0	Canada	Bmc health services research	Non-empirical	Healthcare generally
Khan, Y., S. Sanford, D. Sider, K. Moore, G. Garber, E. de Villa and B. Schwartz (2017)	0	Canada	Bmc health services research	Empirical	Hospital and public health - emergency departments during "emerging incidents"

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Khayal, I. S. and A. M. Farid (2018)	2.00	USA	Complexity	Non-empirical	Health care systems - chronic care
Killingsworth, B., H. E. Newkirk and E. Seeman (2006)	2.08	USA	Health care management review	Non-empirical	Hospital - strategic information systems
Kingsley, P. and E. M. Taylor (2017)	9.00	United Kingdom	Parasitology	Non-empirical	Health care systems - integration
Koerich, M. S., D. S. Backes, K. C. d. Nascimento and A. L. Erdmann (2007)	3.82	Brazil	Acta paulista de enfermagem	Empirical	Hospital - nursing assistant
Koerner, J. (2009)	1.11	USA	Creative nursing	Non-empirical	Nursing - decision making
Koerner, J. G. (1996)	0.36	USA	Nursing administration quarterly	Non-empirical	Nursing
Kottke, T. E., J. A. Huebsch, P. McGinnis, J. M. Nichols, E. D. Parker, J. O. Tillema and M. V. Maciosek (2016)	2.00	USA	The permanente journal	Empirical	Primary care - collaboration
Kramer, M., B. B. Brewer, D. Halfer, P. Maguire, S. Beausoleil, K. Claman, M. Macphee and J. B. Duchscher (2013)	4.40	USA	Journal of nursing management	Empirical	Nursing
Kuipers, P., D. Harvey, M. Lindeman and K. Stothers (2014)	1.25	AUstralia	Rural and remote health	Non-empirical	Workforce - rural - education and training
Kuziemsky, C. (2016)	6.33	Canada	Healthcare management forum	Non-empirical	Decision making
Kuziemsky, C. E., E. M. Borycki and A. W. Kushniruk (2016)	0.50	Canada	Nursing informatics	Non-empirical	Health information technology
Lachman, P., A. Jayadev and M. Rahi (2014)	3.50	United Kingdom	Early human development	Non-empirical	Hospital - NICU
Laliberte, M., D. E Feldman, B. Williams-Jones and M. Hunt (2018)	0	Canada	Physiotherapy theory and practice	Empirical	Physiotherapy - prioritising care
Lalley, C. (2014)	1.75	USA	Nursing administration quarterly	Empirical	Nursing - leadership - workarounds
Lamarche, P. and L. Maillet (2016)	1.00	Canada	Journal of health organization and management	Non-empirical	Primary care
Landis-Lewis, Z., R. Manjomo, O. J. Gadabu, M. Kam, B. N. Simwaka, S. L. Zickmund, F. Chimbwandira, G. P. Douglas and R. S. Jacobson (2015)	3.67	USA	International journal of medical informatics	Empirical	Health system - Malawi EMR implementation

Lanham, H. J., L. K. Leykum, B. S. Taylor, C. J. McCannon, C. Lindberg and R. T. Lester (2013)	15.6	USA	Social science & medicine	Non-empirical	Health care systems
Larkin, D. J., R. C. Swanson, S. Fuller and D. A. Cortese (2016)	7.00	USA	Journal of evaluation in clinical practice	Non-empirical	Health system - US and affordable care act
Laudenslager, M. L. (2014)	3.25	USA	Brain, behavior, and immunity	Non-empirical	Caregivers
Laurenson, M., T. Heath and S. Gribbin (2012)	0.60	United Kingdom	Journal of healthcare leadership	Empirical	Education - leadership
Learmonth, A. M., E. J. Henderson and D. J. Hunter (2017)	0	United Kingdom	Journal of public health	Empirical	Public health
Lefroy, J. and S. Yardley (2015)	3.00	United Kingdom	Medical education	Non-empirical	Education
Lemak, C. H. and E. Goodrick (2003)	1.67	USA	Health care management review	Empirical	Primary care - dental, medical, social for low income populations
Lessard, C. (2007)	6.09	Canada	Social science & medicine	Non-empirical	Research - economic evaluation
Lett, M. (2001)	0.53	Australia	Australian journal of advanced nursing	Non-empirical	Nursing practice
Leykum, L. K., H. J. Lanham, J. A. Pugh, M. Parchman, R. A. Anderson, B. F. Crabtree, P. A. Nutting, W. L. Miller, K. C. Stange and R. R. McDaniel (2014)	8.00	USA	Implementation science	Empirical	Improvement
Leykum, L. K., J. A. Pugh, H. J. Lanham, J. Harmon and R. R. McDaniel (2009)	9.11	USA	Implementation science	Non-empirical	Implementation - evidence-based practice
Leykum, L. K., J. Pugh, V. Lawrence, M. Parchman, P. H. Noel, J. Cornell and R. R. McDaniel (2007)	6.82	USA	Implementation science	Review	Diabetes care
Lindberg, C. and M. Schneider (2013)	2.60	USA	Leadership	Empirical	Leadership
Lindberg, C., A. Herzog, M. Merry and J. Goldstein (1998)	0.25	USA	Physician executive	Non-empirical	Leadership
Litaker, D., A. Tomolo, V. Liberatore, K. C. Stange and D. Aron (2006)	11.83	USA	Journal of general internal medicine	Non-empirical	Primary care - quality improvement
Liu, Y. (2008)	2.20	USA	Journal of nursing management	Non-empirical	Nursing - communication - decision making - cross culture
Liu, Z. C., D. Rexachs, F. Epelde and E. Luque (2017)	3.00	Spain	Journal of computational science	Empirical	Hospital - emergency department

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Longo, F. (2007)	4.27	Italy	Health care management review	Non-empirical	Leadership - change management
Lorthios-Guilledroit, A., L. Richard and J. Filiatrault (2018)	1.00	Canada	Evaluation and program planning	Review	Health promotion - community care
Luria, J. W., S. E. Muething, P. J. Schoettker and U. R. Kotagal (2006)	6.08	USA	Pediatric clinics of north america	Non-empirical	Safety - paediatrics
MacLean, S., L. Berends and J. Mugavin (2013)	0.67	Australia	Australian journal of primary health	Empirical	Primary care - drug and alcohol - improvement
Mahajan, A., S. D. Islam, M. J. Schwartz and M. Cannesson (2017)	0	USA	Anesthia & analgesia	Non-empirical	Hospital - perioperative services - process improvement
Marchal, B., S. Belle, V. De Brouwere and S. Witter (2013)	3.40	Belgium	Bmc health services research	Non-empirical	Health care policy
Mark, A. and M. Jones (2013)	1.00	United Kingdom	The international journal of health planning management	Non-empirical	Health care systems - instability/disturbance
Markham, F. W. (1998)	0.50	USA	Theoretical medicine and bioethics	Non-empirical	Education - medical
Marks, E. (2013)	3.80	USA	Jama internal medicine	Non-empirical	Hospital - readmission rates
Marsland, S. and L. Buchan (2004)	0.93	United Kingdom	Medinfo	Non-empirical	Health informatics
Martin, C. and J. Sturmberg (2009)	6.89	Canada	Journal of evaluation in clinical practice	Non-empirical	Primary care - chronic care (health promotion, prevention, self-management, disease control. Treatment).
Martin, C. M. and J. P. Sturmberg (2005)	5.92	Canada	Medical journal of australia	Non-empirical	Primary care
Mash, B. J., P. Mayers, H. Conradie, A. Orayn, M. Kuiper and J. Marais (2008)	2.80	South Africa	Education for health	Empirical	Primary care
Matheson, A., K. Dew and J. Cumming (2009)	3.11	New Zealand	Health promotion journal of australia	Empirical	Community health - health inequality
Matlow, A. G., J. G. Wright, B. Zimmerman, K. Thomson and M. Valente (2006)	5.00	Canada	Quality and safety in health care	Non-empirical	Coordination of care, paediatrics
Matthews, J. I. and P. T. Thomas (2007)	2.18	United Kingdom	International journal of health care quality assurance	Empirical	Learning
McAllister, C., L. K. Leykum, H. Lanham, H. S. Reisinger, J. L. Kohn, R. Palmer, C. Pezzia, M. Agar, M. Parchman, J. Pugh and R. R. McDaniel (2014)	3.50	USA	Journal of hospital medicine	Empirical	Hospital - teams relationship with patient outcomes

McConnell, E. S., D. Lekan-Rutledge, B. Nevidjon and R. Anderson (2004)	2.07	USA	Journal of nursing education	Non-empirical	Education - aged care
McDaniel, R. R. (1997)	9.38	USA	Health care management review	Non-empirical	Leadership/management
McDaniel, R. R., Jr. (1999)	0.11	USA	Frontiers of health service management	Unable to classify	Leadership/management
McDaniel, R. R., M. E. Jordan and B. F. Fleeman (2003)	10.80	USA	Health care management review	Non-empirical	Learning
McHattie, L.-S., G. Cumming and T. French (2014)	3.00	United Kingdom	Medicine 2.0	Non-empirical	Person-centred care
McKenzie, A., E. Sokpo and A. Ager (2014)	1.00	South Africa	Journal of public health in africa	Empirical	Public health
McKeon, L. M., J. D. Oswaks and P. D. Cunningham (2006)	5.75	USA	Critical nurse specialist	Non-empirical	Hospital – teams
McKimm, J. and A. Till (2015).	2.33	United Kingdom	British journal of hospital medicine	Non-empirical	Clinical leadership
McKinney, S. H., K. Corazzini, R. A. Anderson, R. Sloane and N. G. Castle (2016)	1.50	USA	Health care management review	Empirical	Nursing home - leadership – nursing
McMurtry, A. (2010)	5.33	Canada	Journal of interprofessional care	Empirical	Educational
McMurtry, A., S. Rohse and K. N. Kilgour (2016)	9.50	Canada	Medical education	Non-empirical	Education - interprofessional learning
Mennin, S. (2010)	17.25	USA	Medical education	Non-empirical	Education - learning - medicine
Mennin, S. (2010)a	3.63	USA	Journal of evaluation in clinical practice	Non-empirical	Education
Merry, A. F. (2011)	0.57	New Zealand	The journal of extracorporeal technology	Non-empirical	Safety - decision making
Miles, A. (2009)	4.22	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Medicine and healthcare
Miller, W. L., B. F. Crabtree, P. A. Nutting, K. C. Stange and C. R. Jaen (2010)	18.13	USA	Annals of family medicine	Non-empirical	Primary care
Miller, W. L., B. F. Crabtree, R. McDaniel and K. C. Stange (1998)	14.35	USA	Journal of family practice	Non-empirical	Primary care
Miller, W. L., R. R. McDaniel, B. F. Crabtree and K. C. Stange (2001)	14.82	USA	Journal of family practice	Empirical	Primary care

Minas, H. (2005)	3.54	Australia	Australian psychiatry	Non-empirical	Leadership- for change in mental health
Mitchell, D. (2014)	0.50	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Patient perspectives
Mitchell, G. J., N. Cross, M. Wilson, S. Biernacki, W. N. Wong, B. Adib and D. Rush (2013)	2.00	Canada	Nursing research and practice	Non-empirical	Chronic illness management - nursing health coach
Mitleton-Kelly, E. (2011)	7.86	United Kingdom	The learning organization	Empirical	Health system sustainability
Mohr, J. J., P. Batalden and P. Barach (2004)	10.36	USA	Quality and safety in health care	Non-empirical	Health care organisations generally
Monrouxe, L. V., C. E. Rees and W. Hu (2011)	18.43	United Kingdom	Medical education	Empirical	Education – medicine
Moretti-Pires, R. O. (2009)	10.89	Brazil	Interface - comunicação, saúde, educação	Empirical	Primary care
Morton, A. and J. Cornwell (2009)	3.33	United Kingdom	Bmj	Non-empirical	Hospital - process improvement
Mowles, C., A. van der Gaag and J. Fox (2010)	4.00	United Kingdom	Journal of health organization and management	Non-empirical	Health care systems - change
Mulready-Shick, J. and K. Flanagan (2014)	5.00	USA	Nursing education perspective	Empirical	Education
Munday, D. F., S. A. Johnson and F. E. Griffiths (2003)	1.67	United Kingdom	Palliative medicine	Non-empirical	Palliative care
Murai, M., K. Kitamura and M. D. Fetters (2005)	2.46	USA	Bmc medical education	Empirical	Primary care – education
Murray, P. J. (1992)	0.12	United Kingdom	Intensive and critical care nursing	Non-empirical	Nursing - critical care - education
Nardi, R., G. Scanelli, S. Corrao, I. Iori, G. Mathieu and R. C. Amatrian (2007)	10.00	Italy	European journal of internal medicine	Non-empirical	Internal medicine
Nardi, R., T. Fabbri, G. Belmonte, P. Leandri, M. Mazzetti, A. Pasquale, M. Reta, C. Rizzi, G. Scanelli, I. Iori, G. Gussoni, C. Pedace, G. Mathieu and A. Mazzone (2009)	1.20	Italy	Italian journal of medicine	Unable to classify	Internal medicine - evidence based medicine

Nieuwenhuijze, M., S. Downe, H. Gottfreosdottir, M. Rijnders, A. du Preez and P. V. Rebelo (2015)	1.33	The Netherlands	Midwifery	Review	Hospital – midwifery
Noel, P. H., H. J. Lanham, R. F. Palmer, L. K. Leykum and M. L. Parchman (2013)	11.00	USA	Health care management review	Empirical	Primary care - chronic care-teamwork – learning
Noll, D. C. (1996).	0	USA	Medical group management journal	Non-empirical	Management/leadership
Noll, D. C. (1997)	0.19	USA	Medical group management journal	Non-empirical	Healthcare systems generally
Norman, C. D. (2009)	7.67	Canada	Journal of evaluation in clinical practice	Non-empirical	Health promotion
Norman, C. D. (2013)	1.60	Canada	Journal of evaluation in clinical practice	Non-empirical	Education
Norman, C. D., J. Charnaw-Burger, A. L. Yip, S. Saad and C. Lombardo (2010)	2.88	Canada	Journal of evaluation in clinical practice	Non-empirical	Learning - networks, knowledge generation
Norman, G. (2011)	3.71	Canada	Medical education	Non-empirical	Medicine – education
Notarnicola, I., C. Petrucci, M. R. De Jesus Barbosa, F. Giorgi, A. Stievano, G. Rocco and L. Lancia (2017)	2.00	Italy	International journal of nursing practice	Review	Nursing
Olive, P. (2017)	1.00	United Kingdom	Journal of clinical nursing	Empirical	Hospital - ED following intimate partner violence
Olive, P. (2017)a	0.50	United Kingdom	Journal of clinical nursing	Empirical	Hospital - emergency department - intimate partner violence
Orlowski, S., S. Lawn, M. Ben, A. Venning, G. Jones, M. Winsall, G. Antezana, N. Bidargaddi and P. Musiat (2017)	0.50	Australia	International journal of mental health nursing	Empirical	Mental health services
Orr, M., M. Orr and S. Sankaran (2007)	2.00	New Zealand	Emergence-complexity & organization	Empirical	IT system implementation
O'Sullivan, T. L., C. E. Kuziemsky, D. Toal-Sullivan and W. Cornell (2013)	22.60	Canada	Social science & medicine	Empirical	Public health - health promotion in disaster
Otten, R. and T. Chen (2011)	1.29	USA	Creative nursing	Non-empirical	Leadership - nursing - working relationships
Oyeleye, O., P. Hanson, N. O'Connor and D. Dunn (2013)	16.80	USA	Journal of nursing administration	Empirical	Nursing - workplace bullying
Paley, J. (2007)	8.45	United Kingdom	Nursing inquiry	Non-empirical	Nursing - cardiac rehabilitation

Paley, J. (2010)	7.13	United Kingdom	Journal of health services research and policy	Non-empirical	Healthcare research discipline
Paley, J. and G. Eva (2011)	7.71	United Kingdom	International journal of nursing studies	Non-empirical	Research - academic conceptualisation of healthcare
Papadopoulos, M. C., M. Hadjitheodossiou, C. Chrysostomou, C. Hardwidge and B. A. Bell (2001)	1.65	United Kingdom	Journal of the royal society of medicine	Empirical	Health care system whole - wait lists for surgery
Parchman, M. L., J. A. Pugh, S. D. Culler, P. H. Noel, N. H. Arar, R. L. Romero and R. F. Palmer (2008)	2.50	USA	Implementation science	Non-empirical	Primary care – diabetes
Patel, A. M., T. M. Sundt 3rd and P. Varkey (2008)	0.70	USA	Minnesota medicine	Non-empirical	Medical practice
Patel, V. L., J. Zhang, N. A. Yoskowitz, R. Green and O. R. Sayan (2008)	12.70	USA	Journal of biomedical informatics	Non-empirical	Hospital – decision making - ICU
Patterson, M. and E. S. Deutsch (2015)	5.00	USA	Current problems in pediatric and adolescent health care	Non-empirical	Safety
Pauly, B., M. MacDonald, T. Hancock, W. Martin and K. Perkin (2013)	3.40	Canada	Bmc public health	Non-empirical	Public health services
Peirce, J. C. (2000)	0.06	USA	Health care management review	Non-empirical	Health care organisations
Pelletier, D., S. Gervais, H. Hafeez-Ur-Rehman, D. Sanou and J. Tumwine (2018)	0	USA	International journal of health planning and management	Empirical	Policy
Penney, L. S., L. K. Leykum, P. Noel, E. P. Finley, H. J. Lanham and J. Pugh (2018)	0	USA	Bmj open	Non-empirical	Hospital - readmission rates
Penprase, B. and D. Norris (2005)	2.92	USA	Nursing leadership forum	Non-empirical	Leadership
Perez, B. and A. Liberman (2011)	0.14	USA	The health care manager	Non-empirical	Decision making
Pitkaaho, T., P. Partanen, M. Miettinen and K. Vehvilainen-Julkunen (2015)	4.25	Finland	Journal of advanced nursing	Empirical	Hospital
Piven, M. L., N. Ammarell, D. Bailey, K. Corazzini, C. S. Colon-Emeric, D. Lekan-Rutledge, Q. Utley-Smith and R. A. Anderson (2006)	2.92	USA	Western journal of nursing research	Empirical	Nursing home
Plsek, P. E. and T. Greenhalgh (2001)	110.06	USA	Bmj	Non-empirical	Healthcare – general
Plsek, P. E. and T. Wilson (2001)	41.41	USA	Bmj	Non-empirical	Leadership

