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The global research landscape and future trends in healthcare Total Quality Management

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Abstract

Total Quality Management (TQM) is instrumental in augmenting the quality and efficacy of healthcare service delivery, but a comprehensive evaluation of present and evolving TQM research trends within healthcare research articles is notably absent. This study provides an insightful view into the prevailing international scenarios and upcoming research frontiers in healthcare TQM research field, utilizing bibliometric mapping through VOSviewer. Drawing data from 360 publications in the Web of Science core citation database, it delineates a steady growth in the field over the last 30 years. Research outputs span 51 countries and regions, with notable contributions from the United States, United Kingdom, Netherlands, and Italy. The top five research institutions and numerous authors predominantly hail from the United States. Key keywords in near years encompass healthcare safety, healthcare quality assurance, quality indicators, and the application of Six Sigma management principles. This exploration serves as a pivotal reference for understanding the global research landscape and future trends in healthcare TQM, particularly in guaranteeing quality and safety. Future scientific endeavors will build upon these focus areas, exploring and connecting research gaps in more specialized fields.

Keywords Total quality management, Healthcare management, Big data, Bibliometric study

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Text box 1. Contributions to the literature

- There is a gap in bibliometric studies on Total Quality Management (TQM) within the healthcare.
- The theme of TQM in healthcare has shifted since 2010, from traditional TQM keywords towards healthcare-related implementation keywords.
- The conceptual changes are insufficiently captured in current reviews and meta-analyses.
- Research and practices in Total Quality Management in healthcare should be fit the specificity and needs of the healthcare services. Implementation methods and approaches should not be copy-past of Total Quality Management within the traditional industries.

Introduction**Total Quality Management in healthcare and research focus**

Total Quality Management (TQM) is one of the most prominent developments in management for the *over* past two decades [1]. From the 1990s onwards, TQM saw widespread application in management practices in developed nations and regions [2, 3].

TQM is recognized as a perpetual process where a quality-focused management style is adopted [4], is an integrated process involving all systems and employees in a continuous effort to improve quality, reduce cost, and enhance service to the customer [5]. Every organization member is tasked with establishing and adhering to standards in their roles to not only meet but often surpass the anticipations of both internal and external customers, thereby facilitating enduring organizational prosperity [6]. While initially formulated for industrial and manufacturing entities, numerous researches suggests that TQM's application has broadened to encompass sectors serving societal and population needs, notably, including healthcare service and education industries [7–10].

TQM in healthcare management is a comprehensively-structured and measurable approach to organizational management that seeks to offer a high-quality healthcare service, which is the aim of the quality management programs in all hospitals [1, 11]. TQM involves the application of qualitative and quantitative methods to improve the effectiveness, efficiency, and flexibility of all processes within a healthcare organization [12]. It emphasizes the importance of a patient-centric approach, where patient satisfaction is a primary focus [13]. TQM includes a culture of continuous improvement, where co-operation, communication, and employee involvement are crucial [14, 15]. By integrating TQM principles, healthcare services aim to enhance patient care, reduce medication errors, and ensure a high level of staff satisfaction and engagement [16, 17]. Ultimately, the goal of TQM in healthcare is to increase the quality of care, while also controlling costs, leading to overall organizational excellence in the healthcare sector.

An exhaustive exploration into the global research trajectory pertaining to TQM in healthcare service organizations is a gap and is necessary [13]. The primary objective of this research is using bibliometric methods to explore the development of academic publications on TQM in the healthcare services, a notably complex sector and delivery of service is the fragmented care [18]. The research questions focus on the following: What are the salient themes and hot topics in TQM in healthcare research field? What are the current situations, gaps and future directions in this research field?

Literature review on healthcare Total Quality Management bibliometric study

In 2017, Voon-Hsien Lee and Jun-Jie Hew published an article titled “Is TQM Fading Away? A Bibliometric Analysis of a Decade (2006–2015)” in the International Journal of Services, Economics and Management. They conducted a retrospective bibliometric analysis of TQM academic research from 2006 to 2015. Their findings indicated that, within the specified research timeframe, many journals, countries, and research institutions were still enhancing the state of TQM knowledge, and the citations of recently published TQM articles were increasing. They also encouraged researchers to integrate TQM with specific application disciplines for further study [7].

In 2018, Alzoubi MM, Hayati KS, and others published an article titled “Total quality management in the health-care context: integrating the literature and directing future research” in the journal “Risk Management and Healthcare Policy.” They conducted a systematic review of the literature, meticulously reviewing 25 articles focused on TQM in the health-care context, and concluded that there is “a dearth of studies” in this area [13].

In 2020, an article titled “A Bibliometric View on the Use of Total Quality Management in Services” was published in Total Quality Management & Business Excellence by Chen Zhang, M. R. Moreira, et al. They employed bibliometric methods to examine the landscape of TQM research in the service sector and posited that TQM is more widely applied in the healthcare service compared to other industries [19].

Existing bibliometric and review studies have primarily focused on the researches of TQM in the service and management, with research papers typically appearing in management journals. To date, there has not been a dedicated bibliometric analysis specifically addressing TQM research in the healthcare service, published in healthcare research journals. Consequently, this study represents an innovative contribution to the field.

Materials and methods

Data source

Web of Science (WoS) core collection was chosen as the foundational database for analysis. WoS is a platform owned by Clarivate Analytics [20], and is the largest and most comprehensive core journal citation index data service platform, covering a wide range of disciplines and studies [21, 22]. In this study, informed consent was not mandated for data collection, given the utilization of secondary data, devoid of any personal information.

Search strategy

A Boolean syntax search strategy was employed in the Web of Science core collection database using $TS=((TQM \text{ OR } Total\text{-}Quality\text{-}Management \text{ OR } TQC \text{ OR } Total\text{-}Quality\text{-}Control)AND (healthcare \text{ OR } hospital \text{ OR } medical \text{ OR } medicine))$, resulting in the retrieval of 360 articles, on the date of 9th of September, 2023.

Ten articles published in 2023 and two articles before the year 1990 were excluded, because the two articles published before 1991 were outliers (one from 1970 and one from 1974). This reduction resulted in a total of 348 articles being considered for further analysis. Of them we excluded 22 documents that did not fall into the categories of 'article', 'review article', 'proceeding paper', or 'early access'. Finally, 326 articles were considered for the bibliometric analysis of this study, according to PRISMA principle (Fig. 1). The details of the articles downloaded from the WoS database include title, author(s), year of publication, country or region, affiliation, journal, research orientations and keywords.

Statistical methods

Our research employed statistical methods, including descriptive and bibliometric analysis. Descriptive statistical methods were used for analyzing and summarizing

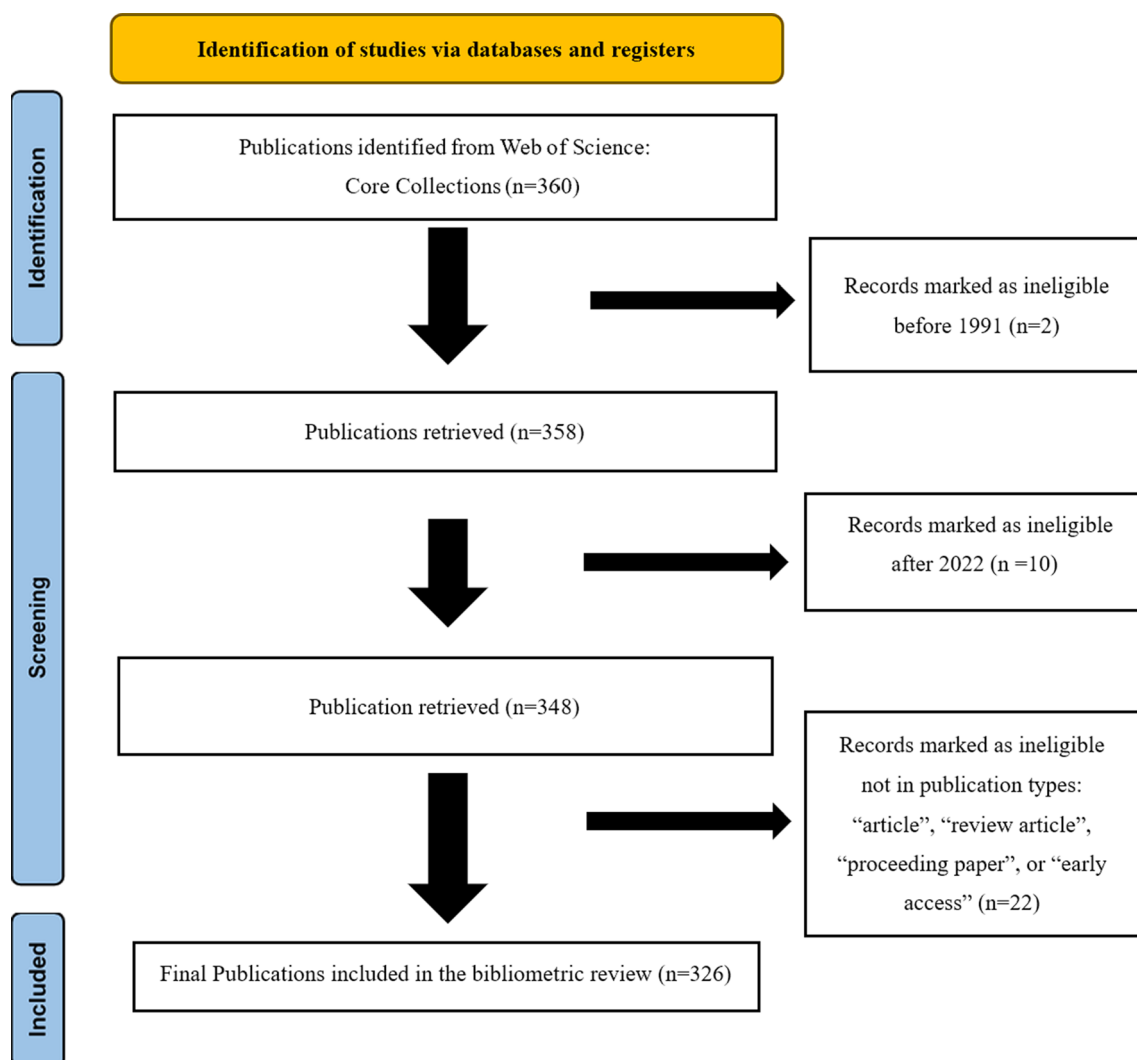


Fig. 1 The PRISMA flowchart of the inclusion and exclusion of the database. (1991–2022)

raw Web of Science (WOS) data, including the analysis of publications by year, curve fitting for the description of global publication trends over time. Descriptive statistics and plotting of publications distributed across different countries and regions, as well as the publication quality in this research field from a bibliometric perspective for different countries, including citation counts, average citation counts, and the H-index as a reflection of quality, and also identified the ranking of publication numbers for different journals, WOS research fields, key authors, and significant publishing institutions [23].

