Educational Reforms and Healthcare Competitiveness through Data-Driven Analysis

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Abstract: *The study deals with the important question of how educational reforms affect healthcare competitiveness, especially when it comes to medical education. The primary study goal is to investigate the connection between improvements to the educational system and the calibre of medical care. To provide a thorough examination of trends over previous ten years, the study focusses on a dataset of 2,646 articles published between 2013 and 2023, taken from the WoS and Scopus databases. The necessity to record current and pertinent advancements in medical education and healthcare justifies the selection of this time frame. The CiteSpace and Biblioshiny programs were applied to conduct a bibliometric analysis, enabling the identification and visualisation of significant patterns and trends in the literature. The research hypothesis was verified by the analysis, which showed a strong association between educational changes and increases in healthcare quality. According to the report, health literacy, health disparities, and medical education are the most important topics. Improving healthcare competitiveness depends on these areas. Policymakers, educators, and healthcare administrators can benefit from the research findings because they offer evidence-based perspectives that can direct future medical education reforms to enhance healthcare outcomes and system competitiveness. The results also point to potential prospects for future investigation, especially when evaluating the long-term effects of educational reforms on international healthcare systems.*

Keywords: educational reforms, CiteSpace, R Studio, bibliometric analysis

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INTRODUCTION

In order to boost competition in the healthcare sector, educational reforms are required. Particularly in the area of medical education, the continually evolving demands of the health sector necessitate a constant upgrading of the educational basis (Sahlberg, 2007). The workforce need is highly competent and flexible. It has never been higher as health systems throughout the globe grapple with issues, including the rise of new diseases, technological advancements in medicine, and shifting demographics (Indrawati & Kuncoro, 2021). Through curricula development that is adaptable to these rapid changes, educational reforms seek to close the gap between traditional medical education and today's healthcare needs.

Education has a direct impact on health by improving general self-awareness about one's own well-being and facilitating easier access to treatment (Raghupathi & Raghupathi, 2020). Modern reforms seek to include cutting-edge teaching methods and new technologies into the classroom in addition to merely improving medical education standards. To guarantee that medical students have the skills they need to thrive in a highly competitive environment, some strategies use artificial intelligence (AI) in education, problem-based learning (PBL), and simulation-based learning (SBL). These methods not only raise teaching standards but also provide students with the analytical and problem-solving abilities they need to handle medical issues (Lerchenfeldt et al., 2020).

A crucial element of these modifications is the focus on giving students practical work experience. This entails exposure to a range of medical settings, clinical rotations, internships, and practical training in addition to academic understanding. During their studies, students can engage in real-life medical scenarios to build the competence needed to manage complex healthcare tasks (Pottle, 2019). This practical experience is essential to ensure that graduates are not only knowledgeable but also capable of applying knowledge to practical settings. It ultimately leads to better treatment outcomes and raises healthcare standards as a whole.

Educational reforms are important because they have an immediate impact on the preparation of highly skilled professionals who can work in a rapidly evolving scientific and medical technology environment (Frenk et al., 2022). Health practitioners need to be able to swiftly adopt medical innovations into their practices because they are always being introduced to new technologies and therapies. Health professionals will be better equipped to adjust to these changes and maintain their competitiveness in global healthcare. It is possible due to redesigned educational programs that emphasize technological advancements.

Furthermore, enhanced education for medical practitioners plays a major role in bolstering international medicine legitimacy (Blake, 2022). The quality of medical education becomes a crucial aspect in determining a country's competitiveness in the global healthcare business. Healthcare gets more globalized and professionals frequently collaborate on international healthcare projects across boundaries (Suzuki et al., 2008; Goodson & Vassar, 2011; Gupta et al., 2022). Health professionals in nations that make proactive educational reform investments are more likely to be leaders in medical innovation, research, and practice in addition to being highly skilled practitioners (Rohrer Vitek et al., 2017).

