Okoroiwu *et al. Cost Effectiveness and Resource Allocation* (2024) 22:68
https://doi.org/10.1186/s12962-024-00576-7

Cost Effectiveness and Resource Allocation

RESEARCH Open Access

Global bibliometric analysis of cost effectiveness analysis in healthcare research from 2013 to 2023

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Abstract

Background Cost-effectiveness analysis (CEA) has become a crucial technique in appraising the efficiency of healthcare interventions and resource allocation decisions. Cost-effectiveness analysis is now widely used to evaluate whether the effect of a healthcare intervention justifies additional expenditure.

Method We used PubMed database with search descriptors: "Cost effectiveness" [Title / Abstract] OR "Cost effectiveness analysis" [Title / Abstract] AND "Healthcare" [Title / Abstract]. The common bibliometric indicators were applied.

Results We retrieved a total of 7,561 articles within 2013 and 2023. The growth pattern showed a progressive pattern. Articles with 5 authors signature had the highest number in publication. The most productive authors in cost effectiveness research in healthcare were Liew Danny and Ademi Zanfina. The most utilized journals for the publications were *BMJ Open*, *PLoS One and Journal of Medical Economics*. The most productive institutions were resident in United Kingdom with the University of York and University of Oxford at the helm.

Conclusion Scientific production in Cost effectiveness in healthcare research was found to be progressive. This study provides a reference for health policy makers, funders, policy decision makers, academics, and hospital economics researchers.

Keywords Cost effectiveness, Cost effectiveness analysis, Cost effectiveness analysis in healthcare

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Introduction

In an era of rising healthcare costs and limited resources, cost-effectiveness analysis (CEA) has emerged as a critical tool for decision-makers in the healthcare sector. The growing demand for high-quality healthcare services, coupled with financial constraints, necessitates the careful allocation of resources to maximize health outcomes. Cost-effectiveness analysis provides a systematic approach to evaluating the relative costs and health benefits of different interventions, enabling policymakers, clinicians, and other stakeholders to make informed decisions that optimize both clinical effectiveness and economic efficiency [1, 2].

The healthcare landscape is characterized by a diverse range of treatment options, technologies, and interventions, each with varying levels of effectiveness and cost. Traditional decision-making approaches often focus on clinical outcomes without fully considering the economic implications, potentially leading to suboptimal resource allocation. By integrating economic evaluation into the decision-making process, CEA offers a more comprehensive framework that accounts for both the costs incurred and the health benefits gained, ultimately guiding the selection of interventions that provide the greatest value for money [3, 4].

The role of CEA in healthcare decision-making has been increasingly emphasized in recent years. Recommendations for best practices in conducting and reporting CEA, such as those outlined in the Consolidated Health Economic Evaluation Reporting Standards (CHEERS), underscore the importance of transparency and rigor in economic evaluations [5]. Furthermore, the application of CEA in real-world settings often encounters challenges related to methodology and implementation, which can impact the effectiveness of resource allocation strategies [6].

The economic burden in healthcare has been an important concern for all parties concerned including the public, government, and industry since the community is continuously faced with difficult decisions about allocating healthcare resources. The current cost consciousness in healthcare is a response to the exorbitant expenses of certain medical interventions, technology, and regimens in comparison to their perceived health advantages. The strong desire to reduce healthcare costs leads to considering which interventions produce the greatest value, based on the economic effectiveness [1, 7]. Moreover, the significance of cost analysis has been emphasized in conjunction with the contexts of Comparative Effectiveness Research, Health Care Reform, and the Affordable Care Act [8].

Cost-effectiveness analysis (CEA) has become a crucial technique in appraising the efficiency of healthcare interventions and resource allocation decisions. Cost-effectiveness analysis is now widely used to evaluate whether the effect of a healthcare intervention justifies additional expenditure. The role of CEA in healthcare decision-making has been increasingly emphasized in recent years [9–12].

The importance of cost effectiveness analysis in healthcare cannot be overemphasized as it is instrumental in healthcare decision-making, providing a framework to ascertain the relative costs and outcomes of medical interventions, most commonly in quality-adjusted life years (QALYs). This approach helps policymakers and healthcare providers in optimizing resource allocation to ensure that healthcare interventions deliver proportionate benefits to justify their costs. Furthermore, CEA serves as a standard tool for comparing and appraising the cost-effectiveness of different interventions, providing a basis for informed decision-making in adopting new pharmaceuticals, medical devices, public health initiatives, and chronic disease management strategies [13]. Additionally, the integration of CEA into healthcare policy structures, as demonstrated by institutions like the National Institute for Health and Care Excellence (NICE) and the Pharmaceutical Benefits Advisory Committee (PBAC), echoes its essential role in determining resource allocation and funding decisions within the healthcare systems [14].