Bibliometrics is an analytical tool that involves specific measurements aimed at quantifying scientific and technological production through published articles [24]. Bibliometric methods introduce quantitative rigor into the subjective analysis of literature. By employing quantitative techniques to describe, evaluate, and monitor publications, they enable clear, systematic, and replicable review processes that enhance the quality of reviews and map research fields, thereby avoiding the subjective biases inherent in manual reviews [25].

There are two main uses of bibliometric methods: performance analysis, which aims to assess the research and publication performance of individuals and institutions; and scientific mapping, which uses visualization tools to reveal the structure and evolution of scientific fields [25, 26].

In this study, VOSviewer is employed due to its user-friendly nature and stability while running, which aligns well with the needs of preliminary research where visualization methods can quickly provide an overview of a scientific research field and enable the exploration of numerous data relationships [27]. As open access software, VOSviewer is also freely available to researchers with limited resources [28]. Developed by Van Eck and Waltman, VOSviewer is designed to construct and visualize bibliometric networks [29, 30]. This software supports the analysis of various factors within these networks, such as journals, researchers, or individual publications, and allows the creation of mapping networks using different relationships, including citations, co-citations, co-authorship, or co-occurrences [29]. VOSviewer simplifies the visualization and exploration of these metric networks for research purposes [30, 31]. Keywords are essential in research articles, containing the most core information [31]. Systematic analysis of keywords in a particular research area helps to clearly understand the trends and hotspots in that field [32]. Additionally, co-occurrence analysis, which assesses the relationship between identified keywords based on the number of publications, is an effective method for exploring future trends and hotspots in research areas of interest.

Results

Global publication trends

After applying the search criteria, we retrieved a total of 326 articles. The number of publications has increased since 1991, with 2 publications, and reached 24 publications in 2018 (Fig. 2a). It can be referred from the graph that there was a period of publication stagnation between 1993 and 2014.

According to Fig. 2b, it can be observed that the curve does not fit the data well; when using a logarithmic curve fit, resulting $y=7-16\exp(0.0185x)$ to describe the relation between publication number by year, the R-squared value is only 0.1003.

Mainly, the development of this research field is characterized by a wave-like progression. This research field progressed since 1990, rising from 2 to 8–14 publications annually, maintaining a high level from 1993 to 2002. A downturn occurred from 2003 to 2005, with fewer than 8 publications annually. From 2006 to 2018, a second wave of rapid growth emerged, peaking at around 10 publications annually from 2011 to 2019 (excluding the outlier of 4 in 2016), with 2018 witnessing a high of 24 publications. Despite a low of 5 publications in 2020, the significant increase to 16 papers in 2022 indicates sustained interest in TQM research within healthcare management.

A total of 51 countries and regions have published publications in the field of research. The top contributors in this field are shown in Fig. 2b and c. The United States has made the most significant contribution with 131 publications; followed by Germany with 42 publications; the United Kingdom with 20 publications; and Netherlands and Canada with 19 publications, respectively. (Figure 2c and d)

The USA leads significantly in publication output in this field, followed by other major publishing countries, which are primarily European nations and China.

The United States has the highest total number of citations (5,134) among all included publications, while England ranks second (967), followed by the Netherlands (933), Italy (828), and Australia (584) (Fig. 3a). Publications from Italy have the highest average number of citations (55.2), followed by the Netherlands (49.11), Australia (48.67), England (48.35), and the US (39.19) (Fig. 3b). The US outranks other countries and regions with the highest H-index of 33, followed by the Netherlands ($n=11$), England ($n=11$), Italy ($n=10$), and Germany ($n=10$) (Fig. 3c).

The USA leads significantly in total citation counts and H-index rankings, ahead of other countries. The H-index indicates both a large scale and strong quality. However, in terms of average citations per paper, Italy, the Netherlands, and Australia rank in the top three, reflecting a higher quality in terms of citations.

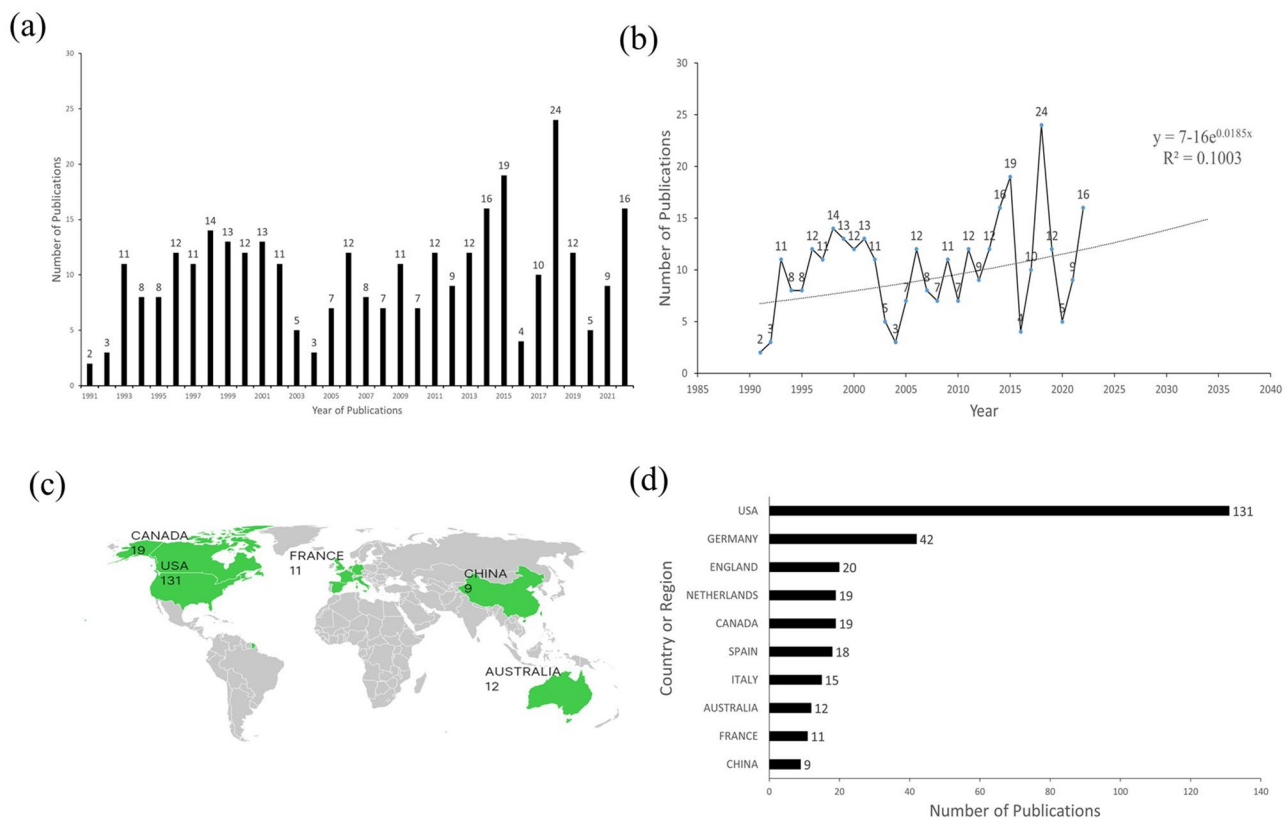


Fig. 2 (a) The number of publications on healthcare TQM by years; (b) The annual publication volume and trend prediction on healthcare TQM; (c) Distribution map of the top 10 countries or regions with the most publications on healthcare TQM; (d) The top 10 countries or regions with the highest publication number on healthcare TQM. (1991–2022)

Analysis of publications

Figure 4a shows the top ten journals with the highest number of publications.

The Journal of Applied Clinical Medical Physics published the most articles/reviews (14 publications), surpassing other journals in this field. The second highest number of publications came from Clinical Chemistry and Laboratory Medicine, Accreditation and Quality Assurance, Journal of Continuing Education in The Health Professions, with a total of 10 articles/reviews. Additionally, there were 9 publications in Journal of Operations Management, 7 in Biochemia Medica, and 7 in Military Medicine.

Figure 4b shows the top 10 research topics related to TQM in healthcare services. The most common areas of research were Health Care Sciences Services (69 publications), General Internal Medicine (41 publications), Public Environmental Occupational Health (29 publications), Medical Laboratory Technology (27 publications), and Radiology Nuclear Medicine Medical Imaging (25 publications).

This reflects research papers focusing primarily TQM in services management, followed by studies in fields such as internal medicine, occupational health, and

medical experimental technologies. It highlights that management topics constitute the predominant focus of TQM research.

Figure 4c shows the top ten authors with the most publications in this field. Among them, Libeer JC ranked first with four articles/reviews, and Bissonnette JP, Cohen DJ, Ehrmeyer SS, Freniere N, Goldschmidt HMJ, Laessig RH, Lippi G, Pomer-Leau-Dalcourt N, Villarreal-Barajas JE, Vogt W followed with three published articles/reviews.

The University of California System, and the University of Wisconsin System have the highest number of publications, with 11 publications each. The US Department of Veterans Affairs has ten publications, followed by VHA (Veterans Health Administration) with nine publications. The top 10 institutions with the highest number of publications are presented in Fig. 4d. This reflects that university research still has the highest publication volume in this area, followed by various other types of research institutions.