Finally, the quality of health services is directly related to the education level of health workers (Vuori, 1980). By ensuring that medical education is up-to-date with the latest science and technology, educational reforms play a critical role in improving the quality of patient care. This increases patient satisfaction, reduces medical errors, and leads to better health outcomes (Tran et al., 2022). In a competitive healthcare environment, the ability to provide high-quality healthcare services is relevant, and educational reforms play an important role in achieving this goal. Thus, enhancing the education of health workers is not simply an end in itself, but a strategic imperative that impacts on the competitiveness and quality of healthcare.

This article's main goal is to use data-driven analysis to examine the connection between healthcare competitiveness and educational improvements. It aims to comprehend the ways in which modifications to the educational system, specifically in medical education, affect the competitiveness and quality of healthcare services. In order to do this, the article will use the CiteSpace tool, which makes it easier to see and analyse scientific publications. That will analyse the body of existing literature and focus on important trends and patterns.

The following research questions are investigated in the current study within the parameters of these goals and the previously indicated concerns:
1. What are the key characteristics and trends in the existing body of research within the field?
2. Which countries and affiliations are the most influential in the research domain?
3. What are the prevailing topics and emerging trends in the field?
4. How do research topics interrelate and evolve?
5. What are the patterns of international collaboration and network centrality in the research field?

LITERATURE REVIEW

The socioeconomic development of many nations is intimately associated with evolution of educational reforms, and this relationship has a substantial effect on the healthcare system and the economy at large. There are a few notable historical stages of educational reform that have had varying effects on these domains.

Early educational reforms (19th century). As manufacturing progressed in the 19th century, many nations realized how crucial organized education was to producing a trained labour force. The earliest national initiatives to enhance basic education were specifically implemented by Britain and Germany (Wollschlager & Guggenheim, 2004). These changes were important in hastening economic expansion and establishing the groundwork for additional social changes, such as better healthcare.

Reforms of the 20th century and the interwar years. World War II saw a more methodical approach to educational improvements. To rebuild and modernize the economy, government programs in the US, Japan, and Europe started to focus not just on quantitative but also on qualitative advances in education (Beauchamp, 1987; Van de Werfhorst, 2019; Bessmer, 2020). Increased funding for science and technology coincided with these reforms, and this investment resulted in notable advancements in healthcare and medicine.

Changes that occurred in the late 20th and early 21st centuries. Information technology and globalisation shaped the late 20th and early 21st centuries, necessitating new methods of teaching (Palvia et al., 2018). Numerous nations, like Finland, Singapore, and South Korea, implemented educational reforms that prioritize creativity, innovation, and the acquisition of skills necessary for global economic participation (Ng, 2020; Jung & Ahn, 2021; Miseliunaite et al., 2022). Through advancements in research and technology, these reforms have not only enhanced the quality of education but also significantly improved healthcare.

One of the important topics examined in socioeconomic development is the relationship between the standard of education and health. Empirical evidence indicates that enhancing educational institutions has a direct impact on population health and the scope of healthcare provided. Both are critical for promoting social and economic prosperity (Raghupathi & Raghupathi, 2020).

The body of research demonstrates a clear connection between population health and educational quality. Specifically, research indicates that improved general population health is positively correlated with higher levels of education (Jehn, 2022). Those with higher levels of education lead healthier lifestyles, are better able to prevent disease, and have access to better medical care. Additionally, studies show that women's education levels are particularly significant for enhancing the health of their children and families since educated mothers are more likely to seek medical attention and heed advise from doctors (Tran et al., 2021).

The healthcare system's ability to deliver high-quality healthcare services at a level that is similar to leading international standards while efficiently employing resources is one aspect of the competitiveness concept in the healthcare industry. In this context, the term "competitiveness" refers to the degree of professionalism of medical staff, the availability and calibre of healthcare services, the effectiveness of healthcare facilities, and the system's capacity to adjust to advances in technology and medicine.