Bibliometric analysis is a quantitative method used to measure the impact and progression of scientific research within a particular field [15]. This method utilizes statistical techniques to evaluate various metrics derived from scholarly publications, such as citation counts, publication frequencies, authorship patterns, and collaboration networks. By examining these metrics, researchers can gain insights into the development, trends, and influence of specific research topics over time. Bibliometric analysis is designed to provide a comprehensive overview of the scholarly output within a given domain. It helps in identifying key research areas, influential authors, leading institutions, and prominent journals. The primary objectives of bibliometric analysis include assessing research productivity, understanding the structure of scientific knowledge, and evaluating the dissemination and impact of research findings. Bibliometric analysis has been applied to various fields to map out research trends and impacts [16–19].

The present study sets off to analyze the global research on cost effectiveness in healthcare using bibliometric means.

Methods

Data source

We used the PUBMED database for the bibliometric analysis. Over 34 million biomedical literature citations from MEDLINE, life science journals, and online

books are included in PUBMED [20, 21]. Supplementary information such as author affiliation and h index were obtained via Google Scholar.

Data collection

We analyzed the bibliometric data on cost effectiveness analysis in healthcare study in the PUBMED published from January 1, 2013 to December 31, 2023. We applied the following keywords: "Cost effectiveness" [Title / Abstract] OR "Cost effectiveness analysis" [Title / Abstract] AND "Healthcare" [Title / Abstract]. Without regard to the type of content and language, we obtained all results for the predetermined search query mentioned above. Bibliometric indicators were calculated using the retrieved data. We used Google Scholar to obtain the citation data for the authors and papers as PUBMED does not save citation records.

Screening protocol and criteria

Only articles with focus on cost effectiveness analysis within the filter time (2013 to 2003) were included. Articles that were not focused on cost effectiveness analysis or outside the time filter frame were excluded. There was no restriction on the type of article. Duplicate articles were also removed. The paper selection was carried out independently by two review groups consisting of the authors. Disagreements were resolved by both groups coming to a consensus. The Flow chat of the screening protocol is shown in Figure S1.

Visualization of social network analysis

We mapped terms from the cost effectiveness analysis and collaboration in the collected PUBMED data using VOSviewer (Center for Science and Technology Studies, Leiden University, The Netherlands) version 1.6.18.

Bibliometric indicators

Impact factor

The impact factor (IF), which was first created as a bibliometric indicator by the Institute for Science Information (Philadelphia, PA, USA), is used to gauge the journal's influence. Its value is frequently a sign of reputation and is updated yearly in Clarivate Analytics' Journal Citation Report (JCR). Except where noted, we used JCR data from 2023.

Author/Institution participation index

We reviewed all of the scientific publications in the field of cost effectiveness analysis in healthcare from 2013 to 2023. It is the proportion of an author's or institution's publications on a given topic (cost effectiveness analysis in this case) to all publications in that field.

Keyword analysis

We used keyword analysis to ratify the trend of discussion and research in view of cost effectiveness analysis in healthcare.

Co-authorship analysis

The interaction of authors who contribute to a certain field of study is referred to as co-authorship. Collaboration is demonstrated by writers' co-authorship of publications [22, 23]. The VOSviewer-generated co-authorship network map displays the cooperative social network of research domains.

Bibliometric mapping

Co-authorship mapping and co-occurrence mapping were the two categories into which bibliometric mapping was separated in this study. Relationships between keywords are referred to as co-occurrence, whilst author relationships inside research institutes are referred to as co-authorship.

The co-authorship network analysis visualization in this study made use of the following interpretation keys: The number or frequency of documents from an author or institution is reflected in the size of the nodes or bubbles (circles) inside the network. Second, the co-authorship link's existence and strength are correlated with or reflected by the lines or arcs connecting nodes. The node's color serves as the final legend: The colors of the nodes are assigned by the VOSviewer clustering algorithm based on an estimate of the degree of similarity between them. As a result, it is reasonable to assume that nodes of the same color are connected. Additionally, the more the relationship of two (2) nodes is closer, the shorter their distance from one another [22].

Results

Results of publication output

We retrieved 7680 publications and only included 7561 publications after removing articles that didn't meet the inclusion criteria. The trend showed a progressive increase along the 10-year time lag (Fig. 1). The tempo of research has been sustained and has remained ≥ 300 publications per year.

Analysis of proportion of articles by number of authors

Our result showed a large span of number of authors per document ranging from single author documents to 77 authors per document. The document with the most authors had 77 author signatures and the most frequent number of signatures was 5 authors (13.1%) (Table 1).