Co-authorship mapping analysis

Co-authorship analysis demonstrates the correlation between items based on the number of co-authored documents [33], which is a potent instrument for evaluating

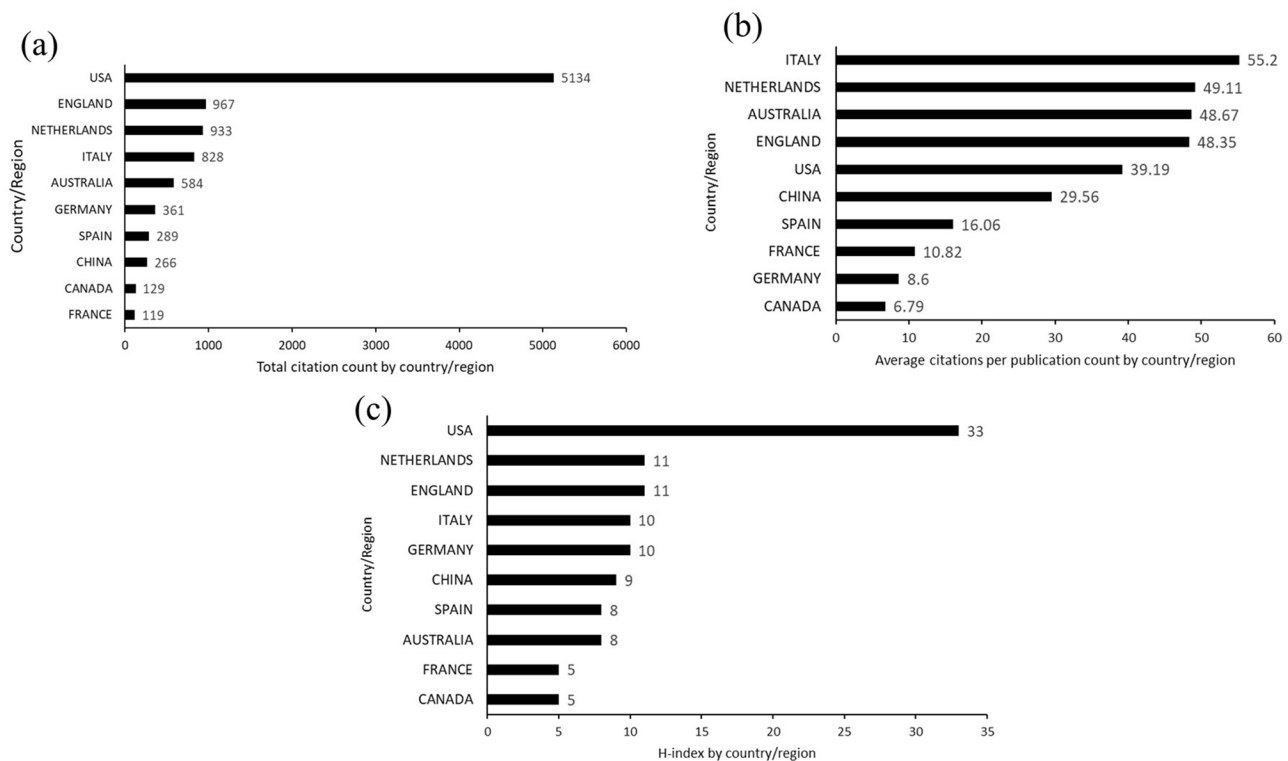


Fig. 3 (a) Top 10 countries or regions with the highest total number of citations on healthcare TQM; (b) Top 10 countries or regions with the highest average number of citations per publication on healthcare TQM; (c) Top 10 countries or regions with the highest H index on healthcare TQM. (1991–2022)

collaboration patterns and identifying leading scientists, countries, and organizations [34].

In Fig. 5a, VOSviewer was used to analyze 61 authors with at least two publications. The top 11 authors with the highest TLS scores are shown in the red cluster on the right side of the figure, represented by Freniere, Norman (citation count=19), Bissonnette, Jean-Pierre (citation count=18), and others. VOSviewer also shows three authors with the highest citations (citation count=479): Friedman, Susan M., Kates, Stephen L., Mendelson, and Daniel A. (all three TLS=4). They are in the light blue cluster on the upper part of the image.

According to the Fig. 5a, we can observe that the red group forms the largest collaborative authorship cluster, they come from various research institutions and medical centers across Canada, forming the most prominent research group with evident connectivity strength in this field.

A total of 25 countries and regions with a minimum limitation of at least three publications were identified and analyzed using VOSviewer (in Fig. 5b). The top five countries and regions with the highest TLS scores are presented as follows: the Netherlands (TLS=30 times), the United States (TLS=30 times), Germany (TLS=29 times), Sweden (TLS=22 times) and Italy (TLS=19 times).

This finding aligns with the analysis of publications where the USA dominates in terms of the highest publication volume. Institutions and authors from the USA are the most frequent collaborators in multinational research articles.

As shown in Fig. 5c, a total of 79 institutions had at least two publications included in the study and were analyzed using VOSviewer. In addition, University of Calgary (TLS=30 times), Tom Baker Cancer Clinic (TLS=29 times), University of Toronto (TLS=29 times), Juravinski Hospital and Cancer Centre (TLS=28 times) and Princess Margaret Cancer Centre (TLS=28 times) were the top five institutions with the highest TLS scores.

These highly collaborative research institutions are from Canada, and the largest red institutional collaboration network in the Fig. 5c indicates that these conditions are consistent with the observation of the largest clustering in the authorship collaboration map originating from Canada.

Journals and publications mapping analysis

Co-citation analysis of journals based on VOSviewer establishes the relationship between items by examining how often they are cited together. Co-citation analysis identifies the connection between two references by counting the number of times they are jointly cited in another article, thereby creating a network of all

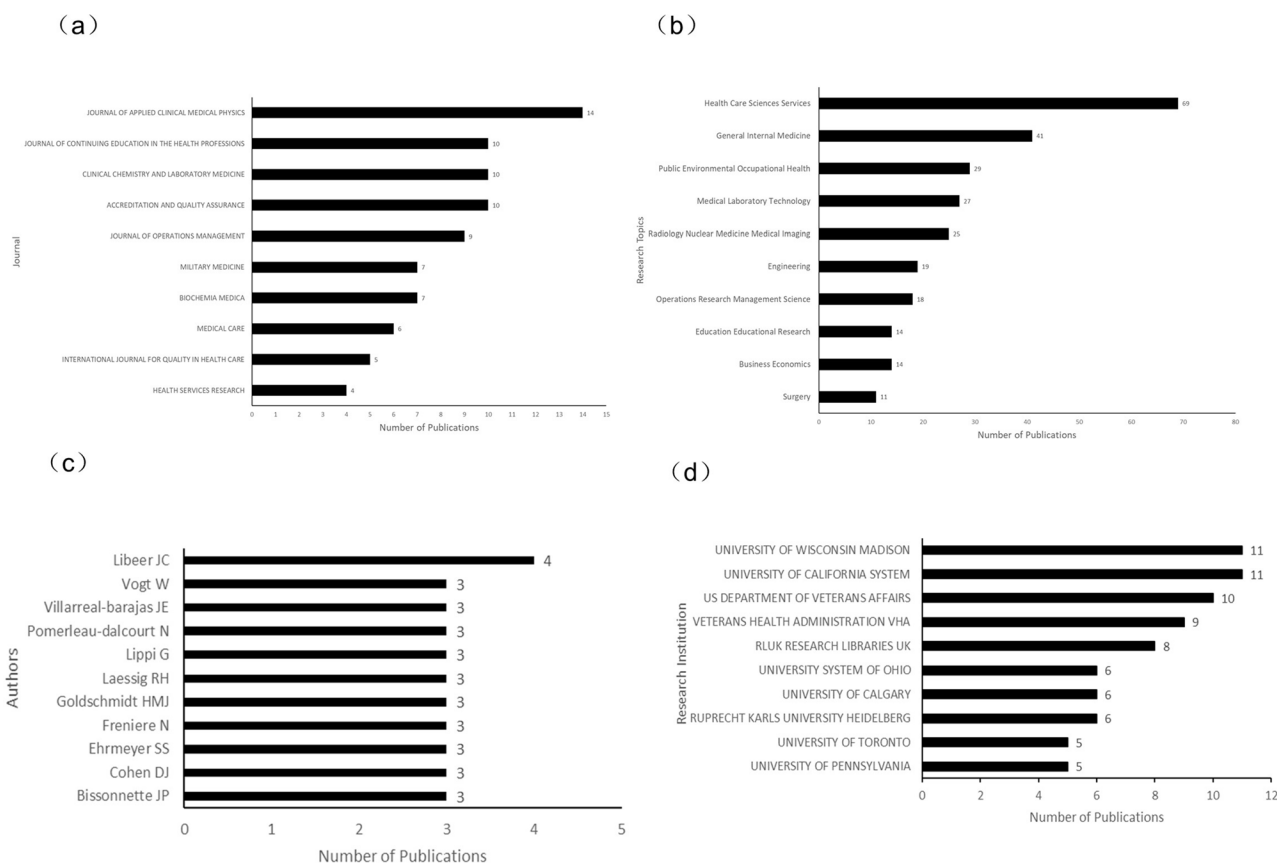


Fig. 4 (a) The top 10 journals in terms of publication quantity on healthcare TQM; (b) The top 10 research topics and orientations on healthcare TQM; (c) The top 10 authors in terms of publication quantity on healthcare TQM; (d) The top 10 institutions in terms of publication quantity on healthcare TQM. (1991–2022)

references within a research area, known as the “intellectual structure [25].” This approach is useful for identifying key literature that can help support cross-disciplinary ideas. In the co-citation visualization figures, the size of the circles in the image represents the corresponding TLS values of each entry. Specifically, larger circle sizes indicate higher TLS values [33].

A total of 78 journal with a minimum number of citations greater than 20 times data points are included in the visualization Fig. 6. The top five journals with the highest TLS scores are illustrated as follows: JAMA-Journal of The American Medical Association (TLS=10,969 times), Critical Care Medicine (TLS=8606 times), New England Journal of Medicine (TLS=6845 times), Medical Care (TLS=5010 times) and Annals of Internal Medicine (TLS=4950 times).