METHODOLOGY

Data extraction

The association between educational reforms and healthcare competitiveness was examined in this study using data from credible sources, such as Web of Science (WoS) and Scopus. They are well-known and reliable techniques for bibliometric analysis of scientific publications. These databases were selected due to their extensive coverage and excellent indexing accuracy of scientific knowledge. The data was gathered on 19 August 2024. All search criteria are represented in Table 1.

Table 1. Prisma Process to Collect 2,646 Articles in Scopus and 2,179 in WoS for Our Analysis

Search identification	Records identified via Scopus searching (n = 2,646) and WOS searching (n = 2,179)
Screening data	Screened records (n = 2,646)
Acceptance data	Full text articles assessed for eligibility (n = 2,646)
Inclusion data	Articles used in bibliometric analysis (n = 2,646)

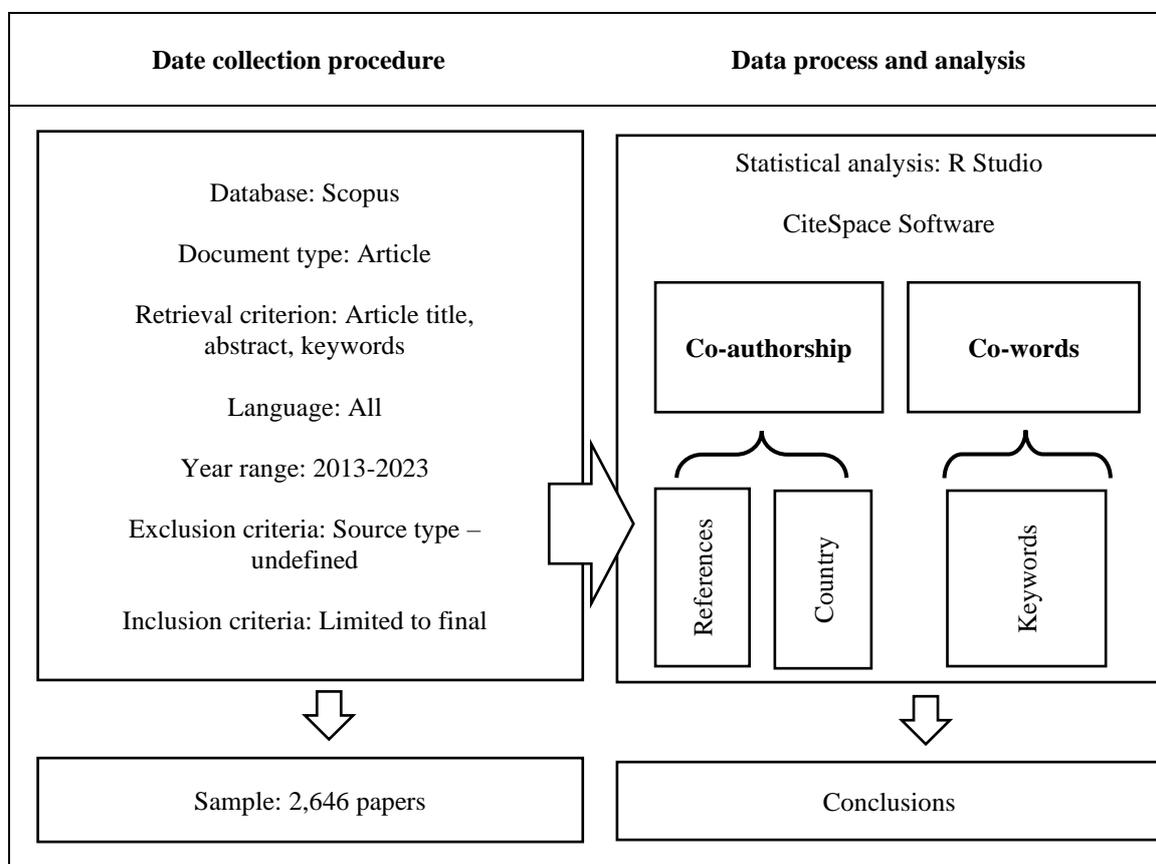*Source: Developed by the authors (based on Scopus and WoS data)*