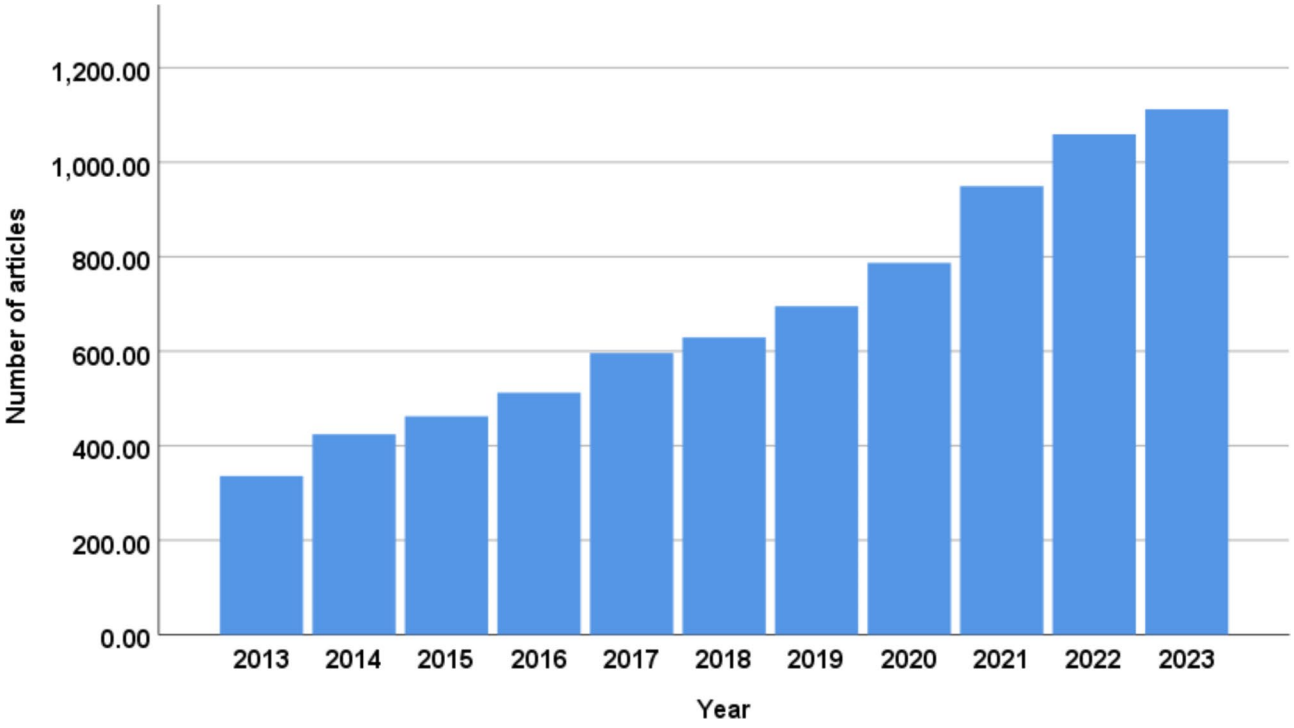

Fig. 1 Trend /evolution of cost effectiveness in healthcare research within the studied years

Analysis of most productive authors by principal author analysis

Table 2 shows the top 11 most productive authors in cost effectiveness analysis-related publication. Liew Dany, Ademi Zanfina, Hunt Barnabay, Bosmans Judith E, Postma Maarten J and You Joyce H were the leading authors among the 42,004 participating authors. Three of the 11 most productive authors were each affiliated with The Netherlands and Australia, while 2 were affiliated with United Kingdom. Each of the remaining were affiliated with China, Hong Kong and Switzerland.

Visualization of co-authorship analysis of authors

Figure 2 shows the network of co-authors made up of authors who have published at least eight (8) cost effectiveness analysis -related research. The node symbol represents an author while the node size represents activity/publications of the author, while links between the authors represent relationship between them.

Though the 7th most productive author, Zeng Xiaohui had the overall highest link strength among the authors that participated in cost effectiveness analysis-related research.

Overlay visualization of author network (Figure S2) showed Zhang Lei, Goa Lan, Postma Maarten, Ademi Zanfina and Liew Danny as more contemporary authors (202–2023; lemon to yellow shade) while Graves Nicholas, Jowett Sue, Bosmans Judith and Evers Sylvia were the old authors (purple shade).

Analysis of most productive institutions

The top most productive institutions in cost effectiveness research in healthcare were represented in Table 3. University of York ($n=97$; PI=1.26%) was the most productive institution, followed by University of Oxford ($n=85$; PI=1.11%), University of Toronto ($n=49$; PI=0.64%), University College, London ($n=46$; PI=0.60) and Erasmus University. Five (5) of the 11 most productive institutions are resident in UK, whereas the remaining are resident each (1) in The Netherlands, Switzerland, Australia, China and Canada.