Pradebon, V. M., A. L. Erdmann, J. L. Leite, S. B. S. de Lima and A. G. Prochnow (2011)	0.71	Brazil	Acta paulista de enfermagem	Empirical	Hospital - paediatric ICU
Priesmeyer, H. R. and L. F. Sharp (1995)	0.61	USA	Quality management in health care	Non-empirical	Leadership - management administration
Priesmeyer, H. R., L. F. Sharp, L. Wammack and J. D. Mabrey (1996)	0.64	USA	Quality management in health care	Non-empirical	Clinical pathways and care continuity
Provost, S. M., H. J. Lanham, L. K. Leykum, R. R. McDaniel and J. Pugh (2015)	14.00	USA	Health care management review	Empirical	Collaboration and teamwork – safety
Puga, F., K. R. Stevens and D. I. Patel (2013)	1.20	USA	Nursing research and practice	Empirical	Hospital - collaborative, transdisciplinary research network
Pype, P., D. Krystallidou, M. Deveugele, F. Mertens, S. Rubinelli and I. Devisch (2017)	2.00	Belgium	Patient education and counseling	Empirical	Collaboration and teamwork
Quinn, G. R., E. Le, K. Soni, G. Berger, Y. E. Mak and R. Pierce (2014)	1.75	USA	The joint commission journal on quality and patient safety	Empirical	Hospital - emergency department
Ramaswamy, R., J. Reed, N. Livesley, V. Boguslavsky, E. G. Ellorio, S. Sax, D. Houleymata, L. Kimble and G. Parry (2018)	0	USA	International journal for quality in health care	Non-empirical	Quality improvement
Rangachari, P. (2008)	1.20	USA	Quality management in health care	Empirical	Hospital - quality indicators
Rantz, M. J., M. K. Flesner and M. Zwygart-Stauffacher (2010)	1.75	USA	Journal of nursing care quality	Non-empirical	Nursing home - quality indicators
Rantz, M. J., M. Zwygart-Stauffacher, M. Flesner, L. Hicks, D. Mehr, T. Russell and D. Minner (2013)	4.40	USA	Journal of the american medical directors association	Empirical	Nursing home
Redfern, S. and S. Christian (2003)	8.67	United Kingdom	Journal of evaluation in clinical practice	Empirical	Community and inpatient
Reid, J., K. Stone, L. Huang and E. S. Deutsch (2016)	1.00	USA	Clinical pediatric emergency medicine	Non-empirical	Hospital - safety - paediatric medicine
Restau, J. and P. Green (2014)	0	USA	Critical care nursing clinics of north america	Non-empirical	Hospital - ICU - palliative care
Reynolds, M., E. Sarriot, R. C. Swanson and E. Rusoja (2018)	1.00	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Health care generally
Rhodes, M. G. (2013)	1.40	The Netherlands	International journal of health policy management	Non-empirical	Health systems

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Rhydderch, M., G. Elwyn, M. Marshall and R. Grol (2004)	6.57	United Kingdom	Quality and safety in health care	Non-empirical	Primary care – indicators
Ribesse, N., P. Bossyns, B. Marchal, H. Karemere, C. J. Burman and J. Macq (2017)	1.67	Belgium	Global health promotion	Non-empirical	Health systems reform
Rice, W. P. (1996)	0.09	USA	Journal of clinical engineering	Unable to classify	Health care generally
Rickles, D., P. Hawe and A. Shiell (2007)	19.55	Canada	Journal of epidemiology and community health	Non-empirical	Health care generally
Righi, A. W., P. Wachs and T. A. Saurin (2012)	1.50	Brazil	Work	Empirical	Emergency medicine - ambulance
Rogers, H., L. Maher and P. E. Plsek (2008)	1.50	United Kingdom	Bmj	Non-empirical	Health care system
Rojas-Mendizabal, V., A. Serrano-Santoyo, R. Conte-Galvan, S. Villarreal-Reyes and R. Rivera-Rodriguez (2017)	0	Mexico	Ingeniería e investigación	Non-empirical	Technology e-health – implementation
Rojas-Mendizabal, V., A. Serrano-Santoyo, R. Conte-Galvan, S. Villarreal-Reyes and R. Rivera-Rodriguez (2017)a	0	Mexico	Ingeniería e investigación	Non-empirical	E-Health – technology
Royeen, C. B. and A. J. Luebben (2002)	0.56	USA	Occupational therapy in health care	Non-empirical	Allied health - occupational therapy
Rusoja, E., D. Haynie, J. Sievers, N. Mustafee, F. Nelson, M. Reynolds, E. Sarriot, R. C. Swanson and B. Williams (2018)	1.00	USA	Journal of evaluation in clinical practice	Review	Research - complexity science in healthcare
Santos, F. A. P. S. d., B. C. Enders, V. E. P. Santos, D. N. A. Dantas and L. S. M. V. d. Miranda (2016)	0	Brazil	Escola anna nery	Non-empirical	Health system - obstetric care
Sargeant, J. (2009)	16.56	Canada	Journal of continuing education in the health professions	Non-empirical	Education - interprofessional education
Sarriot, E. and M. Kouletio (2015)	6.33	USA	Systemic practice and action research	Non-empirical	Health system - sustainability
Schneider, H., R. English, H. Tabana, T. Padayachee and M. Orgill (2014)	3.50	South Africa	Bmc health services research	Empirical	Health system - primary care - implementation
Schoo, A. and K. Kumar (2018)	0	Australia	The clinical teacher	Non-empirical	Education

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Schulz, V. M., A. M. Crombeen, D. Marshall, J. Shadd, K. A. LaDonna and L. Lingard (2017)	1.00	Canada	Journal of pain and symptom management	Empirical	Heart failure
Scott, K. and A. Steinbinder (2009)	0.22	USA	Nursing administration quarterly	Unable to classify	Change and improvement
Scott, K. and J. Van Norman (2009)	1.11	USA	Nursing administration quarterly	Unable to classify	EHR implementation
Sharp, L. F. and H. R. Priesmeyer (1995)	1.43	USA	Quality management in health care	Non-empirical	Health care organisations - generally
Shen, W., L. Jiang, M. Zhang, Y. Ma, G. Jiang and X. He (2014)	0.75	China	Chinese medical journal	Non-empirical	Research - mass casualty incidents
Shirey, M. R., P. R. Ebright and A. M. McDaniel (2013)	7.60	USA	Journal of nursing management	Empirical	Leadership - nursing - decision making
Silva, I. R., A. M. T. Gomes, G. V. Valadares, N. L. P. dos Santos, T. P. da Silva and J. L. Leite (2015)	1.33	Brazil	Revista gaucha de enfermagem	Empirical	Nursing - knowledge of aids/std
Silva, Í. R., J. L. Leite, M. A. Trevizan, I. A. C. Mendes, T. P. d. Silva and S. M. d. S. B. Lins (2017)	0	Brazil	Escola anna nery	Empirical	Education - nursing
Silva, O., E. D. Alves and M. C. S. Rodrigues (2014)	0.50	Brazil	Cultura de los cuidados	Empirical	Nursing - education
Simmons, M. (2003)	0.80	United Kingdom	Journal of hospital infection	Non-empirical	Management of communicable diseases
Simpson, K. M., K. Porter, E. S. McConnell, C. Colón-Emeric, K. A. Daily, A. Stalzer and R. A. Anderson (2013)	6.80	USA	Implementation science	Non-empirical	Implementation/improvement
Sims, T. (2014)	0	USA	Creative nursing	Unable to classify	Pregnancy
Singh, R., J. Hickner, J. Mold and G. Singh (2014)	1.75	USA	Journal of patient safety	Empirical	Primary health care - testing processes
Singh, R., T. Servoss, M. Kalsman, C. Fox and G. Singh (2004)	3.64	USA	Informatics in primary care	Empirical	Primary care
Smit, E. H. and J. J. L. Derksen (2015)	0.33	The Netherlands	Nonlinear dynamics, psychology, and life sciences	Non-empirical	Primary care - psychologists
Smit, E. H. D. and J. J. L. J. Derksen (2017)	0	The Netherlands	Europe's journal of psychology	Empirical	Primary care - psychology

Smith, C. S., C. Francovich, M. Morris, W. Hill, F. Langlois-Winkle, R. Rupper, C. Roth, S. Wheeler and A. Vo (2010)	1.13	USA	Advances in health sciences education	Non-empirical	Education
Smith, H., C. Kuziemsky and C. Champion (2018)	0	Canada	Canadian journal of surgery	Non-empirical	Hospital - surgery - physician extender
Smits, S. J., J. A. Falconer, R. Morland and D. C. Strasser (1997)	0.24	USA	Topics in stroke rehabilitation	Non-empirical	Rehabilitation - stroke
Snoeren, M. M. W. C., B. M. Janssen, T. J. H. Niessen and T. A. Abma (2016)	6.50	The Netherlands	Health care analysis	Empirical	Nursing home - patient centredness - culture change
Soliman, M. and T. A. Saurin (2017)	4.00	Brazil	Journal of manufacturing systems	Review	Lean management
Soubhi, H., E. A. Bayliss, M. Fortin, C. Hudon, M. van den Akker, R. Thivierge, N. Posel and D. Fleiszer (2010)	11.75	Canada	Annals of family medicine	Non-empirical	Primary care
Squires, A., S. J. Uyei, H. Beltran-Sanchez and S. A. Jones (2016)	2.00	USA	Human resources for health	Empirical	Health care workforce - health systems
Ssengooba, F., B. McPake and N. Palmer (2012)	15.50	Uganda	Social science & medicine	Empirical	Performance targets - health systems
Stange, K. C. (2009)	7.78	USA	Annals of family medicine	Non-empirical	Primary care - reform
Stange, K. C. (2011)	1.86	USA	American journal of preventive medicine	Non-empirical	Preventive health
Sterns, S., S. C. Miller and S. Allen (2010)	6.50	USA	Journal of the american medical directors association	Empirical	Nursing home - culture change
Strand, R., G. Rortveit and E. Schei (2004)	1.43	Norway	Complexus	Non-empirical	Medical practice
Stroebel, C. K., R. R. McDaniel Jr, B. F. Crabtree, W. L. Miller, P. A. Nutting and K. C. Stange (2005)	15.69	USA	The joint commission journal on quality and patient safety	Non-empirical	Primary care - quality improvement
Sturmberg, J. P. (2007)	3.27	Australia	Australian family physician	Non-empirical	Clinical generally
Sturmberg, J. P. (2007)	1.09	Australia	Australian family physician	Non-empirical	Primary care - research
Sturmberg, J. P. and P. Cilliers (2009)	3.89	Australia	Journal of evaluation in clinical practice	Non-empirical	Health care systems and practice generally
Sturmberg, J. P., C. M. Martin and D. A. Katerndahl (2014)	20.25	Australia	Annals of family medicine	Review	Primary care
Sweeney, K. G. and R. Mannion (2002)	1.63	United Kingdom	British journal of general practice	Non-empirical	Clinical governance

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Tait, G. L. R., J. Bates, K. A. LaDonna, V. N. Schulz, P. H. Strachan, A. McDougall and L. Lingard (2015)	5.33	Canada	Journal of multidisciplinary healthcare	Empirical	Heart failure
Tan, J., H. J. Wen and N. Awad (2005). "Health care and services delivery systems as complex adaptive systems." Communications of the Acm 48(5): 36-44	11.23	USA	Communications of the acm	Non-empirical	Health care generally - service delivery system
Tang, W. X., L. Wei and L. Zhang (2017)	0	China	International journal of integrated care	Empirical	Health system - health care reform for integrated care
Taylor, E., A. J. Card and M. Piatkowski (2018)	0	USA	Health environments research & design journal	Review	Hospital - patient room
Therrien, M. C., J. M. Normandin and J. L. Denis (2017)	0	Canada	Journal of health organization and management	Non-empirical	Hospital and wider health system
this ref is actually the Sturmberg, O'Halloran, Martin (2012) reference above they missed an author when referencing - line 532). Still missed in our library but please consolidate	11.00	Canada	International journal of integrated care	Empirical	Integrated care
Thomas, M. B. and S. Houston (2005)	0.85	USA	Clinical nurse specialist	Non-empirical	Patient safety
Thompson, D. S., J. Abourbih, L. Carter, G. Adams-Carpino, S. Berry, L. E. Graves and N. J. Ranger (2018)	0	Canada	Journal of interprofessional care	Empirical	Education - interprofessionalism
Thompson, D. S., X. Fazio, E. Kustra, L. Patrick and D. Stanley (2016)	14.00	Canada	Bmc health services research	Review	Research - complexity science in healthcare
Townsend, G. C., M. Kim and D. Sankey (2012)	2.17	Australia	European journal of dental education	Non-empirical	Education - dentistry - problem-based learning
Trenholm, S. and E. Ferlie (2013)	5.00	United Kingdom	Social science & medicine	Empirical	Health system - response to disease
Valencia A, M. (2011)	2.14	Colombia	Revista facultad nacional de salud pública	Non-empirical	Public health
Valeras, A., Gunn, W., and A. Valeras (2013)	0.40	USA	International journal of psychiatry in medicine	Non-empirical	Education
Vallis, M. (2015)	4.33	Canada	Canadian journal of diabetes	Non-empirical	Diabetes management
Van Beurden, E. K., A. M. Kia, A. Zask, U. Dietrich and L. Rose (2013)	7.71	Australia	Health promotion international	Non-empirical	Health promotion

van de Wetering, R. and R. Batenburg (2014)	5.50	The Netherlands	Journal of digital imaging	Empirical	Hospital - IT
van der Vlegel-Brouwer, W. (2013)	2.20	The Netherlands	International journal of integrated care	Non-empirical	Integrated care - policy-practice gap
van Rossum, T. R., F. Scheele, A. Scherpbier, H. E. Sluiter and I. C. Heyligers (2016)	1.50	The Netherlands	Bmc medical education	Non-empirical	Education - medicine
van Wietmarschen, H. A., H. M. Wortelboer and J. van der Greef (2018)	4.00	The Netherlands	Journal of evaluation in clinical practice	Non-empirical	Health care generally
Varghese, J., V. R. Kutty, L. Paina and T. Adam (2014)	4.75	India	Health research policy and systems	Empirical	Public health - vaccination coverage
Velde, B. P., A. G. Greer, D. C. Lynch and S. Escott-Stump (2002)	0.69	USA	Journal of allied health	Non-empirical	Education
Velez Lapao, L. (2007)	3.09	Portugal	Methods of information in medicine	Empirical	Information/IT systems
Vicenzi, A. E. (1994)	1.08	USA	Nursing science quarterly	Non-empirical	Nursing
Vieira, M., P. Klock, R. Costa and A. L. Erdmann (2009)	0.33	Colombia	Aquichan	Non-empirical	Nursing profession
Vogt, E. M. (2002)	0.94	USA	Drug safety	Non-empirical	Medication safety
Vosman, F. and A. Niemeijer (2017)	4.00	The Netherlands	Medicine, health care and philospophy	Non-empirical	Hospital - health care
Walls, M. E. and R. R. McDaniel, Jr. (1999)	0.53	USA	Seminars for nurse managers	Non-empirical	Mergers - leadership - organisational change, nurse management
Walton, M. (2016)	2.50	New Zealand	Evidence and policy	Non-empirical	Public health - governance/policy

Wang, L., X. Zhang, X. Liang and G. Bloom (2016)	2.00	China	Globalization and health	Empirical	Health care policy - global health system - antibiotic resistance
West, G. B. (2012)	8.00	United Kingdom	The lancet	Non-empirical	Medicine
West, G. B. (2012)a	8.00	USA	The lancet	Non-empirical	Medicine
Wilkinson, J., M. Goff, E. Rusoja, C. Hanson and R. C. Swanson (2017)	1.00	USA	Journal of evaluation in clinical practice	Review	Health systems, generally
Wilson, J. (2014)	1.75	United Kingdom	Monash bioethics review	Non-empirical	Translation - evidence into practice - bioethics
Wilson, N. J. and M. J. Hatlie (2001)	0.59	USA	Journal of healthcare quality	Non-empirical	Patient safety
Wilson, T., T. Holt and T. Greenhalgh (2001)	28.06	United Kingdom	Bmj	Non-empirical	Clinical - general
Wouters, E. F. M. and I. M. L. Vanderhoven (2009)	0.56	The Netherlands	Seminars in respiratory and critical care medicine	Non-empirical	Integrated care - chronic disease
Zarowsky, C., S. Haddad and V.-K. Nguyen (2013)	3.60	South Africa	Global health promotion	Non-empirical	Vulnerable groups in healthcare
Zhao, J., H. Yang, H. Guo, Y. Li, Z. Zhang and S. Li (2010)	0	China	Shengwu yixue gongchengxue zazhi	Unable to classify	Hospital
Zimmerman, B. (1999)	3.21	Canada	Healthcare forum journal	Non-empirical	Uncertainty - leadership

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The influence of complexity: A bibliometric analysis of complexity science in healthcare

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The influence of complexity:
A bibliometric analysis of complexity science in healthcare

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ABSTRACT

Objectives

To analyse trends in the academic literature applying complexity science to healthcare, focusing specifically on bibliometric characteristics and indicators of influence.

Design

This study reports a bibliometric analysis via a systematic search of the academic literature applying complexity science to healthcare.

Method

A search of four academic databases was performed on 19 April 2018. Articles details were downloaded and screened against inclusion criteria (peer-reviewed journal articles applying complexity science to healthcare). Publication and content data were then collected from included articles, with analysis focusing on trends over time in the types and topics of articles, and where they are published. We also analysed the influence of this body of work through citation and network analyses.

Results

Articles on complexity science in healthcare were published in 268 journals, though a much smaller subset were responsible for a substantial proportion of this literature. The United States contributed the largest number of articles, followed by the United Kingdom, Canada, and Australia. Over time, the number of empirical and review articles increased, relative to non-empirical contributions. However, in general, non-empirical literature were more influential, with a series of introductory conceptual papers being the most influential based on both overall citations and their use as index references within a citation network. The most common topics of focus were health systems and organisations generally, and education, with recent uptake in research, policy, and change and improvement.

Conclusions

This study identified changes in the types of articles on complexity science in healthcare published over time, and their content. There was evidence to suggest a shift from conceptual work to the application of concrete improvement strategies and increasingly in-depth examination of complex healthcare systems. We also identified variation in the influence of this literature at article-level, and to a lesser extent by topic of focus.

Key words

Complexity science, Healthcare, Bibliometrics, Review, Complex adaptive systems, Health care

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ARTICLE SUMMARY

Strengths and limitations of this study

- Use of an inclusive search strategy based on previously published reviews and including non-empirical and non-English language articles.
- Articles coded by multiple coders into topic themes to determine popular and emerging areas of interest for complexity science in healthcare.
- A focus on citations and index references as a proxy for influence; citation analysis tends to prioritise older contributions that have had more time to accumulate cites.
- Inclusion of only peer-reviewed articles, minimizing the potential influence of some prominent non-peer-reviewed contributions.

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The influence of complexity: A bibliometric analysis of complexity science in healthcare

BACKGROUND

Complexity science provides a way of understanding nonlinearity, in which causation is problematic and multi-faceted, and emergent behaviours are the norm.[1] It developed out of diverse academic traditions, including computer science, physics, sociology, anthropology, economics and mathematics. Different systems can be understood using the complexity paradigm—it finds commonalities and patterns in the behaviour of systems comprised of very different agents (ants, cells, humans, societies, species, bacteria), often labelled via a convenient phrase: complex adaptive systems (CASs).[2] Such systems were initially recognised for displaying "weird", chaotic and dynamic behaviours; thus, chaos theory was developed to explain such phenomenon. However, a focus only on chaos failed to account for why complex systems also often exhibit degrees of homeostasis—that is, they are somehow balanced between the chaotic and unpredictable on the one hand, and the orderly and predictable on the other—for the most part, most of the time.[3] Complexity science provides an understanding of systems that are between phase transitions and are often found just "at the edge of chaos".[3, 1]

The study of complexity challenges traditional approaches to science that favour a controlled view of the world, where variables are held constant and where outcomes are predictable because causes and effects are related, and construed as linear arrangements.[4] CASs are not well-explained through studies that aim for such reduction, decomposition and cause-effect logic, breaking problems down into manageable parts and studying these components individually in an attempt to understand the whole.[5] In short, CASs are *different from*, and *more than* the sum of their parts.