The main data sources for our study were the Social Science Citation Index (SSCI), the Science Citation Index Expanded (SCIE), the Emerging Science Citation Index (ESCI), and the Arts & Humanities Citation Index (AHCI) provided by the WoS Core Collection (WOSCC). These indices provide comprehensive

coverage of the scientific literature, which allows for more accurate bibliometric analyses.

The following keywords were used to search for Scopus publications: ("education reform" OR "education policy" OR "curriculum development" OR "medical education" OR "training in healthcare" OR "healthcare education" OR "professional development" OR "workforce education" OR "health literacy") AND ("healthcare competitiveness" OR "health system performance" OR "medical service quality" OR "healthcare quality" OR "healthcare efficiency" OR "innovation in health" OR "health outcomes" OR "health access"). Articles containing these words in titles, abstracts or keywords were selected for analysis.

For the type of documents, "Article" was selected. Only the final articles were selected. To obtain more accurate results of bibliometric analysis, full-year data were estimated (Donthu et al., 2021). Thus, only articles published between 2013 and 2023 were included in the study, excluding articles published after 2024.

The WoS and Scopus databases were searched for documents based on the above-mentioned criteria. In accordance with the recommendations of earlier research (Moral-Muñoz et al., 2020; Chhabra et al., 2021; Di Vaio et al., 2022), we gathered 2,646 articles related to our study topic for additional analysis by following the procedure shown in Figure 1. The collected articles were further edited, removing duplicates and emphasising peer-reviewed studies to ensure their relevance to study goals. We were able to create a solid dataset with this method, which served as a firm basis for the bibliometric study that followed.

Figure 1. The Integrated Analysis Framework

Source: Developed by the authors (based on Scopus and WoS data)

Data analysis

Various methodologies and analytical instruments were employed to accomplish the study goals. The data from open sources were handled and statistically analysed via the R Studio tool Bibliometrix and the Biblioshiny App. The study examined 2,646 publications covering different facets of educational reforms and how they affect the healthcare system. These data offered a wealth of material for study and made it possible to derive reliable results from statistical processing. Some of these works' conclusions are based on specific databases linked to education reform and health, such as the UNESCO Education Databases and the World Education Reform Database (WERD). These sources include reputable databases like Scopus and Web of Science (WoS).

Besides, the study used the CiteSpace tool to conduct bibliometric analysis of scientific literature. It is a program that runs on Java (Niazi, 2016). Cluster analysis, social network analysis, and other numerous techniques are combined by this scientific literature data mining and visualisation software. The comprehensive analysis of co-citation data of scientific research articles, the examination of knowledge structure in pertinent knowledge domains, the identification of trends and correlations in research development, and the determination of betweenness centrality within critical points in the scientific literature are what makes it novel. It provides this data as a colour atlas that can be used to investigate the speciality dynamics in terms of time-variant mapping from a research front to its intellectual basis (Chuhan, 2021).

With the help of this instrument, publication trends, important topics, notable writers, and the most significant research on educational changes and their impacts on health competitiveness were examined. CiteSpace made it possible to visualize network citation patterns and focus on the key temporal trends and clusters in the scientific literature.

This study made use of CiteSpace 6.1. R3, the most recent version. The parameter settings used in our analysis are listed in Table 2. Following them, networks and specifics about authors, articles, and journals with citation counts were acquired through the CiteSpace use.