Analysis of co-authorship of participating institutions

Figure 3 shows the collaborative network among institutions publishing cost effectiveness related research. The threshold for the mapping was set at minimum of 1 document. The plot showed institutions and sub institutions participating in cost effectiveness related research. The sub-institutions of University of York participating in cost effectiveness related research are: Centre for health economics, university of York, York ($n=34$: link strength=30), Department of Health sciences, University of York, York ($n=26$, LS=34), York trials unit, Department of Health Sciences, University of York, York ($n=9$; LS=5), Centre for Health Economics, University of York, Heslington, ($n=6$; LS=2), York Health Economics Consortium, University of York, York, ($n=6$; LS=1). The sub-institutions of University of Oxford that participated are: Nuffield Department of Primary care Health

Table 1 Trend of authorship signature

Number of author signatures	Frequency	Percent %)
1	265	3.5
2	498	6.6
3	735	9.7
4	902	11.9
5	987	13.1
6	901	11.9
7	698	9.2
8	580	7.7
9	410	5.4
10	332	4.4
11	247	3.3
12	204	2.7
13	157	2.1
14	111	1.5
15	84	1.1
16	82	1.1
17	55	0.7
18	48	0.6
19	43	0.6
20	45	0.6
21	27	0.4
22	19	0.3
23	18	0.2
24	15	0.2
25	13	0.2
26	14	0.2
27	11	0.1
28	6	0.1
29	3	< 0.1
30	5	0.1
31	6	0.1
32	9	0.1
33	7	0.1
35	4	0.1
36	2	< 0.1
37	2	< 0.1
38	5	0.1
40	1	< 0.1
41	2	< 0.1
42	2	< 0.1
44	1	< 0.1
47	2	< 0.1
55	1	< 0.1
65	1	< 0.1
77	1	< 0.1
Total	7561	100

Sciences, University of Oxford, Oxford (n=25; LS=22), Nuffield Department of Population Health, University of Oxford, Oxford (n=17; LS=14), Nuffield Department of Population Health, University of Oxford, Oxford (n=12; LS=12), Nuffield Department of Orthopaedics, Rheumatology and Musculoskeletal Sciences, University of Oxford, Oxford (n=12; LS=11), Health Economics Research Centre, University of Oxford, Oxford (n=7; LS=10), Department of Psychiatry, University of Oxford, Oxford (n=7; LS=8), Nuffield Department of Medicine, University of Oxford, Oxford (n=5; LS=4). The sub-institutions of University of Toronto are: Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto (n=10; LS=9), Dalla Lana School of Public Health, University of Toronto, Toronto, (n=8; LS=8), Department of Medicine, University of Toronto, Toronto (n=5; LS=6), Department of Psychiatry, University of Toronto, Toronto (n=5; LS=4), Institute of Health Policy, Management and Evaluation, University of Toronto, Toronto (n=5; LS=2), Faculty of Medicine, University of Toronto, Toronto (n=5; LS=0).

Analysis of sources with highest publication

Table 4 shows the sources with the highest number of cost effectiveness in health- related research. *BMJ Open*, *PLoS One*, *Journal of Medical Economics*, *Trials*, *Pharmacoeconomics*, *BMC Health Service Research*, *Value in Health*, *Health Technology Assessment*, *Expert Reviews of Pharmacoeconomics and Outcome Research*, and *Applied Health Economics and Health Policy* were the most utilized journals. All the top 10 sources have impact factor greater than 2. Two of these (*Pharmacoeconomics* and *Value in Health*) have impact factor more than 4. Eight (8) of them are ranked Q1 while the remaining 2 were ranked Q2. Seven of the journals are dedicated to health economics and health service, while 2 are multidisciplinary journal. *Trials* was the only clinical journal.

Keywords/Hotspot analysis

Figure 4 shows hotspot analysis of author keywords used in cost effectiveness analysis in healthcare- related studies. Keywords appearing at least 50 times were included in the map. The keyword had several keywords hinged on cost effectiveness analysis. These includes interventions such as monoclonal antibodies, antineoplastic agents, hypoglycemic agents, palliative care, tomography, X-ray, warfarin, etc.; disease conditions such as asthma, atrial fibrillation, breast neoplasm, carcinoma, hepatitis C, HIV infection, diabetes mellitus, hypertension, influenza, mental disorder, obesity, osteoporosis, pulmonary diseases, SARS-CoV-2, stroke, etc. also are, outcomes such as life expectancy, quality adjusted life years, treatment outcome, quality of life, etc. There are also protocols/procedure such as clinical trials, immunization program, survey questionnaire, Markov model, etc. The overlay visualization of the keyword showing older and more recent keywords are represented in figure S3.