In the green cluster, JAMA and NEJM are the two core publishing medicine journals occupying the most central position, with academic journals on general medicine as the main content of the green cluster, including journals on medical biology and experimental biochemistry.

The blue cluster includes The LANCET and some specific field medicine journals in the small cluster on the

right side, as well as journals on healthcare quality and safety and healthcare quality improvement in the upper left corner of the blue cluster.

In the red cluster, the core journals include the Journal of Operation Management, Health Service Research, and Management Science, which focus mainly on the researches on managerial studies and healthcare organizational management.

A total of 55 publications were included in the study with each reference had a minimum number of citations greater than 5 times, and were analyzed using VOSviewer (Fig. 7). The top five publications with the highest TLS scores are presented as follows: Shortell SM, 1995, Health Services Research, v30, p377 (TSL=167 times, cited 37 times), Shortell SM, 2000, Medical Care, v38, p207 (TSL=104 times, cited 17 times), Berwick DM, 1989, New England Journal of Medicine, v320, p53 (TSL=64 times, cited 21 times), Deming W.E., 1994, Out Crisis, MIT Press (TSL=64 times, cited 17times) and Meterko M, 2004, Medical Care, v42, p492 (TSL=62 times, cited 7 times).Table 1. below shows the detail of the five highest co-cited publications, including the full titles and corresponding references.

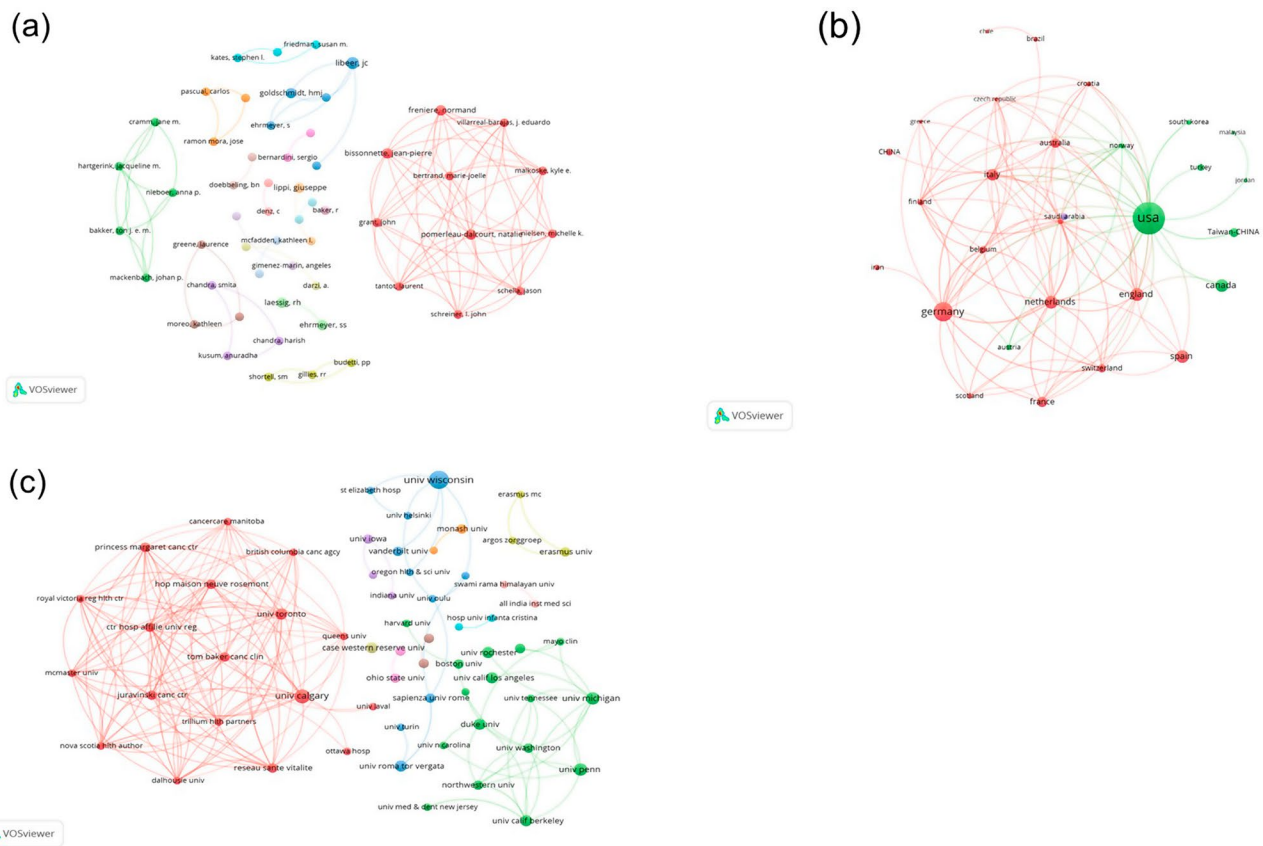


Fig. 5 (a) Co-authorship analysis on healthcare TQM (n=61); (b) Co-authorship analysis of countries and regions on healthcare TQM (n=25); (c) Co-authorship analysis of institutions on healthcare TQM (n=79). (1991-2022)

Among the publications, the top one cited, and top one TLS publication was published in 1995, *Assessing the impact of continuous quality improvement/total quality management: Concept versus implementation* [35], in which the researchers found that a participative, flexible, risk-taking organizational culture was related to quality improvement implementation. Quality improvement implementation was associated with better patient outcomes and human resource development. Larger hospitals had lower clinical efficiency due to bureaucratic and hierarchical cultures hindering quality improvement. According to the figure, the article most highly co-cited is situated in the central part of the graph, connecting with various clusters, clearly indicating its top position in this field.

Co-occurrence mapping analysis

Keywords are an essential part of a research publication and contain the vital information [40]. Co-occurrence analysis effectively uncovers relationships between research items, especially keywords based on their co-appearance in publications [33].

A keyword map of TQM in healthcare is presented, where node size signifies frequency and lines between nodes represent co-occurrence [22].

A total of 1433 keywords were included, and 49 met the criteria of over five occurrences. All keywords were grouped into five clusters (Fig. 8): total quality management (in yellow color), quality assurance (in red color), healthcare and performance (in green color), implementation (in blue color), and models (in purple color). The keywords-clustering processing provide insights into the most prominent topics and trending keywords related to total quality management in modern medical services management.

In the “total quality management” cluster, other important keywords are “quality improvement”, “quality of healthcare”, and “six sigma”. In the “quality assurance” cluster, other main keywords are “quality”, “patient safety”, “management” and “quality indicators”. The main keywords in “implementation” cluster, others are “impact”, “outcomes”, and “interventions”. The cluster centering keyword “healthcare and performance”, other keywords are “quality management”, “accreditation”, “systems”. The cluster of “models” as its main word, other keywords are “program”, and “EFQM” in purple cluster is an acronym

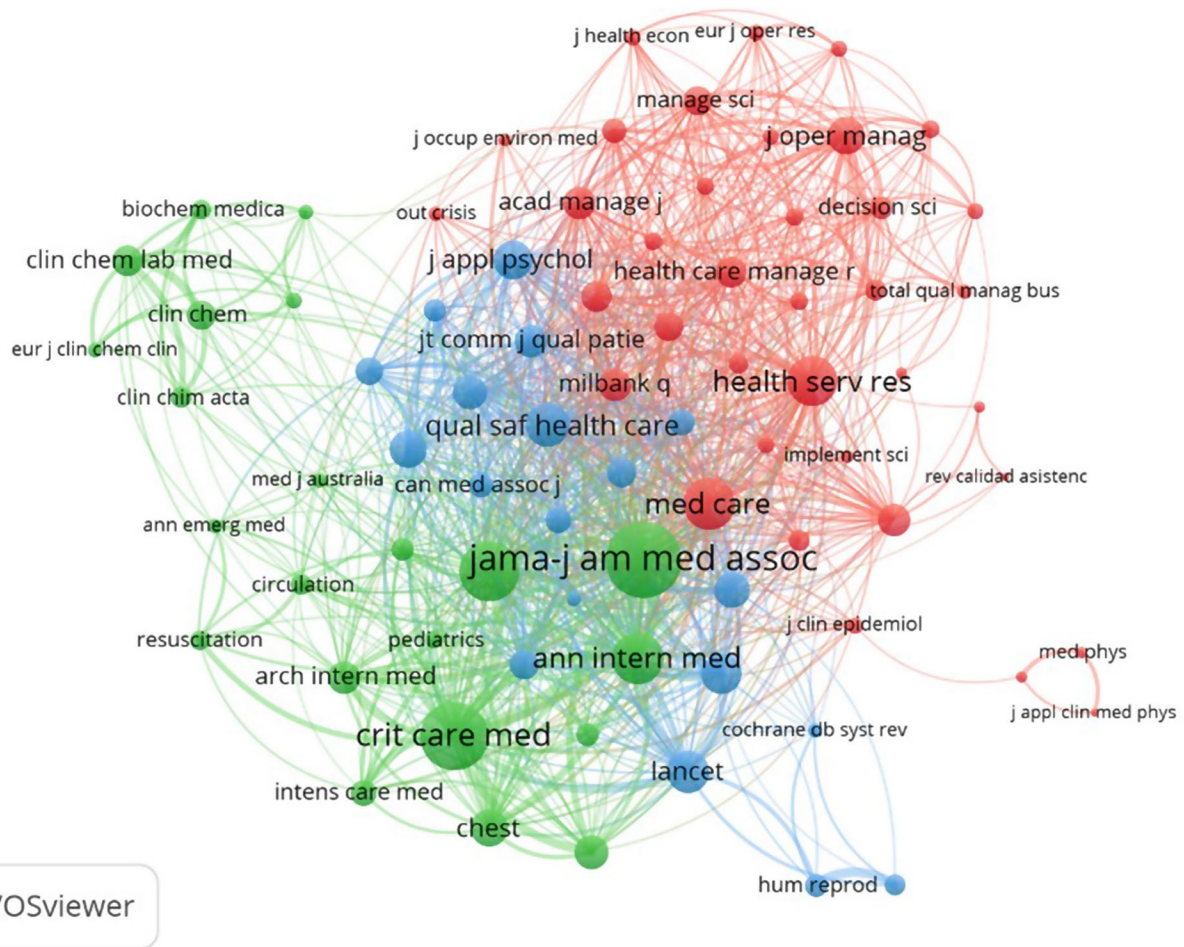


Fig. 6 Co-citation analysis of journals on healthcare TQM ($n=78,1991-2022$)

that stands for: *European Foundation for Quality Management* and its homologous EFQM model, the model is of great importance in the evolvement of quality management theoretical field [41].