Table 2. CiteSpace Parameter Settings

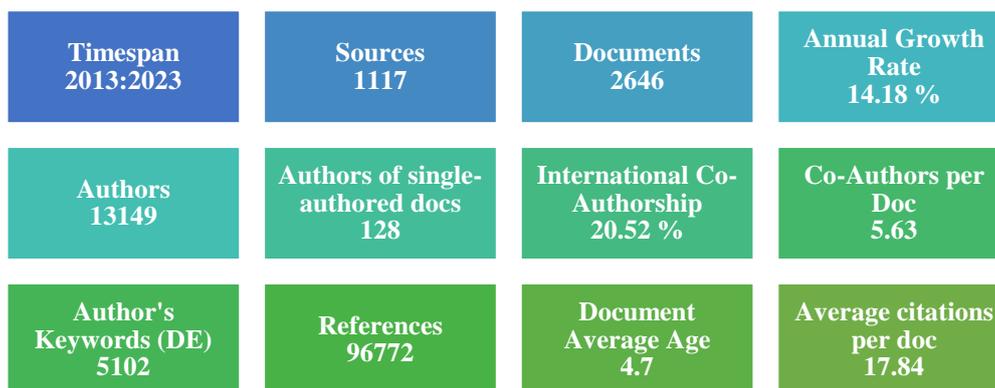| Parameters	Conceptualization
Time slicing	*#1 year per slice*
Pruning	Segmented networks with pruning and pathfinder
Node type	Country, Keyword, Cited References
Links	Default
Selection criteria	g-index (k = 10)
Visualization	Static cluster view and merged network

Source: Developed by the authors (based on CiteSpace 6.1. R3)

RESULTS

Publication statistics

The major publishing rank and trend of this field are intended to be displayed by publication data, which determines field popularity, emergence, topics, and journals that are most favoured by scholars.

An extensive examination was performed among publishing patterns and data in the field using Biblioshiny, a tool available in R Studio (Figure 2).

Timespan 2013:2023	Sources 1117	Documents 2646	Annual Growth Rate 14.18 %
Authors 13149	Authors of single-authored docs 128	International Co-Authorship 20.52 %	Co-Authors per Doc 5.63
Author's Keywords (DE) 5102	References 96772	Document Average Age 4.7	Average citations per doc 17.84

Figure 2. Main Information of the Dataset

Source: Developed by the authors (based on the Scopus database using Biblioshiny App)

The data shows that scholarly curiosity increased significantly between 2013 and 2023, as evidenced by an annual growth rate of 14.18%. With an average of 5.63 co-authors per document and 20.52% of publications involving foreign co-authorship, the data also reveals a strong trend towards collaboration. This points to the existence of an expanding international research network devoted to examining the relationship between healthcare competitiveness and educational changes.

Annual publication number analysis

Figure 3 shows a graph of annual scientists' performance from 2013 to 2023. It indicates that the number of documents published annually is rising steadily, with a notable uptick in 2019. The upward trend indicates an increase in interest and research efforts in the sector, which could be attributed to the increased significance and awareness of education as well as healthcare-related topics.
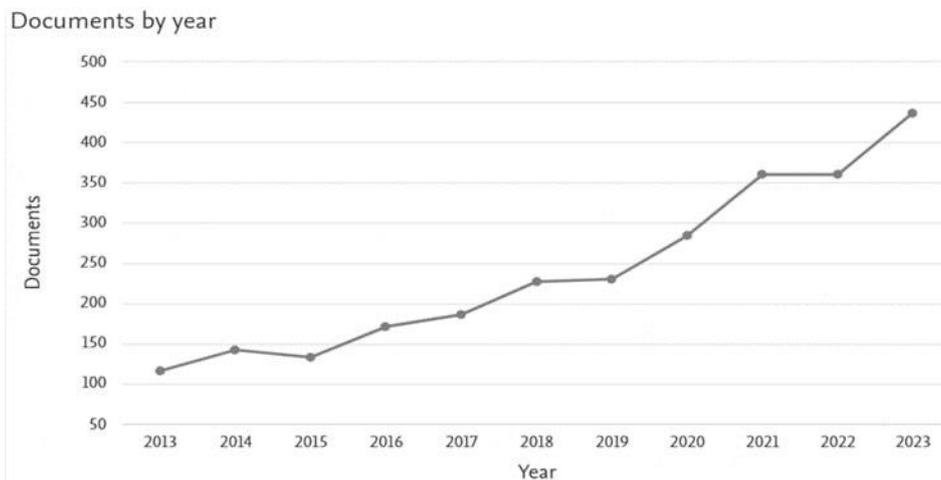
Figure 3. Annual Scientific Performance