Table 2 Top 11 most productive authors

Author name	PI (%)	LS	H-index	Affiliation	Country
Liew Danny	32 (0.42)	35	19,713	University of Adelaide	Australia
Ademi Zanfina	32 (0.42)	33	34	Monash University	Australia
Hunt Barnaby	31 (0.41)	24	NA	Ossian Health Economics and Communication.	Switzerland
Bosmans Judith E.	30 (0.40)	4	NA	Vrije Universiteit, Amsterdam	Netherlands
Postma Maarten J.	24 (0.32)	3	100,228	University of Gronigen	Netherlands
You Joyce H.	24 (0.32)	0	NA	Chinese University of Hong Kong	Hong Kong
Zeng Xiaohui	22 (0.29)	91	NA	Central South University	China
Graves Nicholas	22 (0.29)	2	56,566	Queensland University of Technology	Australia
Jowett Sue	21 (0.28)	20	9,937	University of Birmingham	UK
Evers Sylvia M.	21 (0.28)	12	15,538	Maastricht University	Netherlands
Maccrone Paul	21 (0.28)	5	30.976	University of Greenwich	UK

PI = participation index (number of documents); NA = not available

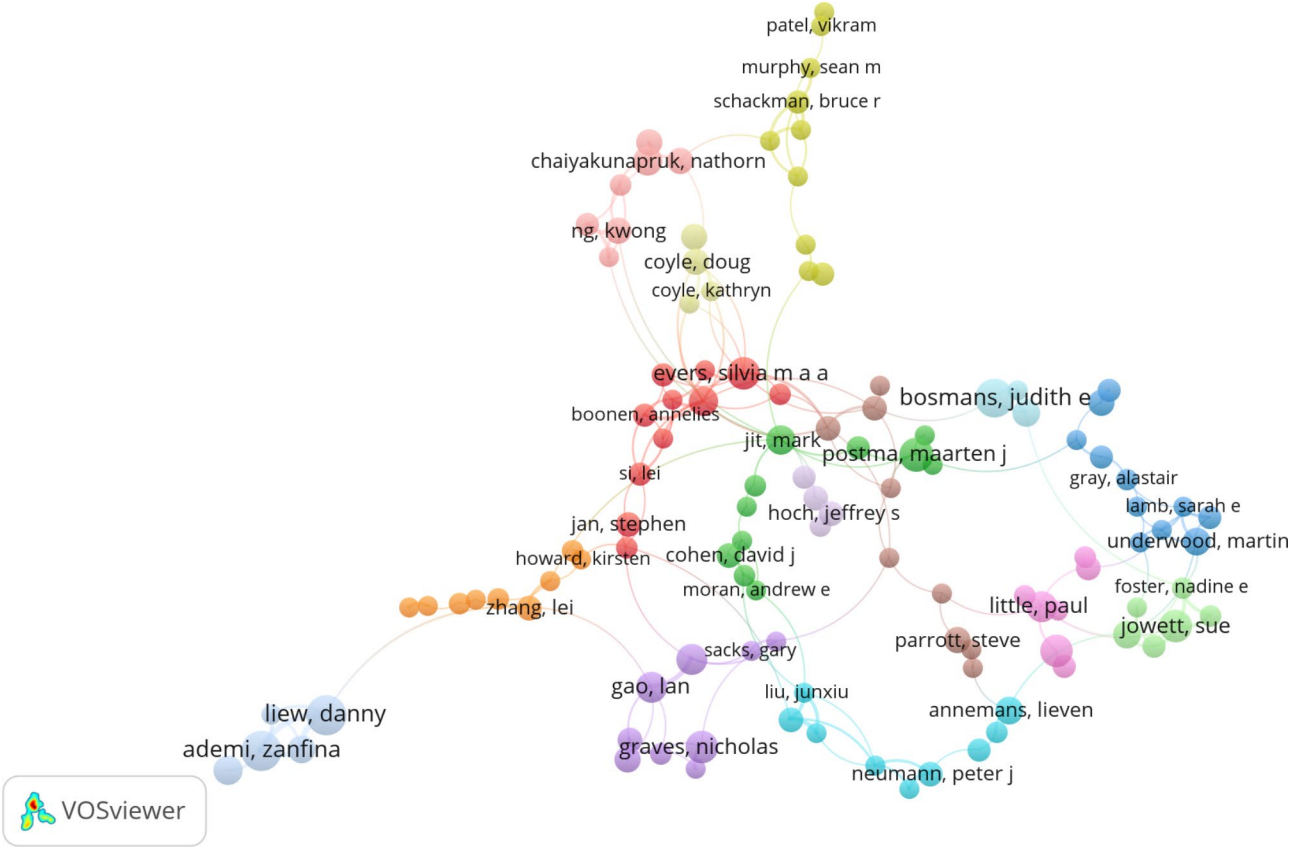

Fig. 2 Visualization of authors productivity and network

Discussion

This study provides a quantitative description of cost effectiveness in healthcare- related research in from 2013 to 2023 in PUBMED. The trend of research output on cost effectiveness in health showed a progressive increase and reassuring trend. The observed progressive growth in publications on cost-effectiveness in healthcare research highlighted the increasing realization of the importance and application of cost-effectiveness analysis in health economics and policy. It signifies several important implications for the field of health economics and policy-making. This trend reflects the increasing emphasis on evidence-based decision-making and the need to optimize healthcare resources effectively.