The study will analyze and discuss these different clusters shown in different colors, revealing the distribution of key terms in healthcare TQM research field and the interrelationships among several categories of research focus.

Research hotspots by timeline

VOSviewer assigns a continuous gradient of colors to each keyword based on their chronological appearance in the included publications [33]. Keywords that appear earlier are assigned darker colors, while keywords that appear later are marked with green, light green, and yellow colors and this research marked the average occurrence year in the development process of this field.

Figure 9 revealed the development trend of keywords in over the near decades. Prior to the year of 2005, academic research topics and keywords focused mainly on

continuous quality improvement, practice guidelines, and assurance.

From 2005 to 2015, research keywords shifted to quality management, quality assurance, healthcare, implementation, impact and a term *efqm*. And the year of 2010 witnessed the transformation of healthcare TQM from traditional industry TQM concept like six sigma, intervention, etc. to a new concept more suited to the healthcare industry, such as measures of clinical outcomes, patient safety, and safety indicators.

After 2015 and until nowadays, keywords in this field of research changed to organizational performance, efficiency, services safety, systems, and errors. In the recent years, keywords of efficiency and safety climate are trending, takes important places in the field of quality management for a healthcare organization, and they are hotspots in the current studies and academic research [42, 43].

These changes in research keywords over time indicate trends and processes of changing directions in this research field at different periods. Meanwhile, recent trends shown in light color suggest that research trends in the other clusters are diversifying, indicating that

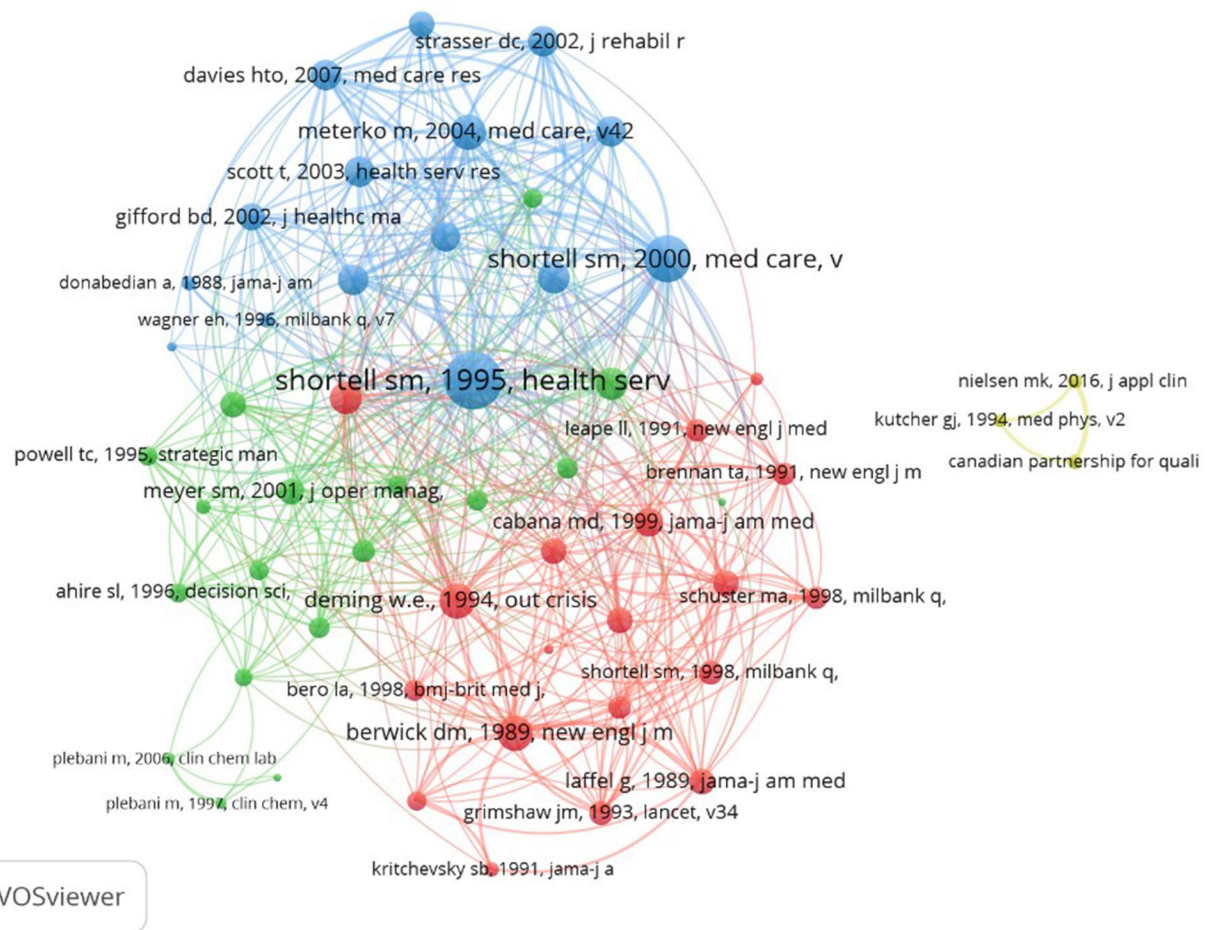


Fig. 7 Co-cited analysis of reference publications on healthcare TQM (n = 55, 1991–2022)

Table 1 Top five publications by TLS in according to Fig. 7 (1991–2022)

TLS	Citations	Title	Country/Region	Reference
167	37	Assessing the impact of continuous quality improvement/total quality management: Concept versus implementation [35]	USA	Shortell, S. M., O'Brien, J. L., et al. [35]
104	17	Assessing the impact of total quality management and organizational culture on multiple outcomes of care for coronary artery bypass graft surgery patients [36]	USA	Shortell, S. M., Jones, R. H., et al. [36]
64	21	Continuous improvement as an ideal in health care [37]	USA	Berwick D. M. [37]
64	17	Out of the Crisis [38]	USA	W. E. Deming. [38]
62	7	Teamwork Culture and Patient Satisfaction in Hospitals [39]	USA	Meterko, M., David C. Mohr, et al. [39]

these research objects' keywords are changing to varying degrees and have different research priorities.

Discussion

Global trends in research of TQM in healthcare

Over the past three decades, research directions regarding Total Quality Management in healthcare background have undergone different levels and shifts according to the descriptive statistics for the number of publications by year. The development of this research field is characterized by a wave-like progression. It rapidly developed since 1990, maintained a high plateau from 1993 to 2002,

experienced a research downturn from 2003 to 2005. The article “Diagnosing and prognosticating the quality movement – a review on the 25 years quality literature (1987–2011)” in 2013 pointed out that TQM research decreased over time after the 1990s, a phenomenon that was also consistent in the academic research field of healthcare background [9]. The number of researches of TQM in healthcare backgrounds showed the change with some lags in this study.

From 2006 to 2018, a notable surge be observed in research activity in the field. A second period of rapid development occurred during this time, particularly from

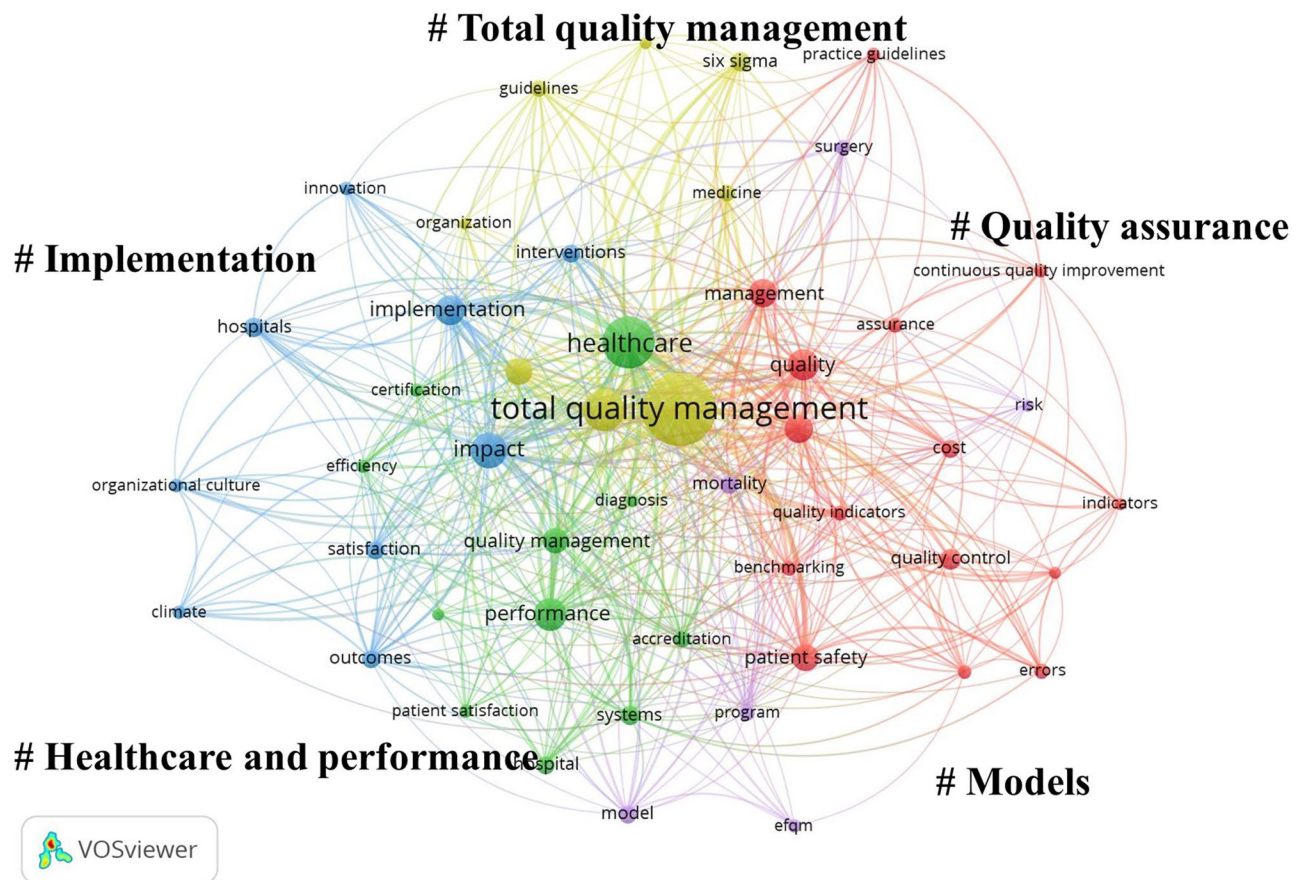


Fig. 8 Keywords clustering co-occurrence analysis on healthcare TQM ($n=49,1991-2022$)