Complexity science has pervaded many disciplines, making its way, for example, into the social sciences and the study of human systems and organisations.[6, 1] The adoption of complexity science principles has been particularly notable in health-related fields, with healthcare systems worldwide recognised as excellent examples of CASs because of the diverse array of agents involved (doctors, patients, nurses, consumer groups, politicians, non-government organisations) and the enormous number of interactions among them.[7, 8] This work gained momentum at the beginning of this century, with the publication of a number of conceptual contributions discussing the application of complexity science principles in areas of healthcare like clinical practice,[9] education,[10] and healthcare management.[11, 12] Since this time, the potential of complexity science in understanding and tackling some of the otherwise intractable challenges of delivering

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healthcare—including patient safety,[13] interprofessional collaboration,[14] sustained improvement,[15] and managing uncertainty [16]—has been considered. Empirical studies applying the principles of complexity science to healthcare have also proliferated. Almost two decades ago, Anderson and McDaniel [17] used complexity theory to understand nurses' decision-making in nursing homes in the United States. Much more recently, Barasa, Molyneux [18] examined hospitals as CASs in their case study of financing decisions in Kenya.

There are signs that literature on complexity science in healthcare is approaching maturity, with literature reviews of the empirical research now being undertaken,[19] especially in the context of health services interventions,[20] as well as publication of a systematic review of empirical and non-empirical complexity ideas.[21] As a complement to these contributions, now is an appropriate time to examine the influence and spread of this literature in greater prevision. Towards this end, bibliometrics is an approach that looks at publication patterns in an area of research literature, including trends over time and globally, and the influence of articles, and the authors and journals publishing such works, indicated by citations.

Aim

This study aimed to analyse trends in the academic literature on applying complexity science to healthcare, focusing specifically on bibliometric characteristics. We also analysed the influence of this body of work through citation and network analyses.

METHOD

Systematic search of the literature

Databases

On the 19 April 2018, the Cochrane Database of Systematic Reviews, CINAHL, EMBASE, and all databases of Web of Science, which includes MEDLINE, were searched using keywords documented below. The general search strategy was based on that taken by Thompson et al.,[19] with a range of search terms associated with complexity theory used to account for broad indexing. This included "chaos theory", because complexity is often described as developing out of,[1] as well as encompassing the more specific concept of, chaos.[22] Keywords related to healthcare and health systems were also searched. No date restrictions were used. An example of the search strategy for Web of Science is in Appendix 1.

Keywords

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1. "Complexity theory" OR "complexity science" OR "complex adaptive system" OR "complexity thinking" OR "complex responsive process theory" OR "chaos theory"
2. healthcare OR "health care" OR "health-care" OR hospital OR "health facilit*" OR "acute care" OR "health organi*" OR "health system" OR "primary care" OR "general practice" OR "aged care" OR "nurs* home OR medic* OR clinic* OR nurs* OR health

Citations returned from these searches were downloaded into the reference management software Endnote, and duplicates were removed. References were then exported to a Microsoft Excel spreadsheet for screening. Articles were reviewed against inclusion criteria and exclusion criteria by the first author, with a consistency check on 5% of the references performed by a second author following accepted practices.[23] References meeting inclusion criteria were classified for bibliometric analysis.

Inclusion and exclusion criteria

Because we were looking at influence, empirical and non-empirical papers (e.g., commentaries, conceptual papers and reviews) published in peer-reviewed academic journals and applying complexity science to healthcare were included in the analysis. We defined healthcare broadly to include not only the professionals involved (e.g., nurses, doctors, administrators) and sites of healthcare delivery (e.g., hospitals, nursing homes), but also education, policy, processes and ethical or research issues related to healthcare. Health promotion and public health articles were initially retained for full-text screening. However, they were ultimately only included if they discussed healthcare sites, professions or aspects of care delivery, rather than, for example, population-based health promotion interventions and issues.

Letters to the editor and editorial papers that only described the contents of an issue were excluded, because they were not thought to sufficiently contribute to the spread of complexity ideas within healthcare. Books, book chapters and conference proceedings were also excluded because bibliometric data is often not available or incomplete for such publications. Articles that were not originally published in English but provided an English-language abstract were included in the bibliometric review if, based on this information, they were found to meet all of the inclusion criteria and none of the exclusion criteria.

Bibliometric analysis

Stage one: Review of article publication data

First bibliometric data on the article, including the year of publication, the journal in which it was published, the corresponding author and their country of residence, were captured from the full-text,

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or the journal or indexing database where full-text was unavailable (either inaccessible to the authors or not available in English).

Stage two: Review of article content

Articles were then classified in greater detail according to their content, including type of article and focus. This involved classifying articles as empirical or non-empirical. The empirical papers were further categorized according to their use of complexity science (e.g., the covered aspects of prediction, conceptual framework, data analysis, or interpretation of findings) following the schema of Thompson et al.[19] Non-empirical papers were classified as: commentaries and editorials, conceptual discussions, conceptual case studies, and protocols. Reviews were also included and classified.

Two of the authors (KC and CP) performed a content analysis on the main focus(es) of all the included articles. This involved inductive descriptive coding of each paper, then comparisons, modifications and expansions of codes to identify the most common topic themes in the literature applying complexity science to healthcare. Generally, details in the abstract and title, in addition to database indexing information, were sufficient to classify whether an article was empirical or non-empirical, and also its main focus. However, some articles did not have an abstract, or the abstract detail was insufficient. Full-text review was conducted during this stage (where full-text was available in English) to ensure the most accurate classification.

Stage three: Analysis of influence

The number of citations an article had received over time was used to calculate influence, with citations collected from Google Scholar in July 2018. We also examined influence by identifying one or more "index" reference(s) for each of the full-text articles reviewed.[1] An index was defined as the most influential, prominent or leading reference(s) cited by an included article that also focused on complexity science within healthcare (as compared with complexity science in biology, management or generally). However, unlike papers in this review, an index reference need not be a peer-reviewed publication; this criterion allowed us to consider influence from other sorts of academic outputs. Where possible, we identified an index reference based on attribution by the authors of that paper, for example, a statement like: "In his appendix to *Crossing the Quality Chasm*,[12] Plsek[13] suggests that, rather than using the principles of mechanical systems to try to improve health care, innovators should employ the principles of complex adaptive systems".[24, p.

[1] Where full-text was available (n=377)

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17] However, in the absence of an explicit statement to this effect, we took the first reference(s) cited when introducing the notion of complexity science applied to healthcare. Some articles included did not have index references, and others were unable to be searched (i.e., full-text not available).

Index references and their citing articles were used in a network analysis, visually constructed in Gephi, version 0.9.2. Network analysis uses graph theory to map and measure relationships among nodes.[25] In this case, the nodes in the network were the articles in the review as well as any index reference(s) they cited, while relationships were directional tie(s) to an index reference (e.g. articles X cited article Y as an index reference). Articles that did not cite an index reference, and were not themselves used as an index reference for another article (i.e., an isolate), were removed from the network analysis, on the basis that they did not contribute to understanding influence. In visualizing the network, the main topic theme of the research output was used to differentiate different categories of articles and identify any possible clustering, as well as distinguish influential index references that were not captured by our review strategy. The most influential academic outputs in the network were assessed using in-degree calculation (the number of inward directed ties to a node i.e., the number of times an index reference was cited by other articles).

Patient and public involvement

Neither patients nor members of the public were involved in this study.

RESULTS

A total of 2,505 articles were returned from searches across the four databases and downloaded into Endnote X8. Following removal of duplicates, citation details (n=2,382) were exported to Microsoft Excel for screening of their titles and abstracts against inclusion criteria by the first author. To ensure the criteria were clear and could be applied consistently, a second author (LAE) screened a subset (5%) of the library. Interrater reliability (Cohen's kappa) between the two authors indicated almost perfect agreement (κ=0.88).[26] Five-hundred and forty-seven references were retained, though a further 93 were excluded at stages one and two of data analysis because, upon review, they did not meet inclusion criteria (reasons documented in Table 1). This left 454 articles that were subjected to the bibliometric analysis. Figure 1 presents the search strategy.

INSERT FIGURE 1 HERE

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Table 1. Reasons for exclusion at full text stage.

Reason for exclusion	Number of articles
Not about complexity science	12
Not in healthcare	31
Not a peer-reviewed academic journal article	49
Article information unable to be found[1]	1
Total	93

[1] Rouse, W. B. (2000). Managing complexity: disease control as a complex adaptive system. Information Knowledge Systems Management, 2(2), 143-165 was published in a now discontinued journal. Citation data unavailable in Google Scholar, precluding bibliometric analysis.

Of the 454 articles considered eligible for inclusion, the research team was able to access full-text in English for 379 articles, permitting a more detailed and accurate classification of content. The remaining 75 articles included in the bibliometric analysis were comprised of 49 articles in English-language journals where full-text was inaccessible, and 26 where full-text was not available in English. See Appendix 2 for summary of data extraction.

Stage one results: Article publication data

The 454 included articles came from 268 different journals, which were primarily health-focused, but varied in scope. Table 2 displays the journals publishing the highest number of articles in the field. The journal publishing the most articles on complexity science applied to healthcare was the *Journal of Evaluation in Clinical Practice* (n=24), followed by *Health Care Management Review* (n=18), and *Social Science & Medicine* (n=11).

Table 2. Top 13 journals publishing articles on complexity science applied to healthcare

Top journals publishing on complexity science in healthcare	Number of articles
Journal of Evaluation in Clinical Practice	24
Health Care Management Review	18
Social Science & Medicine	11
BMC Health Services Research	8
Implementation Science	8
Journal of Advanced Nursing	8
Medical Education	8
Annals of Family Medicine	6
Academic Medicine	5
BMJ	5

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International Journal of Integrated Care	5
Journal of Interprofessional Care	5
Journal of Nursing Administration	5

Using the corresponding author's affiliation as an indicator, we determined that articles applying complexity science principles to healthcare came from 33 countries. The United States of America (n=199, 43.8%), the United Kingdom (n=82, 18.1%), Canada (n=49, 10.8%) and Australia (n=23, 5.1%) accounted for nearly three-quarters of the included papers, as can be seen from Figure 2. Other countries contributing substantially were the Netherlands (n=12, 2.6%) and Brazil (n=17, 3.7%); for Brazil, this included 11 (2.4%) papers published in non-English language journals. Despite the concentration of articles among only a few countries, there was evidence for increasing globalisation over time: prior to 2003, the only countries publishing literature on complexity science applied to healthcare were the UK, USA, Canada and Australia, while in 2017-2018 articles came from 16 different countries. These included, for the first time, France, Pakistan, Serbia, Spain, and Switzerland.

INSERT FIGURE 2 HERE

Stage two results: Article content

The majority of the literature (n=277, 62.8%)[2] applying complexity science to healthcare has been non-empirical. Of these, most (n=178) were conceptual discussions of the relevance of complexity science to aspects of healthcare. For example, Fenwick and Dahlgren [27] considered how complexity principles like emergence and self-organisation apply to simulation-based education in medicine, while Litaker, Tomolo [28] advanced the approach for understanding variation in primary care and developing flexible improvement initiatives. Other types of non-empirical articles included conceptual case-studies (n=39) where discussions of complexity science to healthcare were further concretised by real-world examples often based on the authors' prior research [e.g., 29, 30]; methodological and practical articles (n=23) focused on methods, models and frameworks to apply complexity science in healthcare [e.g., 31, 32]; shorter, more opinion-based commentaries and editorials (n=18); unstructured and narrative reviews (n=12), and protocol papers (n=7).

While there were less empirical contributions (n=149, 33.9%), their publication increased over time, especially over the last five years. These empirical articles predominantly employed

[2] N=13 unable to be classified because full-text was inaccessible and there was insufficient information in the abstract. Percentage calculated on the 441 articles able to be classified.

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complexity science as a conceptual framework (n=109), meaning the theory was introduced early in the article to make sense of the problem at hand. Oyeleye, Hanson [33], in this vein, situated their quantitative study of nurses' burnout and experiences of workplace incivility within a complex adaptive systems framework, noting the paradigms appreciation of individuals' interactions and interconnections, which give rise to unpredictability. In another example, Ssengooba, McPake [34] used a complexity lens in a case study examining the failure of performance-based payment in Uganda, to understand the emergence of new behaviours and adaptation of the healthcare system. To a lesser extent, empirical papers used complexity science for data collection (n=4) or analysis (n=12) where they explicitly linked their design and methods to complexity science principles. For example, Crabtree, Miller [35] made changes to their study design in order to identify attractors, based on an emerging hypothesis of primary care practices functioning like complex systems. Finally, 22 empirical studies used complexity science in a more comprehensive way in the interpretation of the findings of their research.[3][e.g., 36]

As well as empirical and non-empirical articles, publication of structured and systematic reviews (n=15, 3.4%) that either explicitly reviewed complexity science in healthcare [e.g., 37, 20, 19] or used these principles as a lens or framework for their review [e.g., 38, 39] also increased over the last decade. These trends are captured in Figure 3.

INSERT FIGURE 3 HERE

Delving deeper into the content of these articles, we coded the main focus(es) of each of the articles included in the review, then developed broader categories representing common topic themes for complexity science applied to healthcare. Multiple topic themes were often evident in a single article, so themes are not mutually exclusive. These topic themes are displayed in Table 3. The most common topic themes involved a focus on *healthcare settings* (especially *primary care* and *hospitals*), followed by *health systems and organisations generally*, *healthcare professionals* (particularly *nursing* and *medicine*), and *education*. Furthermore, while *healthcare professionals*, and *education* were early topics for complexity science in healthcare, it was not until 2006 that these principles were taken up in articles focused on *change, improvement and implementation*, *research* and *policy* (see Figure 4).

Table 3. Topic themes for articles on complexity science applied to healthcare.

Topic themes	Number of articles[1]	Citations per year
Management and leadership	49	4.0

[3] Full-text unavailable for two empirical articles. There was not enough detail in the title and abstract to determine the use of complexity science.

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Education	59	5.9
Teamwork, collaboration and care coordination	31	4.8
Health systems and organisations generally	76	6.0
Public health and health promotion	31	4.4
Safety, quality and performance	22	2.4
Change, improvement and implementation	39	5.1
Research	14	4.7
Healthcare policy	10	2.3
Health settings	146	3.4
- *aged and nursing care*	*21*	*5.7*
- *ambulatory care*	*2*	*0.8*
- *chronic care*	*9*	*4.3*
- *hospital*	*53*	*2.7*
- *mental health*	*6*	*1.9*
- *paediatrics*	*3*	*3.9*
- *palliative care*	*4*	*1.3*
- *primary care*	*48*	*6.4*
Healthcare professionals	71	3.6
- *allied health*	*2*	*0.3*
- *medicine*	*19*	*7.3*
- *nursing and midwifery*	*44*	*2.7*
- *general*	*6*	*4.0*
Other	33	3.5

[1] Topic themes are not mutually exclusive, except within subthemes of health settings and healthcare professionals.

INSERT FIGURE 4 HERE

Stage three results: Examination of influence

Citation analysis

Influence was calculated using the number of citations each article received averaged by the number of years elapsed since publication. For the field, this amounted to an overall average of 4.9 citations a year per article, although there was high degree of skewedness (Mdn= 2.5, Min=0, Max=110.1).[4] At article-level, influence was considered separately for empirical and non-empirical contributions, which included structured reviews. As can be seen in Table 4, generally, non-empirical articles

[4] Articles published in 2018 not included in calculation.

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were more influential than empirical ones. The most influential article by a substantial margin was the conceptual discussion by Plsek and Greenhalgh,[5] published in 2001 in the BMJ, to introduce a series of papers on complexity in healthcare; numerous other papers in this series also featured in the top 10. A brief description of the main focus of each paper, which was used as the basis for developing topic themes, is present in Table 4. For non-empirical articles, the focus tended to be broader and there were a number of common themes, including application of complexity science to healthcare generally,[5] clinical practice,[40, 9] and education.[41] The empirical articles were however more varied and specific in focus, though nursing homes and primary care were common areas of interest. Influence was also examined according to the topic themes identified in stage two; based on this analysis, we found that articles focusing on complexity science specifically in relation to medical professionals were most influential, followed by articles in the primary care setting and considering health systems and organisations generally (Table 3).

Network analysis of index references

The influence of included articles and other research outputs on complexity science applied to healthcare was further investigated in the network analysis of index references, depicted in the sociogram in Figure 5. The network consisted of 514 nodes (i.e., academic outputs) and 657 directional ties (which output cited another output as an index reference). Of these nodes, 276 (53.7%) were used as an index reference by at least one other research output in this network (indegree >0). The nodes with the highest in-degree are listed in Table 5. The most influential node in the network was the article by Plsek and Greenhalgh,[5] which was cited as an index reference for complexity science in healthcare by 71 other articles in the review. Visualisation revealed an absence of clustering by topic theme; that is, rather than seeing index referencing only between research outputs that explore similar ideas (e.g. management only uses other management outputs as index references), there were connections among the different topic themes. Finally, there were 183 outputs (35.6%) used as index references that had not been included in our review.

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Table 4. Most influential empirical and non-empirical articles on complexity science applied to healthcare.

Empirical article	Citations per year	Main focus description	Non-empirical and review articles	Citations per year	Main focus description
Anderson, Issel [42]	29.4	nursing home	Plsek and Greenhalgh [5]	110.1	healthcare - general
O'Sullivan, Kuziemsky [43]	22.6	public health - health promotion in disaster	Fraser and Greenhalgh [10]	50.6	education
Hanseth, Jacucci [44]	21.8	hospital – EHR/IT	Plsek and Wilson [12]	41.4	leadership
Monrouxe, Rees [45]	18.4	education - medicine	Best, Greenhalgh [38]	40.7	healthcare system - transformation
Oyeleye, Hanson [46]	16.8	nursing - workplace bullying	Goldberger [47]	39.6	clinical practice
Anderson, Corazzini [48]	15.9	nursing homes - job satisfaction	Braa, Hanseth [49]	35.6	EHR/IT - developing countries
Ssengooba, McPake [34]	15.5	performance targets - health systems	Wilson, Holt [9]	28.1	clinical - general
Miller, McDaniel [50]	14.8	primary care	Frye and Hemmer [51]	28.0	education
Boustani, Sachs [52]	14.5	primary care - dementia care	Bleakley [53]	25. 7	education
Provost, Lanham [13]	14.0	collaboration and teamwork - safety	Anderson, Crabtree [31]	25.1	healthcare organisations

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INSERT FIGURE 5 HERE

Table 5. In-Degree

	Most popular index references in network	In-degree	Topic theme of complexity
1	Plsek, P. E. and T. Greenhalgh [5]	71	Health systems and organisations
2	IOM and P. E. Plsek [54]	25	Not in review
2*	Plsek, P. E. and T. Wilson [12]	25	Management/leadership
3	Wilson, T., T. Holt and T. Greenhalgh [9]	19	Healthcare setting
3*	Zimmerman, B., C. Lindberg, and P. Plsek [55]	19	Not in review
4	Fraser, S. W. and T. Greenhalgh [10]	18	Education

* indicates equal levels of in-degree.