The core journals that served as sources for dissemination of cost effectiveness analysis in health care publication were *BMJ Open*, *PLoS One*, *Journal of Medical Economics*, *Trials*, *Pharmacoeconomics*, *BMC Health Service Research*, *Value in Health*, *Health Technology Assessment*, *Expert Reviews of Pharmacoeconomics and*

Table 3 Top 10 most productive institutions

Institution	Country	PI (%)
University of York	UK	97 (1.28)
University of Oxford	UK	85 (1.12)
University of Toronto	Canada	49 (0.65)
University College, London	UK	46 (0.61)
Erasmus University, Rotterdam	Netherlands	41 (0.54)
University of Sheffield	UK	39 (0.51)
University of Birmingham	UK	38 (0.50)
Ossian Health Economics and Communication, Basel	Switzerland	32 (0.42)
China Pharmaceutical University	China	32 (0.42)
Monash University, Melbourne	Australia	32 (0.42)

PI = participation index (number of documents)

Outcome Research, and *Applied Health Economics and Health Policy.* These journals are possible niche for future discourse on novel issues in cost effectiveness analysis in health care. Aside *BMJ Open*, *PLoS One and Trials*, the rest journals are dedicated to health economics. *BMJ Open* is a multidisciplinary medical journal [24] while *PLoS One* is an open access multidisciplinary science journal covering science, engineering, medicine, and the related social sciences and humanities [25].

University of York, University of Oxford, University of Toronto, University College, London and Erasmus University were the most productive institutions. University of York is a UK public higher education institution created by royal charter with 11 colleges. It houses over 20,000 students and 5,000 staff across 11 colleges [26]. On the other hand University of Oxford is a UK private independent, self-governing university with 36 colleges and three societies [27]. University of Toronto is a leading Canadian public university founded in 1827. It has 3 campuses and it is home to over 90,000 students with more than 19,000 international students from 163 countries and regions.

Institutions in the United Kingdom dominated publications in cost effectiveness analysis in healthcare publication research and accounted for 4.0% of all publications. This observation is contrary to previous bibliometric studies in medical subjects where United states dominated research outputs [28–30]. The United Kingdom has been reported to spend between 2.9 and 3% of GDP on research and development. This is way above the OECD and EU benchmarks [31].

Liew Dany, Ademi Zanfina, Hunt Barnabay, Bosmans Judith E, Postma Maarten J and You Joyce H, Zeng