2011 to 2019, reaching its peak in terms of publications in 2018. This phenomenon may indicate a renewed interest and vibrant exploration of the application of TQM in healthcare institutions, also a renewed interest and vitality in the application of TQM in healthcare institutions, which consistent with the observations made by Lee, V-H. and Hew, J-J, this field regained attention and growth since 2013 [7].

The COVID-19 pandemic have influenced TQM research [44], there showed a substantial increase in publications in 2022, with 16 papers, compared to previous years implies that continued attention is being paid to the academic research field of TQM in healthcare management.

Observing the rapid increase in the number of annual research paper publications in this field in the three years after the pandemic, and the attainment of higher values than the previous high plateau period, we can reasonably assume that there will be a greater concentration of academic research in the direction of total quality management in healthcare institutions, as well as providing more in-depth knowledge in the future.

Quality and status of global publications

The total number of citations and the H-index are important indicators for reflecting the academic influence and publication quality of a country or a district [45]. In the field of total quality management research, the United States ranks first in terms of publications, total citations, and H-index, making the greatest contribution in this academic discipline. Italy, the Netherlands, Australia, and England, along with other important developed countries, closely follow, ranking in the top five for publication quantity, citation frequency, and H-index. Additionally, Germany, Canada, and other countries play significant roles in high citation frequencies. The definition of H-index is that a scholar with an index of H has published H publications, each of which has been cited in other publications at least H times [46], and is often used to measure both the productivity and citation impact of the publications of a scholar [45].

It is worth mentioning that both China and Taiwan, China have made significant contributions to the relevant academic research. Due to the comprehensiveness and systematization of TQM in the management of healthcare service organizations [13], developed countries and regions with more advanced healthcare system

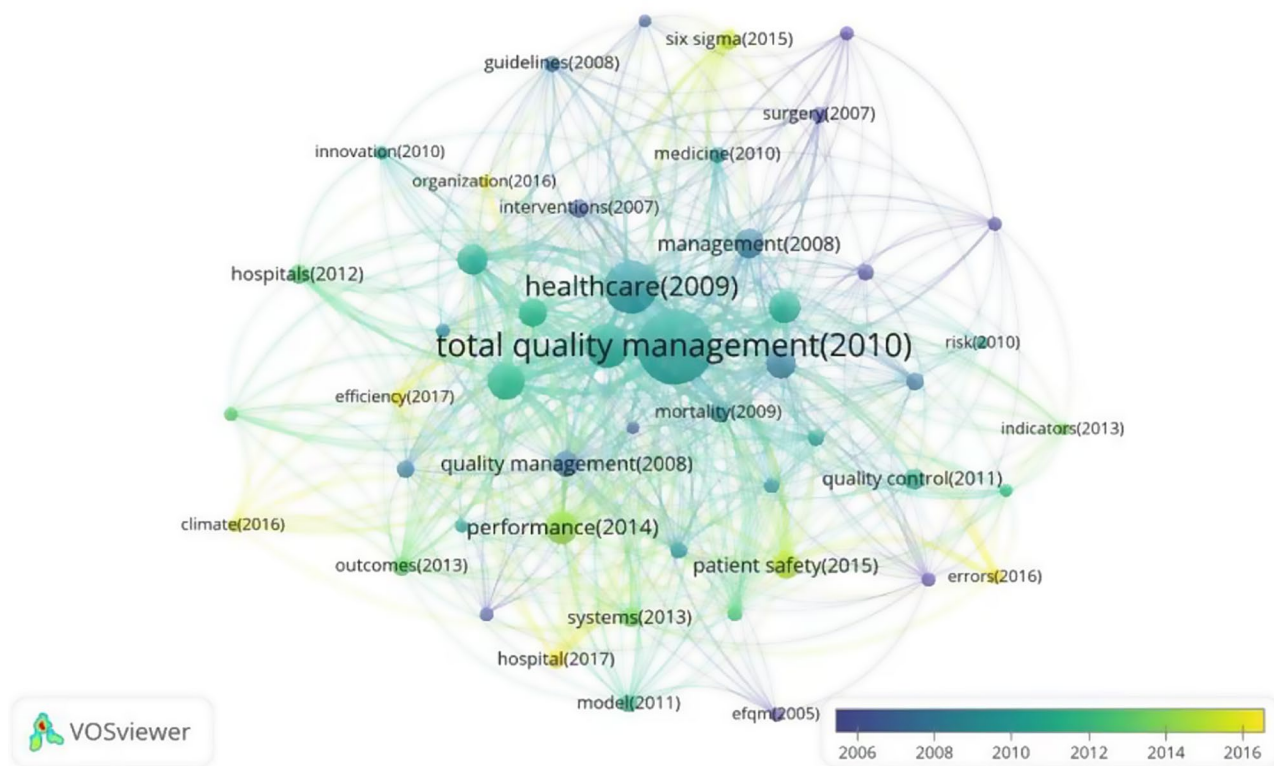


Fig. 9 Keyword evolution analysis by year on healthcare TQM ($n = 49, 1990\text{--}2022$)

management models have invested in academic research in this field [44]. This partially explains the outstanding performance of these regions in the ranking of research in this field.

About journals, Journal of Applied Clinical Medical Physics (IF=2.1) [47], Clinical Chemistry and Laboratory Medicine (IF=6.8) [48], Accreditation and Quality Assurance (IF=0.9) [49], Journal of Continuing Education In The Health Professions (IF=1.8) [50], these journals have published a substantial amount of researches on TQM in healthcare background and are considered as the primary sources for future investigation [51, 52].

In the institutional publishing rankings, the most important publishing institutions are predominantly from the top five countries with the highest publication output, primarily located in the United States. This demonstrates the significant academic influence of the United States in this field. Additionally, among all the authors, the most prolific contributors in terms of published papers are from the United States. This also indicates that to stay updated with the latest advancements in this field, it is crucial to pay closer attention to the work of these authors and the contributions of the key academic institutions [52].

Authors, countries or regions, institutions with higher Total Link Strength (TLS) are more likely to collaborate [53, 54]. The results show that the University of Calgary

is the institution with the most published collaborations, and Freniere, Normand, Bissonnette, Jean-Pierre are the most prolific paper collaborators. Friedman, Susan M., Kates, Stephen L., Mendelson, Daniel A. are the authors with the most cited collaborations. Citation analysis calculates the number of times that academic research is cited together, indicating the influence of this research [31].

The Journal of the American Medical Association (JAMA) (IF=120.7) [55] is the most frequently co-cited journal in this field, demonstrating the significant importance and impact of the top general medical journals, with JAMA as a representative, in academic research through their references and citations. *Assessing the impact of continuous quality improvement/total quality management: Concept versus implementation* [35] is the most highly cited literature and with other top literatures shown in Table 1., which can be considered as milestone or inspiring studies in total quality management research within healthcare services. These highly co-cited literatures are essential references that must be read in this field of research and should be familiar to current and future researchers entering the undergraduate level. Based on them, more comprehensive models or further theoretical studies on healthcare quality management can be developed.

Research focus on TQM in healthcare

This study utilized co-occurrence analysis of keywords to identify three significant research directions. In five clusters: total quality management (yellow cluster), quality assurance (red cluster), implementation (blue cluster), healthcare and performance (green cluster), and models (green cluster), the former four clusters are of large importance in the study. While EFQM, known as European Foundation for Quality Management Excellence Model, is an ever-evolving symbolic model in this field, widely applied in many places [41, 56, 57].

The cluster of “Total Quality Management” includes additional keywords such as “quality improvement”, “quality of healthcare”, and “six sigma”. These keywords are closely associated with total quality management and constitute essential components and aspects of it. Six sigma is a high-level idealistic benchmark for the total quality management for an organization, it takes a vital place. The past decades’ organizational changes, were the main drivers behind the reduction of ICU mortality, as well as reducing cost [58], the two important parts of quality improvement. Six sigma facilitates waste elimination in production processes in hospitals. The continuous improvement model integrates practical knowledge with an understanding of the system under improvement, utilizing observations and modifications to enable measurable outcomes. Six Sigma can also increase the effectiveness of evidence-based quality improvement programs in hospitals [59].

Within the second cluster of “quality assurance,” there are other significant keywords such as “quality”, “patient safety”, “management” and “quality indicators.” These keywords collectively emphasize assuring healthcare safety, which is fundamental for the quality of healthcare. The key to total quality management in healthcare is assuring patient safety, which requires monitoring and measuring patient safety using appropriate health quality indicators. The core is to achieve a patient orientated quality assurance related to the medical benefits and the patient individual needs [60]. Most quality assuring plans are related to the development and evaluation of quality indicators, and it is useful to have a broader reflection on the concept of indicators. In healthcare field, the specific design of a patient safety indicator system depends on the precise definition and measurement context, while in total quality management, the establishment of such an indicator system requires the participation of all staff members in hospitals [61].