DISCUSSION

Complexity science has brought a radical shift in how we think about many of the dynamic relationships and systems present in our world, with healthcare being no exception. This bibliometric review of complexity science in healthcare has identified a number of trends in the types of articles published over time, and the influence of this body of work. It has documented increasing use of a complex systems lens to describe, understand and study aspects of healthcare over the past two and a half decades, with literature emanating from numerous countries and being published in many journals. There has been considerable concentration, with only a few countries (the USA, UK, Canada and Australia) and journals responsible for a disproportionately high number of contributions; indeed, the way articles are spread across countries shows a feature of complexity in that it approximates a power law distribution.[56] At the same time, there is evidence of increasing globalisation of complexity science in healthcare literature over the years.

Our findings indicate increases in empirical research and reviews, relative to non-empirical contributions, suggesting a move from the conceptual to the concrete with regard to understanding complexity in healthcare. A recent review by Thompson, Fazio [19] though, indicates that empirical work in health services research is often inconsistent and lacks sophistication in the use of complexity science methods; similarly, Brainard and Hunter [20] reviewed complexity-informed interventions and noted that there is often a poor operationalisation of complexity science principles. In this regard, our own analysis of non-empirical research has identified a preponderance of broad conceptual discussions, rather than practical or methods articles of *how* to apply complexity science in healthcare. Likewise, empirical contributions largely used complexity science

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to situate their research problem but were less inclined to draw on its tenets in their study design and method.

This bibliometric review further demonstrated that complexity science has permeated diverse contexts and topic areas within healthcare, being particularly prominent in articles on management, education, primary care and hospitals. Interest in research as well as change, improvement and implementation have emerged more recently. In regards to the former, the evolving trend for publishing articles about researching complexity in healthcare suggests increasing awareness of the need to operationalise complexity concepts. Meanwhile, for the latter, a nascent focus on change and improvement mirrors the formalisation of implementation science as a field.[e.g., 57] It is plausible that these will become more prominent target areas in the future for attention by complexity scientists.

Although there was variation in the degree of influence these topics had, based on average citations, our network analysis demonstrated limited clustering according to theme, which suggests cross-fertilisation of ideas across the broader body of work on complexity science in healthcare. At the same time, a number of early contributions on complexity science in healthcare have become widely-recognised in the field as the most influential both in terms of their total citations and their consistent status as index references for other articles.[e.g., 5, 10, 12, 9]

Underscoring the issues this review has identified, in their recent introduction to a series on complexity in medicine and healthcare, Greenhalgh and Papoutsi [58] argued that despite the proliferation of complexity-informed research, this work has been largely superficial. The radical departure the complexity paradigm was thought to represent in the early 2000s, when the evidently seminal BMJ series was published, has not been carried through in research. The approaches of conventional science—prediction and controlled experiments—are not appropriate for studying complexity but are still often used. Going forward, in-depth, mixed-method case studies and ethnography, which can understand context and the interconnectedness of system components, are required, as are new criteria for assessing the quality of complexity-focused research.[58]

Strengths and limitations

The search strategy for this bibliometric analysis was based on that of a published review.[19] However, there might be other terms used to denote a complexity-focused articles other than those utilised here; for example, our search did not capture a study of complexity in patient-doctor interactions by Katerndahl and Parchman [59], likely because of their preference for the term

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"dynamic" and mention of a specific complexity analysis method (orbital dynamics). Therefore, future reviews of complexity should consider this issue in deriving search terms. Our inclusion criteria were designed to be as inclusive as possible, such as in recognising non-English language publications. Peer-reviewed journal articles are best suited to bibliometric and particularly citation analyses, rather than other academic outputs such as books, book chapters and reports, hence this being a requirement for inclusion in our review.[60, 61] While well-justified, our network analysis demonstrates the limits of this approach in that a substantial portion of index references identified were not included in our review, particularly a prominent book by Zimmerman, Lindberg [55] and Plsek's appendix to an Institute of Medicine Report.[54] Despite this limitation, these contributions were included to some extent through our identification of index references.

Furthermore, the citation analysis, as well as our focus on index references, has arguably better illustrated long-term impact than the emerging influence of new and up-and-coming work on complexity science in healthcare, because the publication process can be lengthy, creating delays in the accumulation of citations.[62] Hence, more recent articles, which we have found influential in guiding our own research, such as those by Leykum, Lanham and their colleagues [e.g., 30, 63] may be revealed as more influential in the coming years. The use of "altmetrics" (e.g., social media mentions) in future bibliometric reviews could facilitate assessment of more immediate impact.[64] Lastly, some contributions influential in the field have straddled public health and social care, such as the work of Hawe [65] and Sterman,[66] and so were not included based on our search strategy and inclusion criteria.

CONCLUSION

This study conducted a bibliometric analysis of the peer-reviewed literature in the evolving academic field of complexity science applied to healthcare. We identified a number of trends in where this work has been conducted and published, including that there is sustained and increasing interest in complexity science, with evident spread of ideas globally and into specific topic areas. There were also clear shifts in the types of articles published over time, and their content. As a field, the application of complexity science to healthcare appears to be increasingly focused on *doing* complexity-informed research, rather than discussions of its conceptual and theoretical contours. Finally, we found substantial variation in the influence of this literature at article-level, and to a lesser extent by topic of focus.

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Author Contributions

KC had the original idea for the article and devised the search strategy with support from LAE, JCL and JB. KC oversaw the search, and conducted the title/abstract review and analysis with assistance from CP and LAE. CP performed the network analysis of influence. KC drafted the manuscript. CP, LAE, JCL and JB critically revised the manuscript. All authors agreed upon the final version of the manuscript.

Data Availability Statement

The full data extraction spreadsheet may be made available upon request to the corresponding author.

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Competing Interests

None declared.

Abbreviations

CASs Complex Adaptive Systems

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FIGURE LEGENDS

Figure 1. PRISMA flow diagram of search strategy

Figure 2. Global trends for publishing articles on complexity science applied to healthcare.

Figure 3. Trends over time in the types of articles published on complexity science applied to healthcare. Note data collected mid-2018.

Figure 4. Trend over time in the publications of complexity science applied to healthcare by topic theme.

Figure 5. Sociogram of index references for complexity science applied to healthcare.

Each circle (node) is representative of a research output. The size of node is indicative of in-degree (larger nodes indicate a higher number of references towards the output as an index). Colour of node is indicative of the topic theme. * indicates equal levels of in-degree for corresponding rank.

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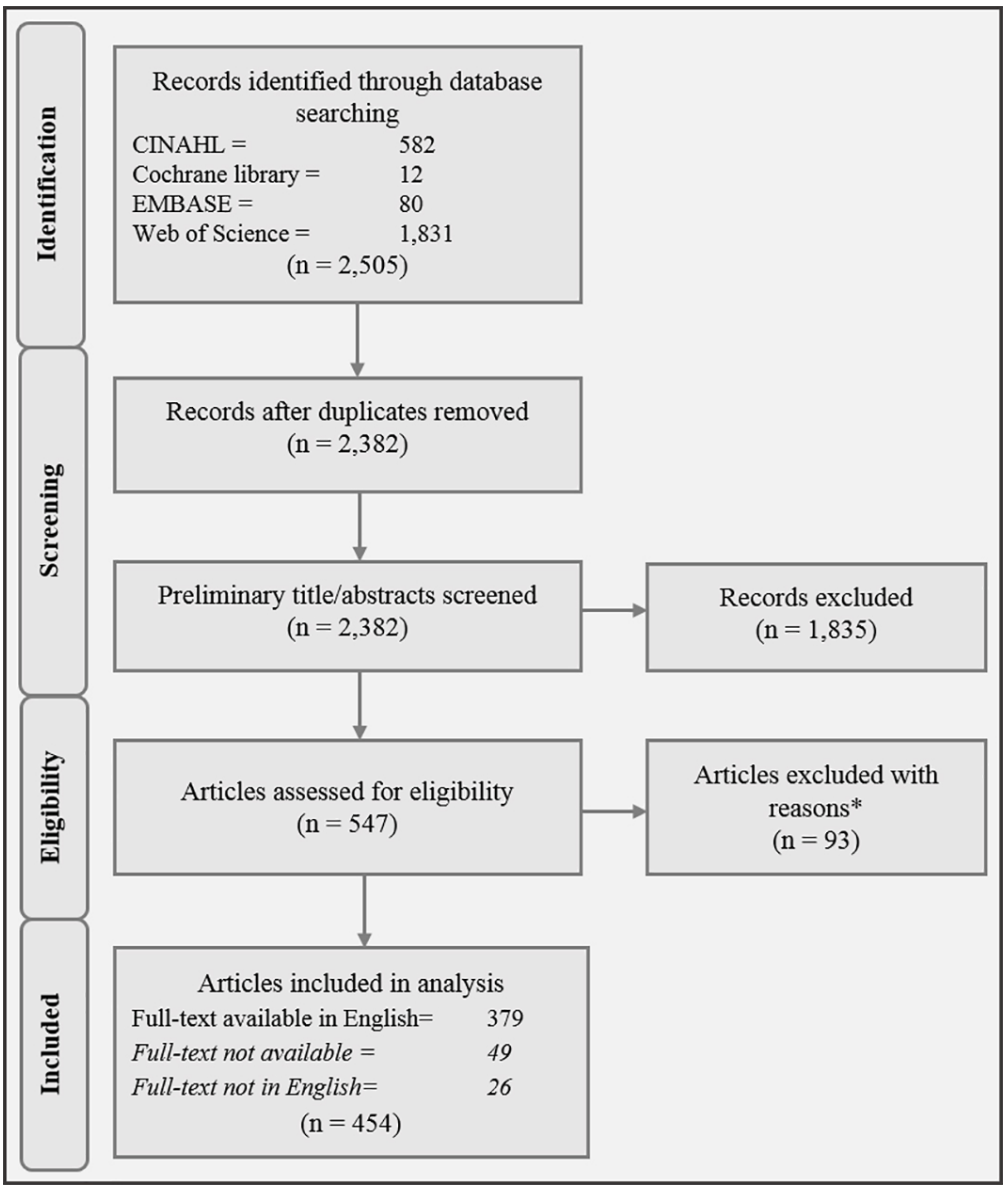

Figure 1. PRISMA flow diagram of search strategy

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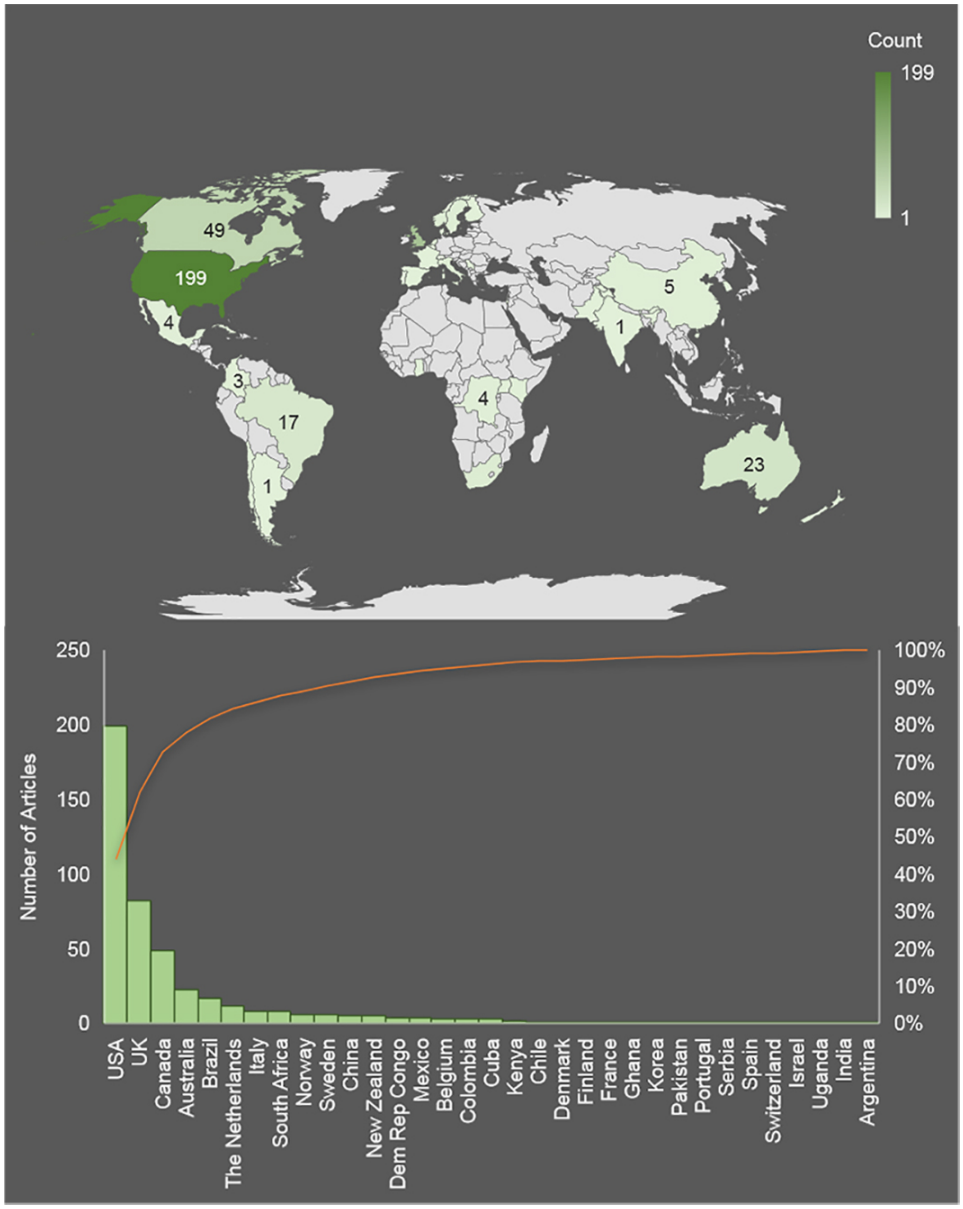

Figure 2. Global trends for publishing articles on complexity science applied to healthcare.

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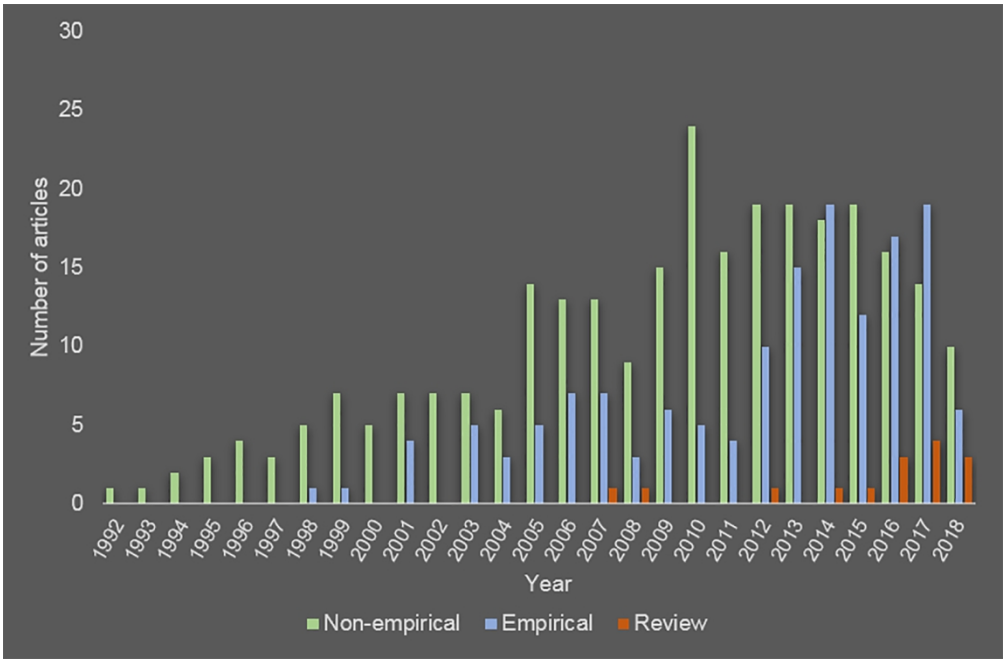

Figure 3. Trends over time in the types of articles published on complexity science applied to healthcare. Note data collected mid-2018

142x93mm (300 x 300 DPI)

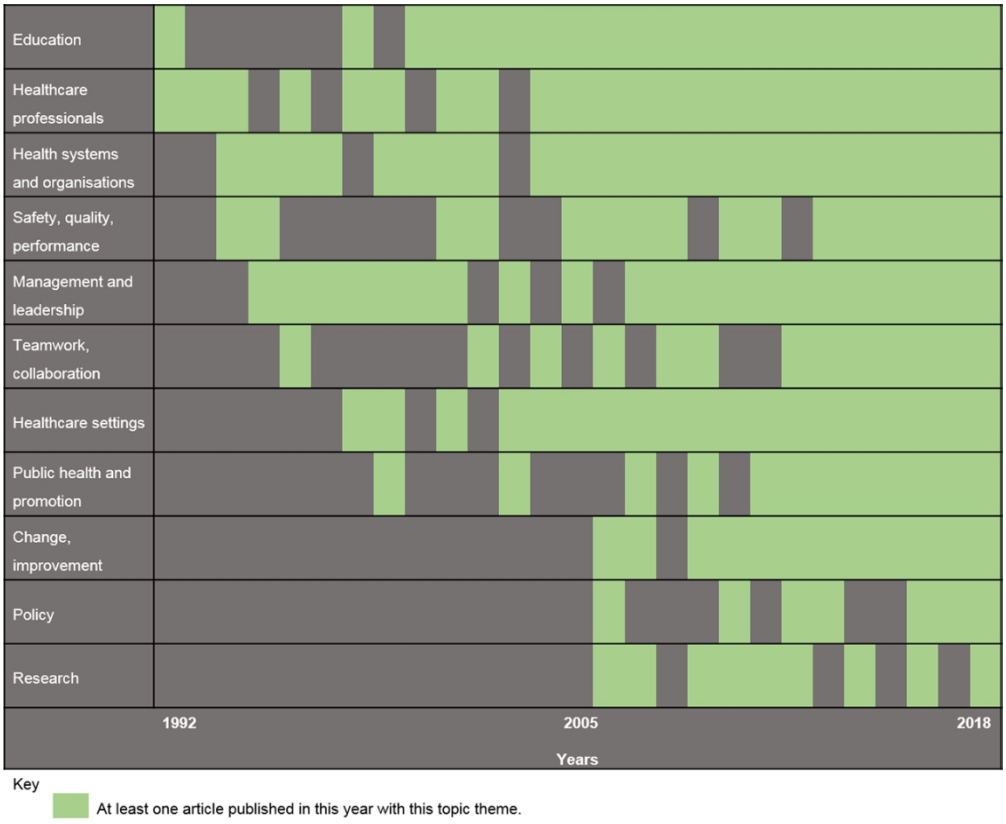

Figure 4. Trend over time in the publications of complexity science applied to healthcare by topic theme.