Source: Developed by the authors (based on Scopus)

COVID-19, which probably sparked a boom in research on healthcare systems, public health, and their interface with education, could be blamed for a rapid increase from 2020. More research in health literacy and remote learning may have resulted from the pandemic emphasis on these topics. A quick transition to online learning environments brought to light the vital importance of digital literacy and fair access to technology (Haleem et al., 2022). As populations needed proper information to navigate the pandemic, public health programs targeted at boosting health literacy became more important. These elements probably contributed to a notable surge in academic production as scholars worked to overcome these obstacles.

Publication affiliation analysis

A three-field map connecting affiliations (AU_UN), keywords (DE), and nations (AU_CO) is shown in Figure 4. The breadth of the bands connecting the USA, Australia, and Canada to different terms in visualisation indicates these three countries are the top contributors to research in this field.
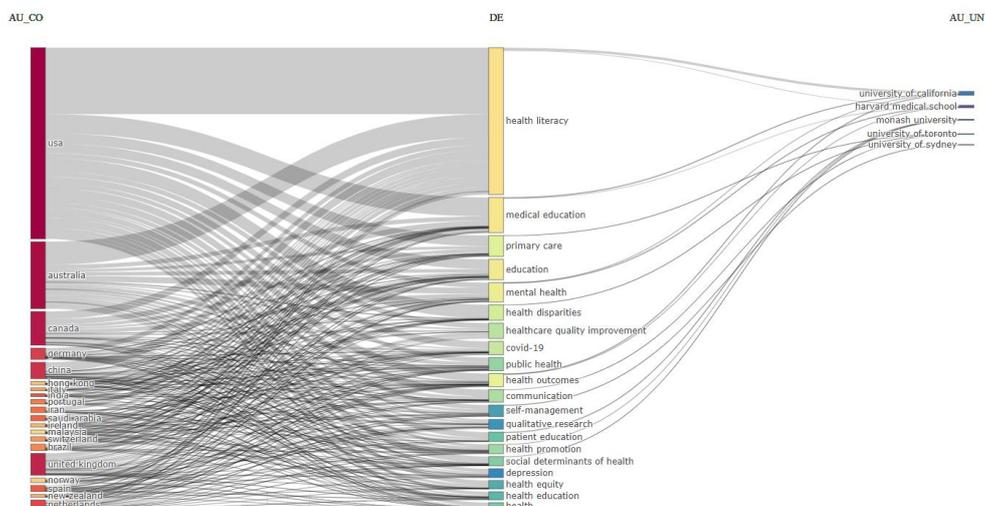

**Figure 4. Three-Field Plot (Countries-Keywords-Affiliations)**

Source: Developed by the authors (based on Scopus using Biblioshiny App)

The main research terms in this discipline are "primary care", "medical education", and "health literacy", which represent the main areas of interest. Leading universities like the University of California, the Harvard Medical School, and Monash University are closely linked to these phrases, indicating that these institutions are at the research forefront in these particular fields.

The intricate web of relationships spanning nations, keywords, and affiliations emphasizes how collaborative this field of study is. The USA play a major role in setting research trends, as evidenced by its dominant position and strong links to elite institutions (Maclean et al., 2021). The existence of keywords like "health disparities" and "COVID-19" among others indicates how the pandemic has affected research priorities and the awareness of health disparities around the world.