In the “implementation” cluster, other major keywords include “impact”, “outcomes”, and “interventions”. The implementation of TQM principles in the healthcare field, requires a radical change in management practice and the organizational culture and its philosophy to effectively increase healthcare performance [62]. A

healthcare management conceptual framework from TQM noticed that some characteristics of organizational culture are associated with error reduction, to improve the medical outcomes [63]. And clinical interventions conducted under the conception of TQM proved effective in studies [64, 65].

The cluster centers on the keyword “healthcare and performance”, with other keywords including “quality management”, “accreditation”, and “systems”. While there are contradictory findings about the impact of accreditation on improving the quality of healthcare services, accreditation continues to be recognized internationally as a quality assurance tool [66]. Accreditation within the healthcare sector constitutes a pivotal element in TQM research that is centered on the realm of healthcare, with a substantial corpus of literature devoted to investigating this domain. Notably, despite the endeavors of certain studies, including a comprehensive one encompassing 36,777 patients, no discernible correlation has been discerned between the accredited status of hospitals and patient satisfaction [67]. Both clinical medical and laboratory certification systems are conducive to building higher-quality healthcare services in any country or region, enhancing the performance of healthcare [68, 69].

Comparison with previous studies

As V-H. Lee and J-J. Hew pointed out in their 2017 paper, the number of citations received by TQM articles published between 2006 and 2017 increased year by year, indicating that it remains a prominent and popular research topic, and encouraging subsequent scholars to strive to advance TQM research to higher levels. They also suggested that scholars consider conducting cross-national comparisons between developed and developing countries and combining TQM with other research fields [7].

Accordingly, the bibliometric research for the time period of 1991–2022 in this article found that developed countries such as the USA and European nations lead in terms of historical total publications. The only non-developed country to make it into the top ten is China. Additionally, this article focuses on a bibliometric study of TQM in the context of health services, which refines the research objectives outlined in previous studies.

Majdi M Alzoubi, K S Hayati et al. conducted a meta-analysis of 25 of the most relevant TQM articles in healthcare between 2005 and 2016, which showed that there are relatively few studies on TQM in the healthcare context. They also believe that such TQM healthcare research is valuable for both researchers and healthcare managers. They identified key terms in TQM for healthcare, including education and training, continuous quality improvement, customer focus/satisfaction, top management commitment, and teamwork, but did not

analyze the evolution of these themes over time [13]. This study, however, uses bibliometric methods to provide a comprehensive analysis of the changes in TQM keywords in healthcare from 1991 to 2022. While systematic reviews focus on detailed content analysis, this bibliometric study takes a broader perspective to investigate the field, providing less granular detail but examining different aspects of the topic.

Chen Zhang led and conducted a bibliometric study on the application of TQM in the service industry, analyzing 3,774 English research articles published between 2004 and 2017. They performed keyword mapping and extensive co-citation analysis. The contribution of this study lies in better understanding the obstacles and difficulties hindering the successful application of TQM in the service sector. It also addresses the limitation of most TQM empirical studies being case studies, which lack interconnection, making generalization impractical.

In contrast, this article primarily focuses on high-quality database articles, specifically 326 articles retrieved from the Web of Science Core Collection, which are more representative and influential, effectively selecting the best of the available literature. Furthermore, it provides a more detailed discussion and analysis of the keywords. The time range of this study is broader than previous studies, covering the period from 1991 to 2022.

Significance and future directions

This study conducted a bibliometric analysis of high-quality English research articles on Total Quality Management (TQM) in the healthcare context, spanning the period from 1991 to 2022. Drawing from an overview of English literature and mapping results retrieved from the Web of Science (WOS) core collection, we identified that global healthcare research has centered on organizational transformation, encompassing the evolving trends in management practices and philosophies aligned with TQM concepts. Enhancing the quality management climate in healthcare and reducing errors emerged as central themes. Looking ahead, TQM is expected to play an even more pivotal role in the intricate landscape of healthcare quality management practices, with more researches on refined TQM-based indicators anticipated.

In future studies, the focus will be as follows. Healthcare quality indicators are measurable, objective, and quantitative measures of key system elements' performance in TQM, which reflect to what extent a system meets the needs and expectations of its customers [70]. In TQIP, a regional quality indicator project in Asia, indicators measures the healthcare quality of hospitals, confirming that the enhancement in both quality and relative efficiency coincides with the philosophy of total quality management [71], which inspires the future TQM researches.

Recent research has focused on keywords such as error, hospital quality climate, and TQM models, in addition to indicators analysis. Future research may further develop on these foundations. The carrying out of TQM in clinical practices, in the near future, can definitely enhance compliance and control in the context of a highly intricate care unit in hospitals, and TQM clinical indicator is a replicable and scalable quality assessment approach for a complex clinical setting, cutting medical errors and assuring the safety of healthcare services [72].

Strength and limitations

This article is the first to employ bibliometric methods to investigate the implementation of Total Quality Management (TQM) in healthcare in such an elaborate manner, in such a timeframe, and to such an extent. By utilizing descriptive statistics, visualization software and bibliometric analysis, the study aims to comprehensively understand the current state and future trends in this field and identify hotspots and collaboration relationships among countries, authors, and institutions.

However, the study has several limitations. While several large academic databases currently exist, considering the accessibility and quality of the contents of the collected databases, only core collection of WOS database of academic articles was adopted as the source of materials, and it is possible that some high-quality research articles were omitted with the WOS core collection's criteria [73]. It is worth noting that while a single database with well-defined search criteria is often sufficient for rigorous bibliometric studies, and the WOS Core Collection includes all high-quality journals and papers under the Clarivate's standards (SCI, SSCI, etc.), the potential for omissions in terms of the completeness of high-quality papers across different databases remains one of the limitations [74, 75].

Secondly, all publications including in this article are in English, which may overlook relevant articles published in other languages. Thirdly, there can be inherent differences between bibliometric analysis results and actual current research outcomes. For example, some high-quality but low-cited-numbered recent publications (by the time of September, 2023) might not have received sufficient attention. Lastly, biases may exist due to variations in author names and keyword expressions.

Conclusion

This article reveals the research themes and trends related to TQM in the healthcare background using bibliometric methods. It describes that the research field of TQM is still led by the USA and European countries, and discovers that Canadian research institutions have the largest cross-institutional cooperation and scholar groups. It also finds that a paper by Shortell et al. in 1995

has the highest number of co-citations in this field, and that world-renowned medical, biochemical, and management journals have provided extensive interdisciplinary evidence for TQM research in healthcare. Based on mapping, this study identifies six major clusters of TQM medical research, discovers that quality management and TQM implementation are the main topics that have already been studied, and finds that the latest focus is on hospital quality management models such as EFQM and indicator systems, which may also shift to research on quality climate researches. With the observation of a fluctuating upward trend, we believe that this field will produce more high-quality English papers in the future.

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Author contributions

Z.H. and R.W. did the acquisition and interpretation of data and wrote the main manuscript text and Z.H. prepared all figures and tables. X.Q, Y.H., L.L., and B.W. designed the work. H.C., X.Q, Y.H., L.L., Y.L. and B.W. substantively revised the manuscript. B.W. and Y.L. obtained the funding support for the manuscript and publication. All authors substantively reviewed the manuscript.

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Data availability

The data supporting the findings of this study are available in web of science database as described in the Methods section of the manuscript.

Declarations

Ethics approval and consent to participate

There are no human or animal studies in this manuscript, and no potentially identifiable human images or data is presented in this study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