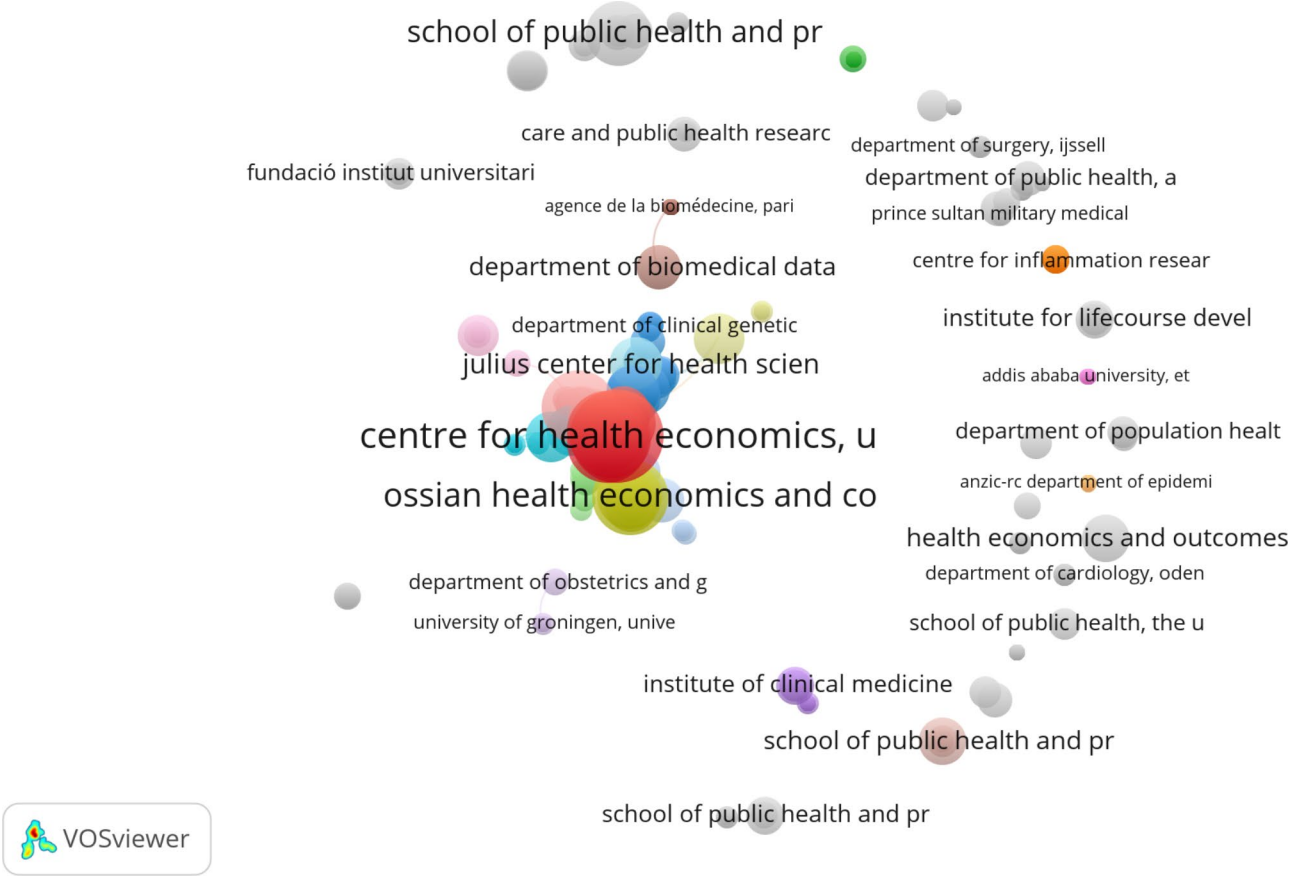

Fig. 3 Visualization of institutions productivity and network

Table 4 Top 10 most productive journal

Journal name	Journal abbreviation	PI (%)	Publisher	Quartile	IF
BMJ Open	*BMJ Open*	355 (4.7)	BMJ Publishing Group	Q1	2.4
PLoS One	*PLoS One*	228 (3.0)	Public Library of Science	Q1	2.9
Journal of Medical Economics	*J Med Econ*	202 (2.7)	Taylor and Francis	Q1	2.4*
Trials	*Trials*	155 (2.0)	BioMed Central Ltd.	Q2	2.5
Pharmacoeconomics	*Pharmacoecon*	155 (2.0)	Springer International	Q1	4.4
BMC Health Service Research	*BMC Health Serv Res*	124 (1.6)	BioMed Central Ltd.	Q1	2.8
Value in Health	*Value Health*	117 (1.5)	Elsevier Ltd.	Q1	4.5
Health Technology Assessment	*Health Technol Assess*	97 (1.3)	National Co-ordinating Center for HTA	Q1	3.6
Expert Review of Pharmacoeconomics and Outcomes Reviews	*Expert Rev Pharmacoecon Outcomes Res*	90 (1.2)	Taylor and Francis	Q2	2.3
Applied Health Economics and Health Policy	*Appl Health Econ Health Policy*	83 (1.1)	Springer International	Q1	3.1