Furthermore, the findings show that the value of cross-disciplinary research is being increasingly acknowledged. The relationship between education and healthcare is becoming clearer since education directly affects health outcomes by influencing things like lifestyle choices, health literacy, and access to care. Therefore, educational reforms should be incorporated into public health initiatives to improve population health and guarantee the effectiveness and equity of healthcare systems.

Figure 5 highlights the highest affiliations in a particular topic by showing the number of publications produced by different institutions. The University of California is in the first place with 153 articles, according to the statistics, which ranks the best universities according to article output. The University of Toronto and Monash University, with 116 and 100 publications, respectively, are two more notable providers. These universities' strong research programs and vibrant academic communities are demonstrated by the great volume of publications they produce.
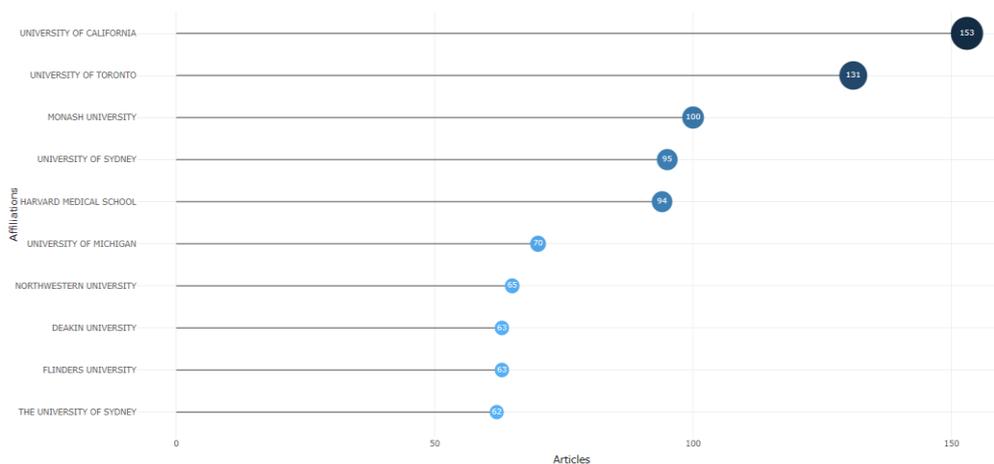
Figure 5. The Most Relevant Affiliations

Source: Developed by the authors (based on Scopus using Biblioshiny App)

Research in these areas must keep growing because the world is still facing problems. It may produce creative solutions that are responsive to the demands of cultures worldwide, which is based on thorough academic research (Wowk et al., 2017). The results show a shift in research efforts towards collaboration, interdisciplinary approaches, and worldwide relevance, in addition to a numeric increase in publications.

Potential causes for high article counts

- *Strong research funding:* Institutions like the University of California often benefit from substantial research funding, which is crucial to conducting extensive and diverse research projects (UCOP Office of Research and Innovation, 2021). This financial support not only facilitates advanced research but also attracts top faculties and researchers who contribute to the high volume of published work.

- *Large research community*: Universities such as the University of Toronto and Monash University boost large and diverse faculties, including numerous research groups (Monash University, 2019). This extensive academic community naturally leads to a higher number of publications as various research projects are carried out simultaneously across different departments and disciplines.