107x90mm (300 x 300 DPI)

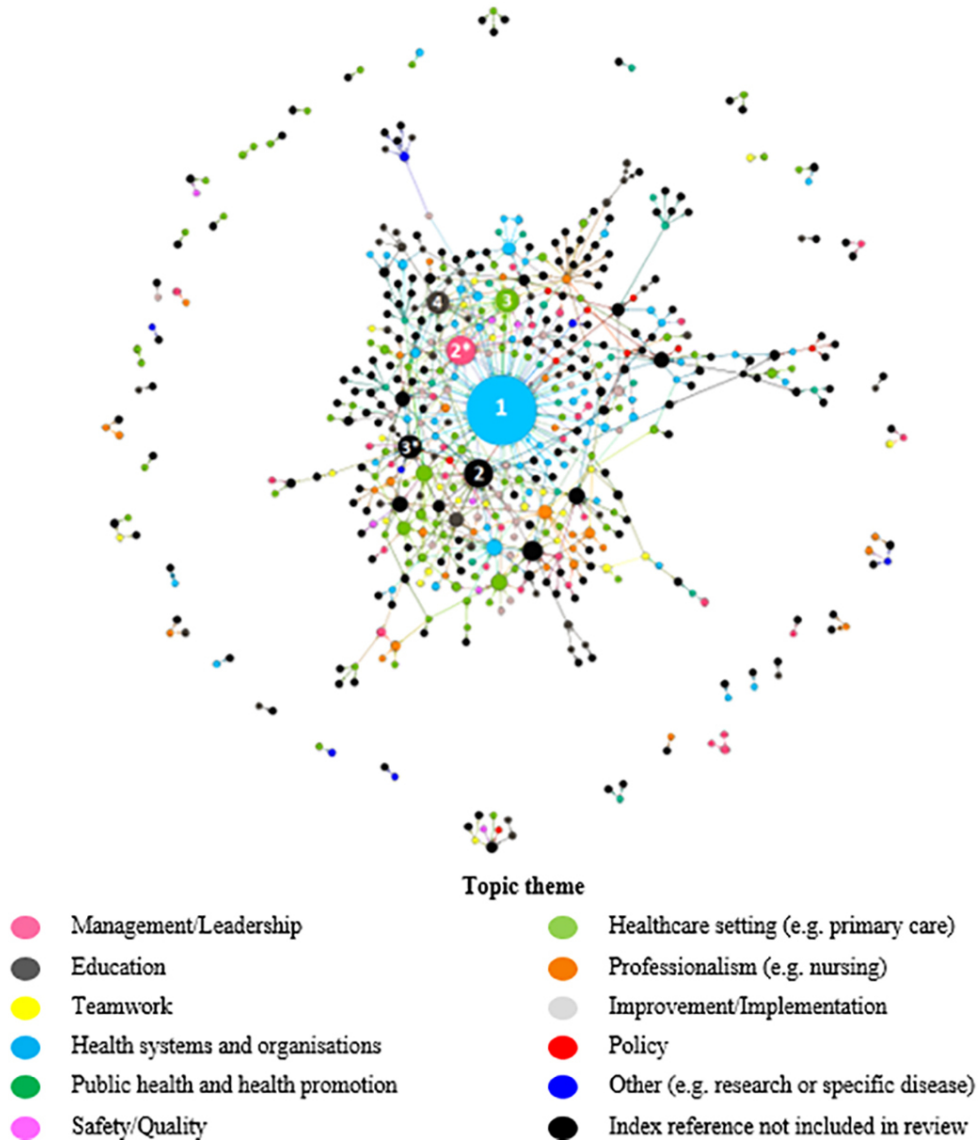

Figure 5. Sociogram of index references for complexity science applied to healthcare.
Each circle (node) is representative of a research output. The size of node is indicative of in-degree (larger nodes indicate a higher number of references towards the output as an index). Colour of node is indicative of the topic theme. * indicates equal levels of in-degree for corresponding rank.

90x103mm (300 x 300 DPI)

Appendix 1.

Database: Web of Science All Databases

Includes Web of Science Core Collection, BIOSIS Citation Index, Current Contents Connect, Inspec®, KCI-Korean Journal Database, MEDLINE®, Russian Science Citation Index, SciELO Citation Index, Zoological Record

1864-Present

Search using TS=topic search (Title, Abstract, Author Keywords, Keywords Plus®)

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1. TS=(healthcare OR "health care" OR "health-care" OR hospital OR "health facilit*" OR "acute care" OR "health organi*" OR "health system" OR "primary care" OR "general practice" OR "aged care" OR "nurs* home" OR medic* OR clinic* OR nurs* OR health)
2. TS=("Complexity theory" OR "complexity science" OR "complex adaptive system" OR "complexity thinking" OR "complex responsive process theory" OR "chaos theory")
3. 1 and 2

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Appendix 2.

Source	Average citations per year	Country of corresponding author	Journal	Empirical	Healthcare context
Abbott, P. A., J. Foster, H. d. F. Marin and P. C. Dykes (2014)	10.75	USA	International journal of medical informatics	Empirical	IT implementation
Afek, A., A. Meilik and Z. Rotstein (2009)	0.22	Israel	Harefuah	Non-empirical	Management
Agyepong, I. A., A. Kodua, S. Adjei and T. Adam (2012)	8.83	Ghana	Health policy and planning	Empirical	Health system - policy
Aherne, M. and J. Pereira (2005)	1.17	Canada	Leadership in health services	Non-empirical	Health care policy - palliative care
Aita, V., H. McIlvain, E. Backer, K. McVea and B. Crabtree (2005)	5.92	USA	Patient education and counseling	Empirical	Primary care - patient-practitioner communication
Albanese, M., G. Mejicano, G. Xakellis and P. Kokotailo (2009)	2.11	USA	Academic medicine	Non-empirical	Health care systems
Allred, C. A., B. J. Burns and S. D. Phillips (2005)	1.69	USA	Administration and policy in mental health and mental health services research	Non-empirical	Community mental health care - assertive community treatment
Anderson, C. A. and A. L. Whall (2011)	0.71	USA	Journal of advanced nursing	Non-empirical	Nursing - research - agent based modelling
Anderson, R. A. and R. R. McDaniel (1999)	5.68	USA	Health care management review	Empirical	Nursing home - nursing - decision making
Anderson, R. A. and R. R. McDaniel Jr (2000)	18.33	USA	Health care management review	Non-empirical	Leadership and professionalism
Anderson, R. A., B. E. Crabtree, D. J. Steele and R. R. McDaniel (2005)	25.08	USA	Qualitative health research	Non-empirical	Health care organisations
Anderson, R. A., C. A. Allred and F. A. Sloan (2003)	1.47	USA	Health care management review	Empirical	Hospital - management practice changes in light of ownership conversion
Anderson, R. A., D. E. Bailey, B. Wu, K. Corazzini, E. S. McConnell, N. M. Thygeson and S. L. Docherty (2015)	5.67	USA	Advances in nursing science	Non-empirical	Leadership – chronic illness
Anderson, R. A., K. Corazzini, K. Porter, K. Daily, R. R. McDaniel and C. Colon-Emeric (2012)	7.33	USA	Implementation science	Non-empirical	Nursing homes

Anderson, R. A., K. N. Corazzini and R. R. McDaniel Jr (2004)	15.93	USA	The gerontologist	Empirical	Nursing homes - job satisfaction
Anderson, R. A., L. M. Issel and R. R. McDaniel (2003)	29.40	USA	Nursing research	Empirical	Nursing home
Anthony, M. K., J. Kloos, P. Beam and K. Vidal (2018)	0	USA	Journal of nursing care	Non-empirical	Hospital - nursing hand-off
Arndt, M. and B. Bigelow (2000)	4.11	USA	Health care management review	Non-empirical	Management
Arruda, C., S. G. R. Lopes, M. H. A. d. L. Koerich, D. R. Winck, B. H. S. Meirelles and A. L. S. F. d. Mello (2015)	2.00	Brazil	Escola anna nery	Non-empirical	Health care networks
Ashmos, D. P., J. W. Huonker and R. R. McDaniel (1998)	5.15	USA	Health care management review	Empirical	Hospital – leadership
Atun, R. A., I. Kyratsis, G. Jelic, D. Rados-Malicbegovic and I. Gurol-Urganci (2007)	7.73	United Kingdom	Health policy and planning	Empirical	Primary care – reform
Augustinsson, S. and P. Petersson (2015)	1.67	Sweden	Journal of research in nursing	Empirical	Hospital - nursing - discharge planning
Baghbanian, A. and G. Torkfar (2012)	1.33	Australia	Australian health review	Non-empirical	Health system - economics and policy
Bailey, D. E., S. L. Docherty, J. A. Adams, D. L. Carthron, K. Corazzini, J. R. Day, E. Neglia, M. Thygeson and R. A. Anderson (2012)	5.00	USA	Journal of healthcare leadership	Non-empirical	Leadership
Barasa, E. W., S. Molyneux, M. English and S. Cleary (2017)	12.00	Kenya	Social science & medicine	Empirical	Hospitals - priority setting
Baskin, K., J. Goldstein and C. Lindberg (2000)	0.89	USA	Physician executive	Non-empirical	Mergers
Beautement, P. and C. Broenner (2012)	0.29	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Health care practice
Bebber, R. and A. Liberman (2008)	0.20	USA	International journal of public policy	Non-empirical	Hospital – bioterrorism
Bedin, D. M., H. B. Kochenborger Scarparo, H. A. Martinez and I. B. Matos (2014)	0	Brazil	Saude e sociedade	Non-empirical	Management
Begun, J. W. and A. A. Kaissi (2005)	3.15	USA	Journal of healthcare management	Empirical	Healthcare planning - leadership/management

Bell, I. R., M. Koithan and D. Pincus (2012)	6.67	USA	Forschende komplementarmedizin	Non-empirical	Complementary medicine
Bennett, C. (2003)	0.13	Canada	Healthcare papers	Non-empirical	Health care system – hospital
Best, A., T. Greenhalgh, S. Lewis, J. E. Saul, S. Carroll and J. Bitz (2012)	40.67	Canada	The milbank quarterly	Review	Health care system – transformation
Betancourt Betancourt, J. A. and R. M. Ramis Andalia (2010)	1.50	Cuba	Revista cubana de salud pública	Non-empirical	Health and healthcare generally
Betancourt Bethencourt, J. A., F. Martínez Álvarez, M. Álvarez Escoda and E. Nicolau Pestano (2016)	0	Cuba	Humanidades médicas	Non-empirical	Education
Betancourt Bethencourt, J. A., R. M. Ramis Andalia and M. Mirabal Nápoles (2014)	2.25	Cuba	Revista cubana de salud pública	Non-empirical	Primary care – translation
Bircher, J. and E. G. Hahn (2017)	3.00	Switzerland	Cureus	Non-empirical	Health and healthcare generally
Bleakley, A. (2006)	25.60	United Kingdom	Medical education	Non-empirical	Education
Bleakley, A. (2006)a	4.33	United Kingdom	Journal of medicine and philosophy	Non-empirical	Hospital - operating theatre, teamwork
Bleakley, A. (2010)	9.38	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Education
Bloom, L. A. and B. S. Bloom (1999)	0.316	USA	International journal of technology assessment in health care	Non-empirical	Decision making
Bogren, M. U., M. Berg, L. Edgren, E. van Teijlingen and H. Wigert (2016)	1.50	Sweden	Sexual and reproductive healthcare	Empirical	Professionalism – midwifery
Boustani, M. A., A. Frame, S. Munger, P. Healey, J. Westlund, M. Farlow, A. Hake, M. G. Austrom, P. Shepard, C. Bubp, J. Azar, A. Nazir, N. Adams, N. L. Campbell, A. Chehresa and P. Dexter (2012)	1.33	USA	Clinical interventions in aging	Empirical	Professional network - dementia care – improvement
Boustani, M. A., G. A. Sachs, C. A. Alder, S. Munger, C. C. Schubert, M. Guerriero Austrom, A. M. Hake, F. W. Unverzagt, M. Farlow, B. R. Matthews, A. J. Perkins, R. A. Beck and C. M. Callahan (2011)	14.50	USA	Aging & mental health	Empirical	Primary care - dementia care

Boustani, M. A., S. Munger, R. Gulati, M. Vogel, R. A. Beck and C. M. Callahan (2010)	5.63	USA	Clinical interventions in aging	Non-empirical	Implementation and system change
Boustani, M., C. Schubert and Y. Sennour (2007)	3.55	USA	Clinical interventions in aging	Non-empirical	Primary health care - dementia
Braa, J., O. Hanseth, A. Heywood, W. Mohammed and V. Shaw (2007)	35.64	Norway	Mis quarterly	Non-empirical	Information systems implementation in developing countries
Bradley, E. H., L. A. Curry, L. A. Taylor, S. W. Pallas, K. Talbert-Slagle, C. Yuan, A. Fox, D. Minhas, D. K. Ciccone, D. Berg and R. Perez-Escamilla (2012)	5.17	USA	Bmj open	Empirical	Community/ family health -LMIC
Brainard, J. and P. R. Hunter (2016)	7.50	United Kingdom	Implementation science	Review	Research -diverse
Brand, S. L., L. E. Fleming and K. M. Wyatt (2015)	0.33	United Kingdom	The scientific world journal	Non-empirical	Health care organisations - workplace wellbeing
Brannon, S. D., P. Kemper and T. Barry (2009)	1.00	USA	Health care management review	Empirical	Management - health organisations
Brennan, C. (2016)	0	USA	Plastic surgical nursing	Non-empirical	Leadership
Breton, J. J. (1999)	0.37	Canada	Canadian journal of psychiatry	Non-empirical	Mental health - health promotion
Bro, F. and J. Kragstrup (2003)	0.20	Denmark	Scandinavian journal of primary health care	Non-empirical	Primary health care
Brooks, E. and R. Geyer (2012)	1.00	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Health system policy - drug advertising to consumers
Brown, C. A. (2006)	4.50	United Kingdom	Disability and rehabilitation	Non-empirical	Rehabilitation - professionalism
Brown, C. A. and C. Richardson (2006)	3.67	United Kingdom	European journal of pain	Empirical	MDT – pain
Browne, A. J., C. Varcoe, M. Ford-Gilboe, C. N. Wathen and E. R. Team (2015)	5.33	Canada	International journal for equity in health	Non-empirical	Primary care – equity
Bujak, J. S. (1999)	0.63	USA	Physician executive	Non-empirical	Leadership - culture - medicine
Bujak, J. S. (2003)	2.47	USA	Frontiers of health service management	Non-empirical	Leadership

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Bullas, S. and J. Bryant (2007)	0.82	United Kingdom	Studies in health information technology and informatics	Non-empirical	IT implementation
Bungay, V. and J. Stevenson (2013)	0.40	Canada	Policy, politics, & nursing practice	Empirical	Nurse leaders - reform
Burke, J. P. and S. L. Pestotnik (1999)	0.74	USA	Current opinion in infectious diseases	Non-empirical	Resistance
Burman, C. J., M. Aphane and P. Delobelle (2015)	3.33	South Africa	African journal of aids research	Non-empirical	Public health and health promotion - AIDS
Burman, C. J., M. Aphane, O. Mtapuri and P. Delobelle (2015)	2.33	South Africa	Sahara-j: journal of social aspects of hiv/aids	Non-empirical	Health promotion - HIV prevention
Burns, J. P. (2001)	4.18	USA	Journal of nursing administration	Non-empirical	Leadership
Butt, G., M. Markle-Reid and G. Browne (2008)	5.80	Canada	International journal of integrated care	Review	Integrated care - health and social service partnership
Buttigieg, S. C., V. Cassar and J. W. Scully (2013)	1.20	United Kingdom	Journal of health organization and management	Empirical	Hospital, leadership, integrated care
Caffrey, L., C. Wolfe and C. McKevitt (2016)	4.00	United Kingdom	Health research policy and systems	Empirical	Health system - implementation and working with research
Callahan, C. M., M. A. Boustani, M. Weiner, R. A. Beck, L. R. Livin, J. J. Kellams, D. R. Willis and H. C. Hendrie (2011)	9.13	USA	Aging & mental health	Non-empirical	Primary care - dementia
Canals L, M. and R. Solís (2005)	0.85	Chile	Revista médica de chile	Non-empirical	Medicine
Carlos, D. M., E. M. M. de Padua, L. M. P. da Silva, M. A. I. Silva, W. E. U. Marques, M. N. D. Leitao and M. D. C. Ferriani (2017)	1.00	Brazil	Journal of clinical nursing	Empirical	Primary health care - family violence
Carney, T. J. and C. M. Shea (2017)	4.00	USA	Computational and mathematical methods in medicine	Non-empirical	Public health - informatics
Chadwick, M. M. (2010)	3.88	USA	Aorn journal	Non-empirical	Leadership - nursing
Chaffee, M. W. and M. M. McNeill (2007)	8.64	USA	Nursing outlook	Non-empirical	Nursing
Chan, M. K., D. D. Meschino, D. Dath, J. Busari, J. D. Bohnen, L. M. Samson, A. Matlow and M. Sanchez-Mendiola (2016)	5.50	Canada	Leadership in health services	Non-empirical	Education - medical - leadership

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Chandler, J., J. Rycroft-Malone, C. Hawkes and J. Noyes (2016)	10.67	United Kingdom	Journal of advanced nursing	Empirical	Health system - improvement and implementation
Checkland, K., I. McDermott, A. Coleman, L. Warwick-Giles, D. Bramwell, P. Allen and S. Peckham (2018)	0	United Kingdom	Public money & management	Empirical	Primary care - oversight, planning, management
Chen, D. T., P. H. Werhane and A. E. Mills (2007)	1.73	USA	Critical care medicine	Non-empirical	Hospital - ICU/critical care medicine
Chinnis, A. and K. R. White (1999)	1.26	USA	Journal of emergency medicine	Non-empirical	Hospital - emergency department
Chou, S.-M. (2004)	0.07	China	Hu li za zhi the journal of nursing	Non-empirical	Nursing
Christian, C. S. and N. Crisp (2012)	1.00	South Africa	Development southern africa	Empirical	Public health
Chughtai, S. and K. Blanchet (2017)	5.00	Pakistan	Health policy and planning	Review	Public health
Ciemins, E. L., J. Brant, D. Kersten, E. Mullette and D. Dickerson (2016)	2.50	USA	Journal of palliative medicine	Empirical	Palliative care - interdisciplinary team work
Clancy, T. R. (2014)	1.00	USA	Journal of nursing administration	Non-empirical	Nursing - workflow
Clancy, T. R., C. White Delaney, B. Morrison and J. K. Gunn (2006)	3.50	USA	Journal of nursing administration	Non-empirical	Nursing - documentation
Clarke, J. R. (2005)	1.62	USA	Journal of the american college of surgeons	Non-empirical	Hospital - surgery - patient safety
Cloninger, C. R. (2013)	3.40	USA	International journal of person centred medicine	Non-empirical	Health promotion - chronic disease - person-centred care
Cockings, J. G., D. A. Cook and R. K. Iqbal (2006)	2.42	United Kingdom	Critical care	Empirical	Hospital - quality and surveillance
Colon-Emeric, C. S., D. Lekan-Rutledge, Q. Utley-Smith, N. Ammarell, D. Bailey, M. L. Piven, K. Corazzini and R. A. Anderson (2006)	3.25	USA	Health care management review	Empirical	Nursing homes
Colon-Emeric, C. S., K. Corazzini, E. S. McConnell, W. Pan, M. Toles, R. Hall, M. P. Cary, M. Batchelor-Murphy, T. Yap, A. L. Anderson, A. Burd, S. Amarasekara and R. A. Anderson (2017)	2.00	USA	Jama internal medicine	Empirical	Nursing homes