PI = participation index (number of documents); * value from JCI of 2022

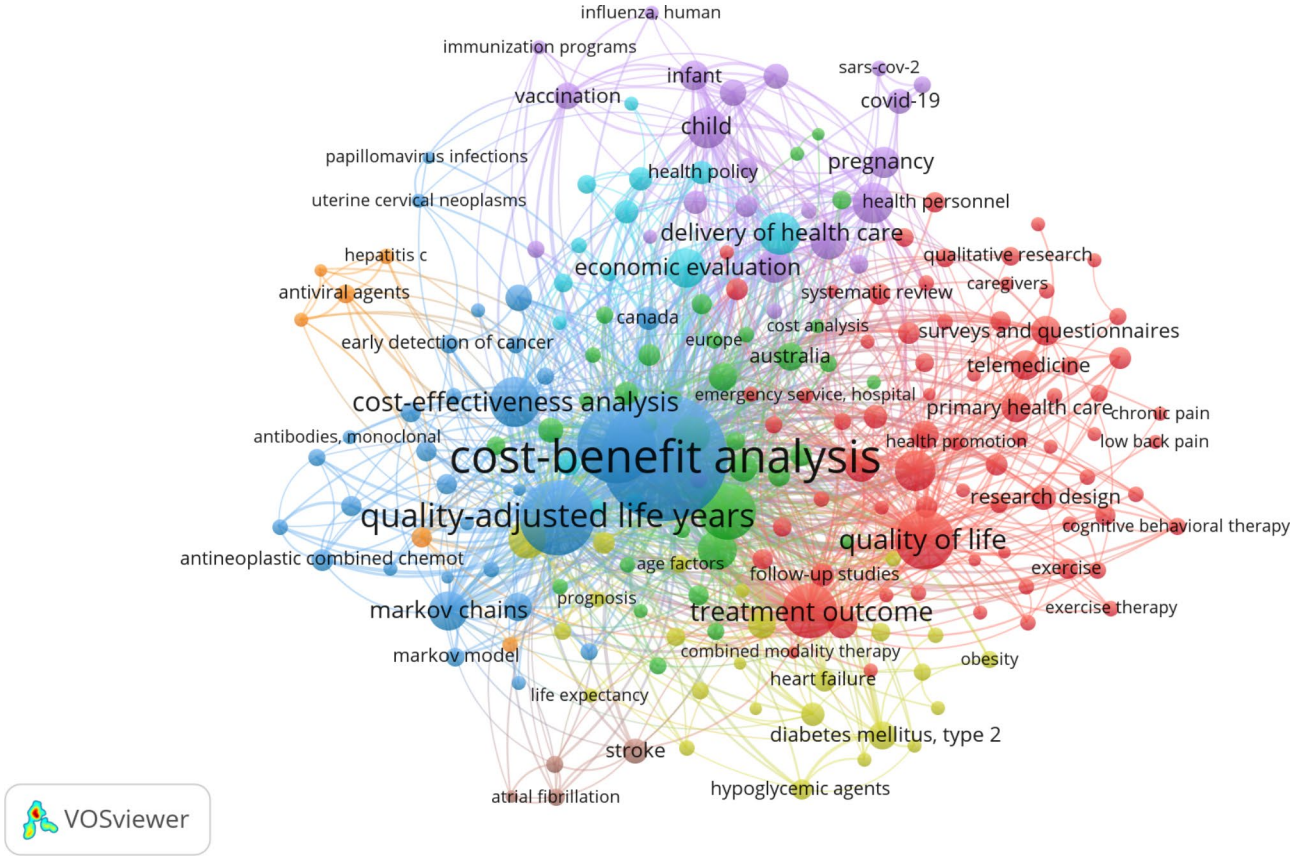

Fig. 4 Visualization of keyword analysis relating to cost effectiveness in healthcare research

Xiaohui, Graves Nicholas, Jowett Sue, Evers Sylvia, and Mccrone Paul, were the prominent authors in cost effectiveness in healthcare- related research. All the top 11 authors were specialized in health economics and had published mostly on that. Postma Maarten J maily specialized in pharmacoeconomics. On the other hand, in addition to research interest in health economics, Zeng Xiaohui is also involved in a couple of clinical trials. Zeng Xiaohui had the highest centrality and link strength as an author. Majority of the authors had H-index more than 9,000. This is a reflection of influential authors within their niche.

There could be several limitations to this study, which are typical of bibliometric research. First, the final result of the examined materials is determined by the standards delineated by the PUBMED database itself. Second, during the research period, local journals that were not indexed in PUBMED would have been overlooked. If the

authors hadn't included our particular search characteristics, we might have missed such article. Finally, because we could only access PUBMED, a free database, we might have overlooked certain articles that were only indexed in other places. Nonetheless, we think the results accurately reflect the research trend in the field of study.

Conclusion

Irrespective of the inherent limitations, we believe that this study has made available a significant representation of the trends in in cost effectiveness in health care-related research. We have shown that research in cost effectiveness in healthcare has grown significantly over time. The research trend was dominated by specialized authors who niched majorly in health economics and health service research. A good number of the publications were made in specialized journals. Institutions in UK dominated the research trend in in cost effectiveness in health care- related research.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12962-024-00576-7.

Supplementary Material 1: Figure S1: Flow chat of screening prtocol

Supplementary Material 2: Figure S2: Visualization of authors productivity and network in overlay view

Supplementary Material 3: Figure S3: Visualization of keyword analysis relating to cost effectiveness in healthcare research in overlay view

Acknowledgements
Not applicable.

Author contributions
Conceptualization: HUO, KLO. Data curation: HUO, Analysis: KLO, HUO, LOU, COE, EIO. Initial manuscript draft: HUO, KLO. All authors read and approved the final manuscript.

Funding
There was no specific funding for this research.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study is based on analysis from secondary data, thus, did not require ethical clearance.

Consent to publish
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 14 July 2024 / Accepted: 4 September 2024
Published online: 16 September 2024

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