- Al-Shdaifat EA. Implementation of total quality management in hospitals. *J Taibah Univ Med Sci.* 2015;10(4):461–6.
- Aquilani B, et al. A systematic literature review on total quality management critical success factors and the identification of new avenues of research. *TQM J.* 2017;29(1):184–213.
- Rokke C, Yadav OP. Challenges and barriers to total quality management: an overview. *Int J Perform Eng.* 2012;8:653–65.
- Miller WJ. A working definition for total quality management (TQM) researchers. *J Qual Manage.* 1996;1(2):149–59.
- Gardner DB, Cummings C. Total quality management and shared governance: synergistic processes. *Nurs Adm Q.* 1994;18(4):56–64.
- Sadikoglu E, Zehir C. Investigating the effects of innovation and employee performance on the relationship between total quality management practices and firm performance: an empirical study of Turkish firms. *Int J Prod Econ.* 2010;127(1):13–26.
- Lee V, Hew J. Is TQM fading away? A bibliometric analysis of a decade (2006–2015). *Int J Serv Econ Manage.* 2017;8:227.
- Agus A. TQM as a Focus for Improving Overall Service Performance and customer satisfaction: an empirical study on a Public Service Sector in Malaysia. *Total Qual Manage Bus Excellence.* 2004;15(5–6):615–28.
- Dahlgard-Park SM, et al. Diagnosing and prognosticating the quality movement - a review on the 25 years quality literature (1987–2011). *Total Qual Manage Bus Excellence.* 2013;24(1–2):1–18.
- Prajogo D. The comparative analysis of TQM practices and quality performance between manufacturing and service firms. *Int J Serv Ind Manag.* 2005;16:217–28.
- Chang T-H, Fuzzy VIKOR. Method: a case study of the hospital service evaluation in Taiwan. *Inf Sci.* 2014;271:196–212.
- Getele GK, Jean AT. Total quality management in the healthcare sector: an empirical research from Ethiopia. *Hum Syst Manage.* 2020;39:441–53.
- Alzoubi MM, et al. Total quality management in the health-care context: integrating the literature and directing future research. *Risk Manage Healthc Policy.* 2019;12:167–77.
- AlQahtani J, Turkey E, Al-Ghamdi A. CONTINUOUS IMPROVEMENT IN TQM. *Int J Manage Inform Technol.* 2014;9:1718–22.
- Durairatnam S, Chong S-C, Jusoh M, People-Related TQM. Practices, Organisational Culture, Organisational Justice and Employee Work-related Attitudes for Quality Performance: A Research Agenda. 2019.
- Yousef N, Yousef F. Using total quality management approach to improve patient safety by preventing medication error incidences. *BMC Health Serv Res.* 2017. 17.
- Hidayah N, Arbianingsih, Ilham. The impact of integrated quality management-based health services on general hospital quality. 2022. 10.
- Aggarwal A, Aeran H, Rathee M. Quality management in healthcare: the pivotal desideratum. *J Oral Biol Craniofac Res.* 2019;9(2):180–2.
- Zhang C, Moreira MRA, Sousa PSA. A bibliometric view on the use of total quality management in services. *Total Qual Manage Bus Excellence.* 2021;32(13–14):1466–93.
- Web of Science Science Citation Index Expanded (SCIE).* 2023; <https://clarivate.com/solutions/web-of-science/>
- Singh VK, et al. The journal coverage of web of Science, Scopus and dimensions: a comparative analysis. *Scientometrics.* 2021;126(6):5113–42.
- Qin X et al. Organisational Culture Research in Healthcare: A Big Data Bibliometric Study. *Healthc (Basel)*, 2023. 11(2).
- Stapor K, Descriptive and Inferential Statistics, in *Introduction to Probabilistic and Statistical Methods with Examples in R*, Stapor K. Editor. 2020, Springer International Publishing: Cham. pp. 63–131.
- Okubo Y. Bibliometric indicators and analysis of research systems: methods and examples. 1997.
- Zupic I, Čater T. Bibliometric methods in management and Organization. *Organizational Res Methods.* 2014;18:429–72.
- Cobo MJ, et al. Science mapping software tools: review, analysis, and cooperative study among tools. *J Am Soc Inform Sci Technol.* 2011;62(7):1382–402.
- van Eck NJ, et al. A comparison of two techniques for bibliometric mapping: multidimensional scaling and VOS. *J Am Soc Inform Sci Technol.* 2010;61(12):2405–16.
- Kirby A. Exploratory bibliometrics: using VOSviewer as a preliminary Research Tool. *Publications.* 2023;11. <https://doi.org/10.3390/publications11010010>.
- Arruda H, et al. VOSviewer and Bibliometrix. *J Med Libr Assoc.* 2022;110(3):392–5.
- van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics.* 2010;84(2):523–38.
- Donthu N, et al. How to conduct a bibliometric analysis: an overview and guidelines. *J Bus Res.* 2021;133:285–96.
- Shao B, Li X, Bian G. A survey of research hotspots and frontier trends of recommendation systems from the perspective of knowledge graph. *Expert Syst Appl.* 2021;165:113764.
- Waltman NJvEL. *VOSviewer Manual.* 2023 [cited 2023; https://www.vosviewer.com/documentation/Manual_VOSviewer_1.6.19.pdf

34. Reyes-Gonzalez L, Gonzalez-Brambila CN, Veloso F. Using co-authorship and citation analysis to identify research groups: a new way to assess performance. *Scientometrics*. 2016;108(3):1171–91.
35. Shortell SM, et al. Assessing the impact of continuous quality improvement/total quality management: concept versus implementation. *Health Serv Res*. 1995;30(2):377–401.
36. Shortell SM, et al. Assessing the impact of total quality management and organizational culture on multiple outcomes of care for coronary artery bypass graft surgery patients. *Med Care*. 2000;38(2):207–17.
37. Berwick DM. Continuous improvement as an ideal in health care. *N Engl J Med*. 1989;320(1):53–6.
38. Deming WE. *Out of the Crisis*. 1994.
39. Meterko M, Mohr DC, Young GJ. Teamwork culture and patient satisfaction in hospitals. *Med Care*. 2004;42(5):492–8.
40. Wang H, et al. A historical review and bibliometric analysis of GPS research from 1991–2010. *Scientometrics*. 2013;95(1):35–44.
41. Management EF. f.Q. *European Foundation for Quality Management*<http://www.efqm.org>
42. Hartmann CW, et al. Relationship of Hospital Organizational Culture to Patient Safety Climate in the Veterans Health Administration. *Med Care Res Rev*. 2009;66(3):320–38.
43. Speroff T, et al. Organisational culture: variation across hospitals and connection to patient safety climate. *Qual Saf Health Care*. 2010;19(6):592–6.
44. Xiao A, et al. Emerging research trends of total quality management in the COVID-19 pandemic: a dynamic evolution analysis. *Economic Research-Ekonomska Istraživanja*. 2023;36(2):2140305.
45. Alonso S, et al. h-Index: a review focused in its variants, computation and standardization for different scientific fields. *J Informetrics*. 2009;3(4):273–89.
46. Hirsch JE. An index to quantify an individual's scientific research output. *Proc Natl Acad Sci U S A*. 2005;102(46):16569–72.
47. Medicine AA. o.Pi. *Journal Metrics: Journal of Applied Clinical Medical Physics*. 2022 [cited 2023; <https://aapm.onlinelibrary.wiley.com/page/journal/15269914/journal-metrics>
48. CCLM. *Clinical Chemistry and Laboratory Medicine (CCLM) IF = 6.8*. CLM is the official journal of the European Federation of Clinical Chemistry and Laboratory Medicine 2023 [cited 2023; <https://www.degruyter.com/journal/key/cclm/html>
49. Accreditation and Quality Assurance Journal for Quality, Comparability and Reliability in Chemical Measurement. 2023 [cited 2023; <https://www.springer.com/journal/769>
50. Tanno LK, Demoly P. Preparing international classification of diseases (ICD)-11: model of allergic and hypersensitivity conditions. *Revue Francaise D Allergologie*. 2020;60(8):595–9.
51. Aksnes DW, Langfeldt L, Wouters P. Citations, citation indicators, and Research Quality: an overview of Basic concepts and theories. Volume 9. SAGE Open; 2019. p. 2158244019829575. 1.
52. Carpenter CR, Cone DC, Sarli CC. Using publication metrics to highlight academic productivity and research impact. *Acad Emerg Med*. 2014;21(10):1160–72.
53. Fonseca BdPfe, et al. Co-authorship network analysis in health research: method and potential use. *Health Res Policy Syst*. 2016;14(1):34.
54. Mao X et al. The status and trends of coronavirus research: a global bibliometric and visualized analysis. *Medicine*. 2020. 99(22).
55. Epstein RH, Dexter F. Rescheduling of previously cancelled Surgical cases does not increase variability in operating Room Workload when cases are scheduled based on maximizing efficiency of Use of operating Room Time. *Anesth Analg*. 2013;117(4):995–1002.
56. Gómez JG, Martínez M, Costa, Martínez Lorente ÁR. EFQM Excellence Model and TQM: an empirical comparison. *Total Qual Manage Bus Excellence*. 2017;28(1–2):88–103.
57. Calvo-Mora A, Domínguez-Cc M, Criado F. Assessment and improvement of organisational social impact through the EFQM Excellence Model. *Total Qual Manage Bus Excellence*. 2018;29(11–12):1259–78.
58. van der Sluijs AF et al. The impact of changes in intensive care organization on patient outcome and cost-effectiveness-a narrative review. *J Intensive Care*. 2017. 5.
59. Lavin P, Vetter MJ. Using lean six Sigma to increase the effectiveness of an evidence-based quality improvement program. *J Nurs Care Qual*. 2022;37(1):81–6.
60. Otto V, Zenker W. From quality assurance to total quality management. Experiences in quality assurance. *Zentralbl Chir*. 2000;125:137–40.
61. Quentin W, Brownwood PV. In: Busse KN, Panteli R D, et al. editors. *Measuring healthcare quality, in improving healthcare quality in Europe: characteristics, effectiveness and implementation of different strategies*. Health Policy Series. Copenhagen (Denmark): European Observatory on Health Systems and Policies; 2019.
62. Gregori D, et al. Knowledge, practice and faith on total Quality Management principles among workers in the Health Care System: evidence from an Italian investigation. *J Eval Clin Pract*. 2009;15(1):69–75.
63. Stock GN, McFadden KL, Gowen CR. Organizational culture, critical success factors, and the reduction of hospital errors. *Int J Prod Econ*. 2007;106(2):368–92.
64. Seltzer SE, et al. Expediting the turnaround of radiology reports in a teaching hospital setting. *Am J Roentgenol*. 1997;168(4):889–93.
65. Isouard G. A quality management intervention to improve clinical laboratory use in acute myocardial infarction. *Med J Aust*. 1999;170(1):11–4.
66. Alhawajreh MJ, Paterson AS, Jackson WJ. Impact of hospital accreditation on quality improvement in healthcare: a systematic review. *PLoS ONE*. 2023;18(12):e0294180.
67. Sack C, et al. Is there an association between hospital accreditation and patient satisfaction with hospital care? A survey of 37 000 patients treated by 73 hospitals. *Int J Qual Health Care*. 2011;23(3):278–83.
68. Ehrmeyer SS, Laessig RH. The American (USA) perspective six years after implementation of CLIA'88 (Federal) regulations. *Accred Qual Assur*. 1999;4(3):93–8.
69. Goldschmidt HMJ, van der Weide WE, van Gennip E. Application of the NIAZ frame of reference; impact on a departmental level. *Accred Qual Assur*. 2001;6(9–10):431–4.
70. Simundic AM, Topic E. Quality indicators. *Biochemia Med*. 2008;18(3):311–9.
71. Chang SJ, et al. Taiwan quality indicator project and hospital productivity growth. *Omega-International J Manage Sci*. 2011;39(1):14–22.
72. Sussmane JB, Torbati D, Gitlow HS. Measuring the quality of therapeutic apheresis care in the pediatric intensive care unit. *J Clin Apheresis*. 2012;27(2):43–50.
73. Clarivate. *Web of Science Core Collection Overview*. 2021 [cited 2024; v2.0; <https://webofscience.help.clarivate.com/Content/wos-core-collection/wos-core-collection.htm>
74. Romanelli JP, et al. Four challenges when conducting bibliometric reviews and how to deal with them. *Environ Sci Pollut Res*. 2021;28(43):60448–58.
75. AlRyalat SAS, Malkawi LW, Momani SM. Comparing Bibliometric Analysis using PubMed, Scopus, and web of Science Databases. *J Vis Exp*. 2019(152).

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