Colon-Emeric, C. S., N. Ammarell, C. Bailey, C. Kirsten, D. Lekan-Rutledge, M. Piven and R. Anderson (2005)	0.08	USA	Journal of the american geriatrics society	Unable to classify	Nursing
Colon-Emeric, C. S., N. Ammarell, D. Bailey, K. Corazzini, D. Lekan-Rutledge, M. L. Piven, Q. Utley-Smith and R. A. Anderson (2006)	6.58	USA	Qualitative health research	Empirical	Nursing home - communication between medicine-nursing
Cooper, A. and B. Wren (2012)	1.33	United Kingdom	Psychoanalytic psychotherapy	Non-empirical	Mental health
Cooper, H. and E. Spencer-Dawe (2006)	7.75	United Kingdom	Journal of integrated care	Empirical	Education - interprofessional
Cooper, H. and R. Geyer (2008)	3.30	United Kingdom	Social science & medicine	Non-empirical	Education
Cooper, H. and R. Geyer (2009)	2.33	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Chronic disease management – diabetes
Cooper, H., E. Spencer-Dawe and E. McLean (2005)	10.15	United Kingdom	Journal of interprofessional care	Empirical	Education - medicine, nursing, physiotherapy, OT undergraduates
Copelli, F. H. d. S., R. J. T. d. Oliveira, C. M. S. d. Oliveira, B. H. S. Meirelles, A. L. S. F. d. Mello and A. L. P. Magalhães (2016)	1.50	Brazil	Aquichan	Review	Nursing - leadership
Copnell, B. (1998)	1.00	Australia	Journal of advanced nursing	Non-empirical	Nursing - nursing knowledge
Coppa, D. F. (1993)	1.84	USA	Journal of advanced nursing	Non-empirical	Nursing
Cornforth, A. (2013)	1.60	United Kingdom	British journal of nursing	Non-empirical	Primary care - self-management – COPD
Crabtree, B. F. (2003)	3.13	USA	Health care management review	Non-empirical	Primary care
Crabtree, B. F., P. A. Nutting, W. L. Miller, R. R. McDaniel, K. C. Stange, C. R. Jaen and E. Stewart (2011)	17.57	USA	Medical care	Non-empirical	Primary care - change/improvement
Crabtree, B. F., W. L. Miller and K. C. Stange (2001)	9.53	USA	Journal of family practice	Empirical	Primary care
Cruz, R. A., E. L. Araujo, N. M. Nascimento, R. J. Lima, J. R. Franca and J. D. Oliveira (2017)	1.00	Brazil	Revista brasileira de enfermagem	Unable to classify	Nursing - education

Cucolo, D. F. and M. G. Perroca (2015)	3.67	Brazil	Acta paulista de enfermagem	Empirical	Nursing
Curtis, S. and M. Riva (2010)	8.63	United Kingdom	Progress in human geography	Non-empirical	Human geography and health systems
Curtis, S. and M. Riva (2010)a	4.63	United Kingdom	Progress in human geography	Non-empirical	Human geography and health systems and policy
Curtis, S., K. Oven, J. Wistow, C. Dunn and L. Dominelli (2018)	3.00	United Kingdom	Environment and planning c: politics and space	Empirical	Aged - health and social care
da Silva, A. L. and M. G. de Freitas (2010)	0.50	Brazil	Revista da escola de enfermagem da usp	Empirical	Education
D'Agata, A. L. and J. M. McGrath (2016)	2.50	USA	Advances in nursing science	Non-empirical	Hospital - neonatal ICU
Dattee, B. and J. Barlow (2010)	4.50	United Kingdom	Journal of health services research and policy	Empirical	Whole system change
Dattee, B. and J. Barlow (2017)	1.00	France	Organization science	Empirical	Healthcare system
Davis, B. and D. Sumara (2010)	9.25	Canada	Journal of evaluation in clinical practice	Non-empirical	Research - education
de Bock, B. A., D. L. Willems and H. C. Weinstein (2018)	1.00	The Netherlands	Journal of evaluation in clinical practice	Empirical	Hospital - ICU, decision making
De Simone, J. (2006)	2.33	Italy	Journal of evaluation in clinical practice	Non-empirical	Evidence-based medicine
De Vito, E. L. (2016)	0	Argentina	Medicina	Non-empirical	Medicine
de Zulueta, P. C. (2016)	9.50	United Kingdom	Journal of healthcare leadership	Non-empirical	Leadership - compassionate leadership
deMattos, P. C., D. M. Miller and E. H. Park (2012)	2.83	USA	Management decision	Non-empirical	Hospital - trauma- decision making
Deutsch, E. S., Y. Dong, L. P. Halamek, M. A. Rosen, J. M. Taekman and J. Rice (2016)	2.50	USA	Human factors	Non-empirical	Education
Doebbeling, B. N. and M. E. Flanagan (2011)	1.86	USA	Medical care	Non-empirical	Healthcare systems
Doll, W. E. and D. Trueit (2010)	5.88	USA	Journal of evaluation in clinical practice	Non-empirical	Healthcare professionals broadly
Donaldson, A., E. Lank and J. Maher (2005)	1.85	United Kingdom	Journal of change management	Non-empirical	Education and learning - communities of practice in cancer
Donini, L. M., R. D. Grave, A. Caretto, L. Lucchin, N. Melchionda, E. Nisoli, P. Sbraccia, A. Lenzi and M. Cuzzolaro (2014)	1.75	Italy	Eating and weight disorders	Non-empirical	Health condition and its management - obesity

Donnelly, F. and R. Wiechula (2012)	2.17	Australia	Nurse education today	Non-empirical	Education - nurse placement
Dreher, M. C., P. Clinton and A. Sperhac (2014)	2.50	USA	Journal of professional nursing	Non-empirical	Education
Dunn, K. S. and C. K. Riley-Doucet (2017)	0	USA	Nurse educator	Unable to classify	Nursing
Durie, R. and K. Wyatt (2007)	3.18	United Kingdom	Social science & medicine	Empirical	Health geography
Durie, R. and K. Wyatt (2013)	4.20	United Kingdom	Critical public health	Empirical	Community and public health
Dyck, L. R., A. Caron and D. Aron (2006)	1.58	USA	Journal of management development	Non-empirical	Change/improvement
Edgren, L. (2008)	10.10	Sweden	International journal of integrated care	Non-empirical	Integrated care
Edgren, L. and K. Barnard (2012)	8.33	Sweden	Leadership in health services	Non-empirical	Health and social care integration
Eika, M., B. Dale, G. A. Espnes and S. Hvalvik (2015)	3.67	Norway	Bmc health services research	Empirical	Nursing homes - nursing - care transitions
Ellis, B. (2010)	4.13	United Kingdom	Informatics in primary care	Empirical	Primary care
Ellis, B. and S. I. Herbert (2011)	6.43	United Kingdom	Informatics in primary care	Non-empirical	Primary care - clinical governance
Ellis, L. A., K. Churruca and J. Braithwaite (2017)	2.00	Australia	International journal of mental health systems	Non-empirical	Mental health services
Ellsbury, D. L. (2010)	0.88	USA	Clinics in perinatology	Non-empirical	Hospital - neonatal medicine
Erdek, M. A. and P. J. Pronovost (2004)	7.50	USA	International journal for quality in health care	Empirical	Hospital - pain assessment
Erdmann, A. L., K. C. d. Nascimento, G. Marcelino and J. A. Ribeiro (2005)	1.85	Brazil	Fascicles of escola anna nery revista de enfermagema	Empirical	Education - graduate nurses
Essen, A. and S. Lindblad (2013)	7.33	Sweden	Social science & medicine	Empirical	Rheumatology
Fajardo Ortiz, G. (2013)	0	Mexico	Ludus vitalis	Non-empirical	Medicine
Fajardo-Ortiz, G., M. A. Fernandez-Ortega, A. Ortiz-Montalvo and R. A. Olivares-Santos (2015)	0.67	Mexico	Cirugía y cirujanos (english edition)	Non-empirical	Health systems
Farmer, E. A., J. D. Beard, W. D. Dauphinee, T. LaDuca and K. V. Mann (2002)	2.19	Australia	Medical education	Non-empirical	Medical performance assessment

Favaretti, C. (2013)	0.40	Italy	Recenti progressi in medicina	Non-empirical	Health care organisations generally
Fennell, M. L. and C. M. Adams (2011)	2.43	USA	Annual review of sociology	Non-empirical	Health care organisations generally
Fenwick, T. (2012)	6.83	United Kingdom	Journal of education and work	Non-empirical	Education - learning for collaboration
Fenwick, T. and M. A. Dahlgren (2015)	16.33	United Kingdom	Medical education	Non-empirical	Education
Fernandez, A., J. Sturmberg, S. Lukersmith, R. Madden, G. Torkfar, R. Colagiuri and L. Salvador-Carulla (2015)	10.67	Australia	Health research policy and systems	Non-empirical	Evidence-based medicine movement history
Florczak, K., M. Poradzisz and S. Hampson (2012)	1.00	USA	Nursing science quarterly	Non-empirical	Nursing profession
Fontanesi, J., A. Martinez, T. O. Boyo and R. Gish (2015)	0.33	USA	The journal of medical practice management: mpm	Empirical	Quality improvement
Forbes-Thompson, S., T. Leiker and M. R. Bleich (2007)	4.91	USA	Health care management review	Empirical	Nursing homes
Ford, R. (2009)	5.56	USA	Health services management research	Empirical	Leadership
Frame, A., M. LaMantia, B. B. Reddy Bynagari, P. Dexter and M. Boustani (2013)	2.20	USA	Egems	Empirical	Primary care - EHR – improvement
Fraser, S. W. and T. Greenhalgh (2001)	50.59	United Kingdom	Bmj open	Non-empirical	Education
Frasso, R., A. Golinkoff, H. Klusaritz, K. Kellom, H. Kollar-McArthur, M. Miller-Day, R. Gabbay and P. F. Cronholm (2017)	1.00	USA	Applied nursing research	Empirical	Primary care - nurse-led practices
Freddi, G. and J. L. Roman-Pumar (2011)	2.00	Italy	Annali dell istituto superiore di sanita	Non-empirical	Evidence-based medicine
Freed, D. H. (1995)	0	USA	Hospital material management quarterly	Non-empirical	Health care generally - quality
Friel, S., L. Hattersley and R. Townsend (2015)	9.33	Australia	Annual review of public health	Non-empirical	Public health - trade
Frye, A. W. and P. A. Hemmer (2012)	28.00	USA	Medical teacher	Non-empirical	Education

Gardam, M., L. Gitterman, L. Rykert and E. Vicencio (2017)	0	Canada	Healthcare papers	Non-empirical	Health care delivery - safety
Gary, J. C. (2014)	1.25	USA	Dimensions of critical care nursing	Empirical	Improving patient-centred care - nursing - ICU
Gatrell, A. C. (2005)	13.54	United Kingdom	Social science & medicine	Non-empirical	Health geography
Gear, C., J. Koziol-McLain, D. Wilson and F. Clark (2016)	1.00	New Zealand	Bmc family practice	Empirical	Primary care - family violence
Geary, C. R. and K. L. Schumacher (2012)	7.17	USA	Advances in nursing science	Non-empirical	Care transitions
Ghazzawi, A., C. Kuziemsky and T. O'Sullivan (2016)	3.50	Canada	Bmc health services research	Empirical	Stroke - rehabilitation - carers
Glenn, L. A., J. Stocker-Schnieder, R. McCune, M. McClelland and D. King (2014)	2.00	USA	Journal of advanced nursing	Empirical	Hospital - nursing maternity care during labour
Glynn, L. G. and R. Scully (2010)	1.00	United Kingdom	International journal of clinical practice	Non-empirical	Healthcare generally
Goldberger, A. L. (1996)	39.59	USA	The lancet	Non-empirical	Medical practice
Goldman, E., M. Plack, C. Roche, J. Smith and C. Turley (2009)	5.11	USA	Journal of workplace learning	Empirical	Hospital - emergency department/ learning
Gonnering, R. S. (2010)	1.00	USA	Journal of surgical education	Non-empirical	Education - surgical
Gonzalez, M. G., K. N. Kelly, A. M. Dozier, F. Fleming, J. R. T. Monson, A. Z. Becerra, C. T. Aquina, C. P. Probst, B. J. Hensley, N. Sevdalis and K. Noyes (2017)	1.00	USA	Qualitative health research	Empirical	Hospital - surgical care – transitions
Gordon, L., C. Rees, J. Ker and J. Cleland (2017)	1.00	United Kingdom	Advances in health sciences education	Empirical	Leadership
Gormley, G. J. and T. Fenwick (2016)	3.00	United Kingdom	Perspectives on medical education	Empirical	Education - medical
Grady, C. M. (2016)	4.00	Canada	Leadership in health services	Empirical	Leadership - medical
Green, C. A., S. E. Estroff, B. J. H. Yarborough, M. Spofford, M. R. Solloway, R. S. Kitson and N. A. Perrin (2014)	5.75	USA	Schizophrenia bulletin	Non-empirical	Mental health care
Greene, R. A., E. Dasso, S. Ho and A. M. Genaidy (2014)	2.25	USA	Population health management	Non-empirical	Health care systems - person-centred care

Greenhalgh, T., P. Plsek, T. Wilson, S. Fraser and T. Holt (2010)	5.88	United Kingdom	Journal of health services research and policy	Non-empirical	Research
Griffiths, F. and D. Byrne (1998)	4.20	United Kingdom	British journal of general practice	Non-empirical	Primary care
Griffiths, F. and G. North American Primary Care Research (2007)	1.45	United Kingdom	Annals of family medicine	Non-empirical	Primary care
Grudniewicz, A., T. Tenbensel, J. M. Evans, C. Steele Gray, G. R. Baker and W. P. Wodchis (2018)	0	Canada	Social science & medicine	Empirical	Health policy - integrated care
Haffeld, J. (2012)	2.67	Norway	Global public health: an international journal for research, policy and practice	Non-empirical	Global health system
Haffeld, J. (2013)	1.40	USA	Reproductive health matters	Non-empirical	Health systems - governance
Haffeld, J. and H. Siem (2013)	1.00	Norway	Current pharmogenomics and personalized medicine	Unable to classify	Policy and governance international
Hafferty, F. W. and B. Castellani (2010)	13.50	USA	Academic medicine	Non-empirical	Medical professionalism
Hafferty, F. W. and D. Levinson (2008)	9.50	USA	Perspectives in biology and medicine	Non-empirical	Medicine - professionalism
Haigh, C. (2002)	3.81	United Kingdom	Journal of advanced nursing	Non-empirical	Nursing
Haigh, C. A. (2008)	0.80	United Kingdom	Journal of nursing management	Empirical	Nursing - management
Hall, P., L. Weaver and P. A. Grassau (2013)	4.40	Canada	Journal of interprofessional care	Non-empirical	Integrated care - education
Hamilton, A. B., M. M. Farmer, T. Moin, E. P. Finley, A. J. Lang, S. M. Oishi, A. K. Huynh, J. Zuchowski, S. G. Haskell and B. Bean-Mayberry (2017)	1.00	USA	Implementation science	Non-empirical	Primary care - women's health
Hammerly, M. (2002)	0.44	USA	American journal of medical quality	Non-empirical	Collaborative medicine
Hanseth, O., E. Jacucci, M. Grisot and M. Aanestad (2006)	21.75	Norway	Mis quarterly	Empirical	Hospital – HER
Hast, A. S., A. M. DiGioia, D. Thompson and G. Wolf (2013)	3.00	USA	Journal of nursing administration	Unable to classify	Organisational change

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Henriksen, E. and U. Rosenqvist (2003)	2.33	Sweden	Health & social care in the community	Empirical	Aged care
Hill, P. S. (2011)	11.13	Australia	Global public health: an international journal for research, policy and practice	Non-empirical	Governance - health care systems
Hilts, L., M. Howard, D. Price, C. Risdon, G. Agarwal and A. Childs (2013)	3.40	Canada	Family practice	Empirical	Primary care
Ho, S. and L. G. Sandy (2014)	1.75	USA	Journal of general internal medicine	Non-empirical	Health care system - economics and funding
Hoben, M., P. G. Norton, L. R. Ginsburg, R. A. Anderson, G. G. Cummings, H. J. Lanham, J. E. Squires, D. Taylor, A. S. Wagg and C. A. Estabrooks (2017)	5.00	Canada	Trials	Non-empirical	Nursing home - quality and improvement
Hodges, H. F. (2011)	7.43	USA	Journal of nursing education	Empirical	Education - nursing
Hoffman, E. (2000)	1.22	USA	Academic medicine	Non-empirical	Women's health - educating about
Holden, L. M. (2005)	14.46	USA	Journal of advanced nursing	Non-empirical	Nursing
Holder, R. and C. Ramagem (2012)	2.17	USA	World hospitals and health services: the official journal of the international hospital federation	Non-empirical	Leadership
Holmboe, E. S. (2018)	3.00	USA	Academic medicine	Non-empirical	Education - medicine
Homa, L., J. Rose, P. S. Hovmand, S. T. Cherng, R. L. Riolo, A. Kraus, A. Biswas, K. Burgess, H. Aungst, K. C. Stange, K. Brown, M. Brooks-Terry, E. Dec, B. Jackson, J. Gilliam, G. E. Kikano, A. Reichsman, D. Schaadt, J. Hilfer, C. Ticknor, C. V. Tyler, A. Van der Meulen, H. Ways, R. F. Weinberger and C. Williams (2015)	5.00	USA	Annals of family medicine	Empirical	Primary care
Hopkinson, S. G. and D. L. Wiegand (2017)	0	USA	Journal of clinical nursing	Empirical	Nursing practice
Horvat, A. and J. Filipovic (2018)	5.00	Serbia	Journal of evaluation in clinical practice	Empirical	Leadership
Hunt, S. R., K. Corazzini and R. A. Anderson (2014)	4.50	USA	Journal of applied gerontology	Empirical	Nursing homes - management - care quality

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Hutchison, D. (1994)	0.54	USA	Quality progress	Non-empirical	Quality management - health care organisation
Innes, A. D., P.D. Campion and F.E. Griffiths (2005)	8.15	United Kingdom	British journal of general practice	Non-empirical	Clinical consultation
Irimu, G. W., A. Greene, D. Gathara, H. Kihara, C. Maina, D. Mbori-Ngacha, D. Zurovac, M. Santau, J. Todd and M. English (2014)	1.50	Kenya	Bmc health services research	Empirical	Implementation of CPGs
Issel, L. M. and R. A. Anderson (2001)	0.88	USA	Research in nursing and health	Empirical	Community case managers - nursing - decision making
James, K. M. (2010)	3.38	USA	Creative nursing	Non-empirical	Education - nursing
Jana, M., L. Letsela, E. Scheepers and R. Weiner (2015)	1.00	South Africa	Journal of health communication	Non-empirical	Public health - health promotion/communication
Jolley, G. (2014)	9.00	Australia	Evaluation and program planning	Non-empirical	Health promotion - community care
Joly, B. M., M. Booth, P. Mittal and G. Shaler (2012)	3.17	USA	Evaluation & the health professions	Non-empirical	Quality improvement
Jorm, C. and C. Roberts (2018)	3.00	Australia	Academic medicine	Non-empirical	Education - evaluation
Jorm, C., G. Nisbet, C. Roberts, C. Gordon, S. Gentilcore and T. F. Chen (2016)	4.50	Australia	Bmc medical education	Empirical	Education - interprofessional learning
Joshi, R., D. Joshi and P. Cheriyath (2017)	5.00	USA	Patient preference and adherence	Empirical	Diabetes management - technology app
Juarez, F. (2010)	0	Colombia	International journal of psychological research	Empirical	Health system - economic
Kaehne, A. (2016)	3.00	United Kingdom	Journal of integrated care	Non-empirical	Programme evaluation (integration programmes)
Kapp, J. M., E. J. Simoes, A. DeBiasi and S. J. Kravet (2017)	4.00	USA	Systems research and behavioural science	Non-empirical	Population health - improvement
Karam, E., M. C. Levesque, G. Jacquemin, A. Delure, I. Robidoux, M. T. Laramee, A. Odobescu, P. G. Harris and A. M. Danino (2014)	1.50	Canada	Annals of burns and fire disasters	Empirical	Multidisciplinary teams
Karemere, H. and J. Macq (2014)	0.50	Democratic Republic of Congo	Global health promotion	Empirical	Hospital

Karemere, H., J. B. Kahindo, N. Ribesse and J. Macq (2013)	0.40	Democratic Republic of Congo	Medecine et sante tropicales	Non-empirical	Hospital - governance
Karemere, H., N. Ribesse, B. Marchal and J. Macq (2015)	1.00	Democratic Republic of Congo	Conflict and health	Empirical	Hospital
Karemere, H., N. Ribesse, J.-B. Kahindo and J. Macq (2015)	1.00	Democratic Republic of Congo	The pan african medical journal	Empirical	Hospital
Katerndahl, D., R. Wood and C. R. Jaen (2017)	0	USA	Journal of evaluation in clinical practice	Empirical	Ambulatory care
Kernick, D. (2006)	7.75	United Kingdom	Family practice	Non-empirical	Health service generally
Kernick, D. and A. Mitchell (2010)	1.56	United Kingdom	Journal of interprofessional care	Non-empirical	Co-production - patient-centredness
Khan, B. A., S. Lasiter and M. A. Boustani (2015)	0	USA	The american journal of nursing	Non-empirical	Hospital - ICU
Khan, S., A. Vandermorris, J. Shepherd, J. W. Begun, H. J. Lanham, M. Uhl-Bien and W. Berta (2018)	0	Canada	Bmc health services research	Non-empirical	Healthcare generally
Khan, Y., S. Sanford, D. Sider, K. Moore, G. Garber, E. de Villa and B. Schwartz (2017)	0	Canada	Bmc health services research	Empirical	Hospital and public health - emergency departments during "emerging incidents"
Khayal, I. S. and A. M. Farid (2018)	2.00	USA	Complexity	Non-empirical	Health care systems - chronic care
Killingsworth, B., H. E. Newkirk and E. Seeman (2006)	2.08	USA	Health care management review	Non-empirical	Hospital - strategic information systems
Kingsley, P. and E. M. Taylor (2017)	9.00	United Kingdom	Parasitology	Non-empirical	Health care systems - integration
Koerich, M. S., D. S. Backes, K. C. d. Nascimento and A. L. Erdmann (2007)	3.82	Brazil	Acta paulista de enfermagem	Empirical	Hospital - nursing assistant
Koerner, J. (2009)	1.11	USA	Creative nursing	Non-empirical	Nursing - decision making
Koerner, J. G. (1996)	0.36	USA	Nursing administration quarterly	Non-empirical	Nursing

Kottke, T. E., J. A. Huebsch, P. McGinnis, J. M. Nichols, E. D. Parker, J. O. Tillema and M. V. Maciosek (2016)	2.00	USA	The permanente journal	Empirical	Primary care - collaboration
Kramer, M., B. B. Brewer, D. Halfer, P. Maguire, S. Beausoleil, K. Claman, M. Macphee and J. B. Duchscher (2013)	4.40	USA	Journal of nursing management	Empirical	Nursing
Kuipers, P., D. Harvey, M. Lindeman and K. Stothers (2014)	1.25	AUstralia	Rural and remote health	Non-empirical	Workforce - rural - education and training
Kuziemsky, C. (2016)	6.33	Canada	Healthcare management forum	Non-empirical	Decision making
Kuziemsky, C. E., E. M. Borycki and A. W. Kushniruk (2016)	0.50	Canada	Nursing informatics	Non-empirical	Health information technology
Lachman, P., A. Jayadev and M. Rahi (2014)	3.50	United Kingdom	Early human development	Non-empirical	Hospital - NICU
Laliberte, M., D. E Feldman, B. Williams-Jones and M. Hunt (2018)	0	Canada	Physiotherapy theory and practice	Empirical	Physiotherapy - prioritising care
Lalley, C. (2014)	1.75	USA	Nursing administration quarterly	Empirical	Nursing - leadership - workarounds
Lamarche, P. and L. Maillet (2016)	1.00	Canada	Journal of health organization and management	Non-empirical	Primary care
Landis-Lewis, Z., R. Manjomo, O. J. Gadabu, M. Kam, B. N. Simwaka, S. L. Zickmund, F. Chimbwandira, G. P. Douglas and R. S. Jacobson (2015)	3.67	USA	International journal of medical informatics	Empirical	Health system - Malawi EMR implementation
Lanham, H. J., L. K. Leykum, B. S. Taylor, C. J. McCannon, C. Lindberg and R. T. Lester (2013)	15.6	USA	Social science & medicine	Non-empirical	Health care systems
Larkin, D. J., R. C. Swanson, S. Fuller and D. A. Cortese (2016)	7.00	USA	Journal of evaluation in clinical practice	Non-empirical	Health system - US and affordable care act
Laudenslager, M. L. (2014)	3.25	USA	Brain, behavior, and immunity	Non-empirical	Caregivers
Laurenson, M., T. Heath and S. Gribbin (2012)	0.60	United Kingdom	Journal of healthcare leadership	Empirical	Education - leadership

Learmonth, A. M., E. J. Henderson and D. J. Hunter (2017)	0	United Kingdom	Journal of public health	Empirical	Public health
Lefroy, J. and S. Yardley (2015)	3.00	United Kingdom	Medical education	Non-empirical	Education
Lemak, C. H. and E. Goodrick (2003)	1.67	USA	Health care management review	Empirical	Primary care - dental, medical, social for low income populations
Lessard, C. (2007)	6.09	Canada	Social science & medicine	Non-empirical	Research - economic evaluation
Lett, M. (2001)	0.53	Australia	Australian journal of advanced nursing	Non-empirical	Nursing practice
Leykum, L. K., H. J. Lanham, J. A. Pugh, M. Parchman, R. A. Anderson, B. F. Crabtree, P. A. Nutting, W. L. Miller, K. C. Stange and R. R. McDaniel (2014)	8.00	USA	Implementation science	Empirical	Improvement
Leykum, L. K., J. A. Pugh, H. J. Lanham, J. Harmon and R. R. McDaniel (2009)	9.11	USA	Implementation science	Non-empirical	Implementation - evidence-based practice
Leykum, L. K., J. Pugh, V. Lawrence, M. Parchman, P. H. Noel, J. Cornell and R. R. McDaniel (2007)	6.82	USA	Implementation science	Review	Diabetes care
Lindberg, C. and M. Schneider (2013)	2.60	USA	Leadership	Empirical	Leadership
Lindberg, C., A. Herzog, M. Merry and J. Goldstein (1998)	0.25	USA	Physician executive	Non-empirical	Leadership
Litaker, D., A. Tomolo, V. Liberatore, K. C. Stange and D. Aron (2006)	11.83	USA	Journal of general internal medicine	Non-empirical	Primary care - quality improvement
Liu, Y. (2008)	2.20	USA	Journal of nursing management	Non-empirical	Nursing - communication - decision making - cross culture
Liu, Z. C., D. Rexachs, F. Epelde and E. Luque (2017)	3.00	Spain	Journal of computational science	Empirical	Hospital - emergency department
Longo, F. (2007)	4.27	Italy	Health care management review	Non-empirical	Leadership - change management
Lorthios-Guilledroit, A., L. Richard and J. Filiatrault (2018)	1.00	Canada	Evaluation and program planning	Review	Health promotion - community care
Luria, J. W., S. E. Muething, P. J. Schoettker and U. R. Kotagal (2006)	6.08	USA	Pediatric clinics of north america	Non-empirical	Safety - paediatrics

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MacLean, S., L. Berends and J. Mugavin (2013)	0.67	Australia	Australian journal of primary health	Empirical	Primary care - drug and alcohol - improvement
Mahajan, A., S. D. Islam, M. J. Schwartz and M. Cannesson (2017)	0	USA	Anesthia & analgesia	Non-empirical	Hospital - perioperative services - process improvement
Marchal, B., S. Belle, V. De Brouwere and S. Witter (2013)	3.40	Belgium	Bmc health services research	Non-empirical	Health care policy
Mark, A. and M. Jones (2013)	1.00	United Kingdom	The international journal of health planning management	Non-empirical	Health care systems - instability/disturbance
Markham, F. W. (1998)	0.50	USA	Theoretical medicine and bioethics	Non-empirical	Education - medical
Marks, E. (2013)	3.80	USA	Jama internal medicine	Non-empirical	Hospital - readmission rates
Marsland, S. and L. Buchan (2004)	0.93	United Kingdom	Medinfo	Non-empirical	Health informatics
Martin, C. and J. Sturmberg (2009)	6.89	Canada	Journal of evaluation in clinical practice	Non-empirical	Primary care - chronic care (health promotion, prevention, self-management, disease control. Treatment).
Martin, C. M. and J. P. Sturmberg (2005)	5.92	Canada	Medical journal of australia	Non-empirical	Primary care
Mash, B. J., P. Mayers, H. Conradie, A. Orayn, M. Kuiper and J. Marais (2008)	2.80	South Africa	Education for health	Empirical	Primary care
Matheson, A., K. Dew and J. Cumming (2009)	3.11	New Zealand	Health promotion journal of australia	Empirical	Community health - health inequality
Matlow, A. G., J. G. Wright, B. Zimmerman, K. Thomson and M. Valente (2006)	5.00	Canada	Quality and safety in health care	Non-empirical	Coordination of care, paediatrics
Matthews, J. I. and P. T. Thomas (2007)	2.18	United Kingdom	International journal of health care quality assurance	Empirical	Learning
McAllister, C., L. K. Leykum, H. Lanham, H. S. Reisinger, J. L. Kohn, R. Palmer, C. Pezzia, M. Agar, M. Parchman, J. Pugh and R. R. McDaniel (2014)	3.50	USA	Journal of hospital medicine	Empirical	Hospital - teams relationship with patient outcomes
McConnell, E. S., D. Lekan-Rutledge, B. Nevidjon and R. Anderson (2004)	2.07	USA	Journal of nursing education	Non-empirical	Education - aged care
McDaniel, R. R. (1997)	9.38	USA	Health care management review	Non-empirical	Leadership/management

McDaniel, R. R., Jr. (1999)	0.11	USA	Frontiers of health service management	Unable to classify	Leadership/management
McDaniel, R. R., M. E. Jordan and B. F. Fleeman (2003)	10.80	USA	Health care management review	Non-empirical	Learning
McHattie, L.-S., G. Cumming and T. French (2014)	3.00	United Kingdom	Medicine 2.0	Non-empirical	Person-centred care
McKenzie, A., E. Sokpo and A. Ager (2014)	1.00	South Africa	Journal of public health in africa	Empirical	Public health
McKeon, L. M., J. D. Oswaks and P. D. Cunningham (2006)	5.75	USA	Critical nurse specialist	Non-empirical	Hospital – teams
McKimm, J. and A. Till (2015).	2.33	United Kingdom	British journal of hospital medicine	Non-empirical	Clinical leadership
McKinney, S. H., K. Corazzini, R. A. Anderson, R. Sloane and N. G. Castle (2016)	1.50	USA	Health care management review	Empirical	Nursing home - leadership – nursing
McMurtry, A. (2010)	5.33	Canada	Journal of interprofessional care	Empirical	Educational
McMurtry, A., S. Rohse and K. N. Kilgour (2016)	9.50	Canada	Medical education	Non-empirical	Education - interprofessional learning
Mennin, S. (2010)	17.25	USA	Medical education	Non-empirical	Education - learning - medicine
Mennin, S. (2010)a	3.63	USA	Journal of evaluation in clinical practice	Non-empirical	Education
Merry, A. F. (2011)	0.57	New Zealand	The journal of extracorporeal technology	Non-empirical	Safety - decision making
Miles, A. (2009)	4.22	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Medicine and healthcare
Miller, W. L., B. F. Crabtree, P. A. Nutting, K. C. Stange and C. R. Jaen (2010)	18.13	USA	Annals of family medicine	Non-empirical	Primary care
Miller, W. L., B. F. Crabtree, R. McDaniel and K. C. Stange (1998)	14.35	USA	Journal of family practice	Non-empirical	Primary care
Miller, W. L., R. R. McDaniel, B. F. Crabtree and K. C. Stange (2001)	14.82	USA	Journal of family practice	Empirical	Primary care
Minas, H. (2005)	3.54	Australia	Australian psychiatry	Non-empirical	Leadership- for change in mental health

Mitchell, D. (2014)	0.50	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Patient perspectives
Mitchell, G. J., N. Cross, M. Wilson, S. Biernacki, W. N. Wong, B. Adib and D. Rush (2013)	2.00	Canada	Nursing research and practice	Non-empirical	Chronic illness management - nursing health coach
Mitleton-Kelly, E. (2011)	7.86	United Kingdom	The learning organization	Empirical	Health system sustainability
Mohr, J. J., P. Batalden and P. Barach (2004)	10.36	USA	Quality and safety in health care	Non-empirical	Health care organisations generally
Monrouxe, L. V., C. E. Rees and W. Hu (2011)	18.43	United Kingdom	Medical education	Empirical	Education – medicine
Moretti-Pires, R. O. (2009)	10.89	Brazil	Interface - comunicação, saúde, educação	Empirical	Primary care
Morton, A. and J. Cornwell (2009)	3.33	United Kingdom	Bmj	Non-empirical	Hospital - process improvement
Mowles, C., A. van der Gaag and J. Fox (2010)	4.00	United Kingdom	Journal of health organization and management	Non-empirical	Health care systems - change
Mulready-Shick, J. and K. Flanagan (2014)	5.00	USA	Nursing education perspective	Empirical	Education
Munday, D. F., S. A. Johnson and F. E. Griffiths (2003)	1.67	United Kingdom	Palliative medicine	Non-empirical	Palliative care
Murai, M., K. Kitamura and M. D. Fetters (2005)	2.46	USA	Bmc medical education	Empirical	Primary care – education
Murray, P. J. (1992)	0.12	United Kingdom	Intensive and critical care nursing	Non-empirical	Nursing - critical care - education
Nardi, R., G. Scanelli, S. Corrao, I. Iori, G. Mathieu and R. C. Amatrian (2007)	10.00	Italy	European journal of internal medicine	Non-empirical	Internal medicine
Nardi, R., T. Fabbri, G. Belmonte, P. Leandri, M. Mazzetti, A. Pasquale, M. Reta, C. Rizzi, G. Scanelli, I. Iori, G. Gussoni, C. Pedace, G. Mathieu and A. Mazzone (2009)	1.20	Italy	Italian journal of medicine	Unable to classify	Internal medicine - evidence based medicine
Nieuwenhuijze, M., S. Downe, H. Gottfreosdottir, M. Rijnders, A. du Preez and P. V. Rebelo (2015)	1.33	The Netherlands	Midwifery	Review	Hospital – midwifery

Noel, P. H., H. J. Lanham, R. F. Palmer, L. K. Leykum and M. L. Parchman (2013)	11.00	USA	Health care management review	Empirical	Primary care - chronic care-teamwork – learning
Noll, D. C. (1996).	0	USA	Medical group management journal	Non-empirical	Management/leadership
Noll, D. C. (1997)	0.19	USA	Medical group management journal	Non-empirical	Healthcare systems generally
Norman, C. D. (2009)	7.67	Canada	Journal of evaluation in clinical practice	Non-empirical	Health promotion
Norman, C. D. (2013)	1.60	Canada	Journal of evaluation in clinical practice	Non-empirical	Education
Norman, C. D., J. Charnaw-Burger, A. L. Yip, S. Saad and C. Lombardo (2010)	2.88	Canada	Journal of evaluation in clinical practice	Non-empirical	Learning - networks, knowledge generation
Norman, G. (2011)	3.71	Canada	Medical education	Non-empirical	Medicine – education
Notarnicola, I., C. Petrucci, M. R. De Jesus Barbosa, F. Giorgi, A. Stievano, G. Rocco and L. Lancia (2017)	2.00	Italy	International journal of nursing practice	Review	Nursing
Olive, P. (2017)	1.00	United Kingdom	Journal of clinical nursing	Empirical	Hospital - ED following intimate partner violence
Olive, P. (2017)a	0.50	United Kingdom	Journal of clinical nursing	Empirical	Hospital - emergency department - intimate partner violence
Orlowski, S., S. Lawn, M. Ben, A. Venning, G. Jones, M. Winsall, G. Antezana, N. Bidargaddi and P. Musiat (2017)	0.50	Australia	International journal of mental health nursing	Empirical	Mental health services
Orr, M., M. Orr and S. Sankaran (2007)	2.00	New Zealand	Emergence-complexity & organization	Empirical	IT system implementation
O'Sullivan, T. L., C. E. Kuziemsky, D. Toal-Sullivan and W. Cornell (2013)	22.60	Canada	Social science & medicine	Empirical	Public health - health promotion in disaster
Otten, R. and T. Chen (2011)	1.29	USA	Creative nursing	Non-empirical	Leadership - nursing - working relationships
Oyeleye, O., P. Hanson, N. O'Connor and D. Dunn (2013)	16.80	USA	Journal of nursing administration	Empirical	Nursing - workplace bullying
Paley, J. (2007)	8.45	United Kingdom	Nursing inquiry	Non-empirical	Nursing - cardiac rehabilitation

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Paley, J. (2010)	7.13	United Kingdom	Journal of health services research and policy	Non-empirical	Healthcare research discipline
Paley, J. and G. Eva (2011)	7.71	United Kingdom	International journal of nursing studies	Non-empirical	Research - academic conceptualisation of healthcare
Papadopoulos, M. C., M. Hadjitheodossiou, C. Chrysostomou, C. Hardwidge and B. A. Bell (2001)	1.65	United Kingdom	Journal of the royal society of medicine	Empirical	Health care system whole - wait lists for surgery
Parchman, M. L., J. A. Pugh, S. D. Culler, P. H. Noel, N. H. Arar, R. L. Romero and R. F. Palmer (2008)	2.50	USA	Implementation science	Non-empirical	Primary care – diabetes
Patel, A. M., T. M. Sundt 3rd and P. Varkey (2008)	0.70	USA	Minnesota medicine	Non-empirical	Medical practice
Patel, V. L., J. Zhang, N. A. Yoskowitz, R. Green and O. R. Sayan (2008)	12.70	USA	Journal of biomedical informatics	Non-empirical	Hospital – decision making - ICU
Patterson, M. and E. S. Deutsch (2015)	5.00	USA	Current problems in pediatric and adolescent health care	Non-empirical	Safety
Pauly, B., M. MacDonald, T. Hancock, W. Martin and K. Perkin (2013)	3.40	Canada	Bmc public health	Non-empirical	Public health services
Peirce, J. C. (2000)	0.06	USA	Health care management review	Non-empirical	Health care organisations
Pelletier, D., S. Gervais, H. Hafeez-Ur-Rehman, D. Sanou and J. Tumwine (2018)	0	USA	International journal of health planning and management	Empirical	Policy
Penney, L. S., L. K. Leykum, P. Noel, E. P. Finley, H. J. Lanham and J. Pugh (2018)	0	USA	Bmj open	Non-empirical	Hospital - readmission rates
Penprase, B. and D. Norris (2005)	2.92	USA	Nursing leadership forum	Non-empirical	Leadership
Perez, B. and A. Liberman (2011)	0.14	USA	The health care manager	Non-empirical	Decision making
Pitkaaho, T., P. Partanen, M. Miettinen and K. Vehvilainen-Julkunen (2015)	4.25	Finland	Journal of advanced nursing	Empirical	Hospital
Piven, M. L., N. Ammarell, D. Bailey, K. Corazzini, C. S. Colon-Emeric, D. Lekan-Rutledge, Q. Utley-Smith and R. A. Anderson (2006)	2.92	USA	Western journal of nursing research	Empirical	Nursing home
Plsek, P. E. and T. Greenhalgh (2001)	110.06	USA	Bmj	Non-empirical	Healthcare – general

Plsek, P. E. and T. Wilson (2001)	41.41	USA	Bmj	Non-empirical	Leadership
Pradebon, V. M., A. L. Erdmann, J. L. Leite, S. B. S. de Lima and A. G. Prochnow (2011)	0.71	Brazil	Acta paulista de enfermagem	Empirical	Hospital - paediatric ICU
Priesmeyer, H. R. and L. F. Sharp (1995)	0.61	USA	Quality management in health care	Non-empirical	Leadership - management administration
Priesmeyer, H. R., L. F. Sharp, L. Wammack and J. D. Mabrey (1996)	0.64	USA	Quality management in health care	Non-empirical	Clinical pathways and care continuity
Provost, S. M., H. J. Lanham, L. K. Leykum, R. R. McDaniel and J. Pugh (2015)	14.00	USA	Health care management review	Empirical	Collaboration and teamwork – safety
Puga, F., K. R. Stevens and D. I. Patel (2013)	1.20	USA	Nursing research and practice	Empirical	Hospital - collaborative, transdisciplinary research network
Pype, P., D. Krystallidou, M. Deveugele, F. Mertens, S. Rubinelli and I. Devisch (2017)	2.00	Belgium	Patient education and counseling	Empirical	Collaboration and teamwork
Quinn, G. R., E. Le, K. Soni, G. Berger, Y. E. Mak and R. Pierce (2014)	1.75	USA	The joint commission journal on quality and patient safety	Empirical	Hospital - emergency department
Ramaswamy, R., J. Reed, N. Livesley, V. Boguslavsky, E. G. Ellorio, S. Sax, D. Houleymata, L. Kimble and G. Parry (2018)	0	USA	International journal for quality in health care	Non-empirical	Quality improvement
Rangachari, P. (2008)	1.20	USA	Quality management in health care	Empirical	Hospital - quality indicators
Rantz, M. J., M. K. Flesner and M. Zwygart-Stauffacher (2010)	1.75	USA	Journal of nursing care quality	Non-empirical	Nursing home - quality indicators
Rantz, M. J., M. Zwygart-Stauffacher, M. Flesner, L. Hicks, D. Mehr, T. Russell and D. Minner (2013)	4.40	USA	Journal of the american medical directors association	Empirical	Nursing home
Redfern, S. and S. Christian (2003)	8.67	United Kingdom	Journal of evaluation in clinical practice	Empirical	Community and inpatient
Reid, J., K. Stone, L. Huang and E. S. Deutsch (2016)	1.00	USA	Clinical pediatric emergency medicine	Non-empirical	Hospital - safety - paediatric medicine
Restau, J. and P. Green (2014)	0	USA	Critical care nursing clinics of north america	Non-empirical	Hospital - ICU - palliative care
Reynolds, M., E. Sarriot, R. C. Swanson and E. Rusoja (2018)	1.00	United Kingdom	Journal of evaluation in clinical practice	Non-empirical	Health care generally

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Rhodes, M. G. (2013)	1.40	The Netherlands	International journal of health policy management	Non-empirical	Health systems
Rhydderch, M., G. Elwyn, M. Marshall and R. Grol (2004)	6.57	United Kingdom	Quality and safety in health care	Non-empirical	Primary care – indicators
Ribesse, N., P. Bossyns, B. Marchal, H. Karemere, C. J. Burman and J. Macq (2017)	1.67	Belgium	Global health promotion	Non-empirical	Health systems reform
Rice, W. P. (1996)	0.09	USA	Journal of clinical engineering	Unable to classify	Health care generally
Rickles, D., P. Hawe and A. Shiell (2007)	19.55	Canada	Journal of epidemiology and community health	Non-empirical	Health care generally
Righi, A. W., P. Wachs and T. A. Saurin (2012)	1.50	Brazil	Work	Empirical	Emergency medicine - ambulance
Rogers, H., L. Maher and P. E. Plsek (2008)	1.50	United Kingdom	Bmj	Non-empirical	Health care system
Rojas-Mendizabal, V., A. Serrano-Santoyo, R. Conte-Galvan, S. Villarreal-Reyes and R. Rivera-Rodriguez (2017)	0	Mexico	Ingeniería e investigación	Non-empirical	Technology e-health – implementation
Rojas-Mendizabal, V., A. Serrano-Santoyo, R. Conte-Galvan, S. Villarreal-Reyes and R. Rivera-Rodriguez (2017)a	0	Mexico	Ingeniería e investigación	Non-empirical	E-Health – technology
Royeen, C. B. and A. J. Luebben (2002)	0.56	USA	Occupational therapy in health care	Non-empirical	Allied health - occupational therapy
Rusoja, E., D. Haynie, J. Sievers, N. Mustafee, F. Nelson, M. Reynolds, E. Sarriot, R. C. Swanson and B. Williams (2018)	1.00	USA	Journal of evaluation in clinical practice	Review	Research - complexity science in healthcare
Santos, F. A. P. S. d., B. C. Enders, V. E. P. Santos, D. N. A. Dantas and L. S. M. V. d. Miranda (2016)	0	Brazil	Escola anna nery	Non-empirical	Health system - obstetric care
Sargeant, J. (2009)	16.56	Canada	Journal of continuing education in the health professions	Non-empirical	Education - interprofessional education
Sarriot, E. and M. Kouletio (2015)	6.33	USA	Systemic practice and action research	Non-empirical	Health system - sustainability

Schneider, H., R. English, H. Tabana, T. Padayachee and M. Orgill (2014)	3.50	South Africa	Bmc health services research	Empirical	Health system - primary care - implementation
Schoo, A. and K. Kumar (2018)	0	Australia	The clinical teacher	Non-empirical	Education
Schulz, V. M., A. M. Crombeen, D. Marshall, J. Shadd, K. A. LaDonna and L. Lingard (2017)	1.00	Canada	Journal of pain and symptom management	Empirical	Heart failure
Scott, K. and A. Steinbinder (2009)	0.22	USA	Nursing administration quarterly	Unable to classify	Change and improvement
Scott, K. and J. Van Norman (2009)	1.11	USA	Nursing administration quarterly	Unable to classify	EHR implementation
Sharp, L. F. and H. R. Priesmeyer (1995)	1.43	USA	Quality management in health care	Non-empirical	Health care organisations - generally
Shen, W., L. Jiang, M. Zhang, Y. Ma, G. Jiang and X. He (2014)	0.75	China	Chinese medical journal	Non-empirical	Research - mass casualty incidents
Shirey, M. R., P. R. Ebright and A. M. McDaniel (2013)	7.60	USA	Journal of nursing management	Empirical	Leadership - nursing - decision making
Silva, I. R., A. M. T. Gomes, G. V. Valadares, N. L. P. dos Santos, T. P. da Silva and J. L. Leite (2015)	1.33	Brazil	Revista gaucha de enfermagem	Empirical	Nursing - knowledge of aids/std
Silva, Í. R., J. L. Leite, M. A. Trevizan, I. A. C. Mendes, T. P. d. Silva and S. M. d. S. B. Lins (2017)	0	Brazil	Escola anna nery	Empirical	Education - nursing
Silva, O., E. D. Alves and M. C. S. Rodrigues (2014)	0.50	Brazil	Cultura de los cuidados	Empirical	Nursing - education
Simmons, M. (2003)	0.80	United Kingdom	Journal of hospital infection	Non-empirical	Management of communicable diseases
Simpson, K. M., K. Porter, E. S. McConnell, C. Colón-Emeric, K. A. Daily, A. Stalzer and R. A. Anderson (2013)	6.80	USA	Implementation science	Non-empirical	Implementation/improvement
Sims, T. (2014)	0	USA	Creative nursing	Unable to classify	Pregnancy
Singh, R., J. Hickner, J. Mold and G. Singh (2014)	1.75	USA	Journal of patient safety	Empirical	Primary health care - testing processes
Singh, R., T. Servoss, M. Kalsman, C. Fox and G. Singh (2004)	3.64	USA	Informatics in primary care	Empirical	Primary care

Smit, E. H. and J. J. L. Derksen (2015)	0.33	The Netherlands	Nonlinear dynamics, psychology, and life sciences	Non-empirical	Primary care - psychologists
Smit, E. H. D. and J. J. L. J. Derksen (2017)	0	The Netherlands	Europe's journal of psychology	Empirical	Primary care - psychology
Smith, C. S., C. Francovich, M. Morris, W. Hill, F. Langlois-Winkle, R. Rupper, C. Roth, S. Wheeler and A. Vo (2010)	1.13	USA	Advances in health sciences education	Non-empirical	Education
Smith, H., C. Kuziemsky and C. Champion (2018)	0	Canada	Canadian journal of surgery	Non-empirical	Hospital - surgery - physician extender
Smits, S. J., J. A. Falconer, R. Morland and D. C. Strasser (1997)	0.24	USA	Topics in stroke rehabilitation	Non-empirical	Rehabilitation - stroke
Snoeren, M. M. W. C., B. M. Janssen, T. J. H. Niessen and T. A. Abma (2016)	6.50	The Netherlands	Health care analysis	Empirical	Nursing home - patient centredness - culture change
Soliman, M. and T. A. Saurin (2017)	4.00	Brazil	Journal of manufacturing systems	Review	Lean management
Soubhi, H., E. A. Bayliss, M. Fortin, C. Hudon, M. van den Akker, R. Thivierge, N. Posel and D. Fleiszer (2010)	11.75	Canada	Annals of family medicine	Non-empirical	Primary care
Squires, A., S. J. Uyei, H. Beltran-Sanchez and S. A. Jones (2016)	2.00	USA	Human resources for health	Empirical	Health care workforce - health systems
Ssengooba, F., B. McPake and N. Palmer (2012)	15.50	Uganda	Social science & medicine	Empirical	Performance targets - health systems
Stange, K. C. (2009)	7.78	USA	Annals of family medicine	Non-empirical	Primary care - reform
Stange, K. C. (2011)	1.86	USA	American journal of preventive medicine	Non-empirical	Preventive health
Sterns, S., S. C. Miller and S. Allen (2010)	6.50	USA	Journal of the american medical directors association	Empirical	Nursing home - culture change
Strand, R., G. Rortveit and E. Schei (2004)	1.43	Norway	Complexus	Non-empirical	Medical practice
Stroebel, C. K., R. R. McDaniel Jr, B. F. Crabtree, W. L. Miller, P. A. Nutting and K. C. Stange (2005)	15.69	USA	The joint commission journal on quality and patient safety	Non-empirical	Primary care - quality improvement
Sturmberg, J. P. (2007)	3.27	Australia	Australian family physician	Non-empirical	Clinical generally
Sturmberg, J. P. (2007)	1.09	Australia	Australian family physician	Non-empirical	Primary care - research

Sturmberg, J. P. and P. Cilliers (2009)	3.89	Australia	Journal of evaluation in clinical practice	Non-empirical	Health care systems and practice generally
Sturmberg, J. P., C. M. Martin and D. A. Katerndahl (2014)	20.25	Australia	Annals of family medicine	Review	Primary care
Sweeney, K. G. and R. Mannion (2002)	1.63	United Kingdom	British journal of general practice	Non-empirical	Clinical governance
Tait, G. L. R., J. Bates, K. A. LaDonna, V. N. Schulz, P. H. Strachan, A. McDougall and L. Lingard (2015)	5.33	Canada	Journal of multidisciplinary healthcare	Empirical	Heart failure
Tan, J., H. J. Wen and N. Awad (2005). "Health care and services delivery systems as complex adaptive systems." Communications of the Acm 48(5): 36-44	11.23	USA	Communications of the acm	Non-empirical	Health care generally - service delivery system
Tang, W. X., L. Wei and L. Zhang (2017)	0	China	International journal of integrated care	Empirical	Health system - health care reform for integrated care
Taylor, E., A. J. Card and M. Piatkowski (2018)	0	USA	Health environments research & design journal	Review	Hospital - patient room
Therrien, M. C., J. M. Normandin and J. L. Denis (2017)	0	Canada	Journal of health organization and management	Non-empirical	Hospital and wider health system
this ref is actually the Sturmberg, O'Halloran, Martin (2012) reference above they missed an author when referencing - line 532). Still missed in our library but please consolidate	11.00	Canada	International journal of integrated care	Empirical	Integrated care
Thomas, M. B. and S. Houston (2005)	0.85	USA	Clinical nurse specialist	Non-empirical	Patient safety
Thompson, D. S., J. Abourbih, L. Carter, G. Adams-Carpino, S. Berry, L. E. Graves and N. J. Ranger (2018)	0	Canada	Journal of interprofessional care	Empirical	Education - interprofessionalism
Thompson, D. S., X. Fazio, E. Kustra, L. Patrick and D. Stanley (2016)	14.00	Canada	Bmc health services research	Review	Research - complexity science in healthcare
Townsend, G. C., M. Kim and D. Sankey (2012)	2.17	Australia	European journal of dental education	Non-empirical	Education - dentistry - problem-based learning
Trenholm, S. and E. Ferlie (2013)	5.00	United Kingdom	Social science & medicine	Empirical	Health system - response to disease

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Valencia A, M. (2011)	2.14	Colombia	Revista facultad nacional de salud pública	Non-empirical	Public health
Valeras, A., Gunn, W., and A. Valeras (2013)	0.40	USA	International journal of psychiatry in medicine	Non-empirical	Education
Vallis, M. (2015)	4.33	Canada	Canadian journal of diabetes	Non-empirical	Diabetes management
Van Beurden, E. K., A. M. Kia, A. Zask, U. Dietrich and L. Rose (2013)	7.71	Australia	Health promotion international	Non-empirical	Health promotion
van de Wetering, R. and R. Batenburg (2014)	5.50	The Netherlands	Journal of digital imaging	Empirical	Hospital - IT
van der Vlegel-Brouwer, W. (2013)	2.20	The Netherlands	International journal of integrated care	Non-empirical	Integrated care - policy-practice gap
van Rossum, T. R., F. Scheele, A. Scherpbier, H. E. Sluiter and I. C. Heyligers (2016)	1.50	The Netherlands	Bmc medical education	Non-empirical	Education - medicine
van Wietmarschen, H. A., H. M. Wortelboer and J. van der Greef (2018)	4.00	The Netherlands	Journal of evaluation in clinical practice	Non-empirical	Health care generally
Varghese, J., V. R. Kutty, L. Paina and T. Adam (2014)	4.75	India	Health research policy and systems	Empirical	Public health - vaccination coverage
Velde, B. P., A. G. Greer, D. C. Lynch and S. Escott-Stump (2002)	0.69	USA	Journal of allied health	Non-empirical	Education
Velez Lapao, L. (2007)	3.09	Portugal	Methods of information in medicine	Empirical	Information/IT systems
Vicenzi, A. E. (1994)	1.08	USA	Nursing science quarterly	Non-empirical	Nursing
Vieira, M., P. Klock, R. Costa and A. L. Erdmann (2009)	0.33	Colombia	Aquichan	Non-empirical	Nursing profession
Vogt, E. M. (2002)	0.94	USA	Drug safety	Non-empirical	Medication safety
Vosman, F. and A. Niemeijer (2017)	4.00	The Netherlands	Medicine, health care and philospophy	Non-empirical	Hospital - health care

Walls, M. E. and R. R. McDaniel, Jr. (1999)	0.53	USA	Seminars for nurse managers	Non-empirical	Mergers - leadership - organisational change, nurse management
Walton, M. (2016)	2.50	New Zealand	Evidence and policy	Non-empirical	Public health - governance/policy
Wang, L., X. Zhang, X. Liang and G. Bloom (2016)	2.00	China	Globalization and health	Empirical	Health care policy - global health system - antibiotic resistance
West, G. B. (2012)	8.00	United Kingdom	The lancet	Non-empirical	Medicine
West, G. B. (2012)a	8.00	USA	The lancet	Non-empirical	Medicine
Wilkinson, J., M. Goff, E. Rusoja, C. Hanson and R. C. Swanson (2017)	1.00	USA	Journal of evaluation in clinical practice	Review	Health systems, generally
Wilson, J. (2014)	1.75	United Kingdom	Monash bioethics review	Non-empirical	Translation - evidence into practice - bioethics
Wilson, N. J. and M. J. Hatlie (2001)	0.59	USA	Journal of healthcare quality	Non-empirical	Patient safety
Wilson, T., T. Holt and T. Greenhalgh (2001)	28.06	United Kingdom	Bmj	Non-empirical	Clinical - general
Wouters, E. F. M. and I. M. L. Vanderhoven (2009)	0.56	The Netherlands	Seminars in respiratory and critical care medicine	Non-empirical	Integrated care - chronic disease
Zarowsky, C., S. Haddad and V.-K. Nguyen (2013)	3.60	South Africa	Global health promotion	Non-empirical	Vulnerable groups in healthcare

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Zhao, J., H. Yang, H. Guo, Y. Li, Z. Zhang and S. Li (2010)	0	China	Shengwu yixue gongchengxue zazhi	Unable to classify	Hospital
Zimmerman, B. (1999)	3.21	Canada	Healthcare forum journal	Non-empirical	Uncertainty - leadership

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