- *Interdisciplinary research:* These institutions might also engage heavily in interdisciplinary research, which explores a broader range of topics and subsequently produces a higher number of articles.
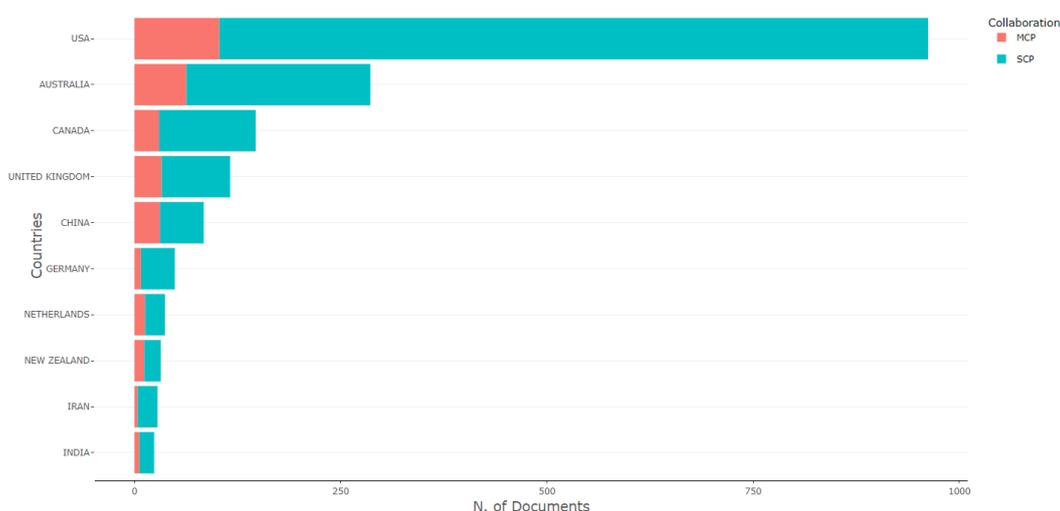
Interdisciplinary approaches often lead to innovative findings that are likely to be published in various high-impact journals, further boosting the institutional publication count.

According to the data, top universities probably produce research that is prolific in number, high quality, and impact. A considerable emphasis on research production as a gauge of academic performance may be indicated by the capacity to create a large number of papers. Besides, it appears that interdisciplinary approaches, community size, and research funding are important determinants of institutional research output because of the association that exists between these attributes with high article counts.

This pattern might be used as a guide by other institutions hoping to boost research output. It is possible for other universities to increase their own publication counts and academic prominence in their particular fields. That is done by focusing on new financing, cultivating sizable and vibrant research communities, and encouraging interdisciplinary collaboration.

Publication country analysis

Figure 6 illustrates the number of documents associated with corresponding authors from different countries. They are divided into two categories: MCP (Multiple Country Publications) and SCP (Single Country Publications). The USA leads with a substantial margin, followed by Australia, Canada, and the UK. The dominance of SCP (Single Country Publications) in most countries, particularly the USA, suggests that much of the research is being conducted domestically without extensive international collaboration. An exactly similar situation is with the rank of the most cited countries (Figure 7).

Figure 6. Corresponding Author's Countries

Source: Developed by the authors (based on Scopus using Biblioshiny App)

Figure 7. The Most Cited Countries

Source: Developed by the authors (based on Scopus using Biblioshiny App)

Publication category analysis

The most often occurring terms found in the dataset are shown in Table 3, which also highlights important topics in the academic literature.

Table 3. The Most Frequent Words in Scopus

Words	Occurrences
Health literacy	674
Medical education	154
Education	89
Mental health	78
Health outcomes	64
Primary care	64
Health disparities	61
COVID-19	52
Healthcare quality improvement	52
Communication	50

Source: Developed by the authors (based on Scopus using Biblioshiny App)

The terms are included in the table with the number of occurrences for each. "Health literacy" appears most frequently (674 times). This suggests that the examined corpus of material has a strong emphasis on health literacy.

The terms "medical education" and "education" are also noteworthy. They appear 154 and 89 times respectively, indicating the importance of educational topics in health. Words like "health outcomes" (64 occurrences) and "mental health" (78 occurrences) further highlight the importance of well-being and health-related outcomes.

The terms "primary care" (64 occurrences), "health disparities" (61 occurrences), and "COVID-19" (52 occurrences) are present because they draw attention to the continued challenges in public health, especially with regard to accessibility and equity of healthcare. Besides, the terms "healthcare quality improvement" and "communication", with 52 and 50 occurrences, imply an emphasis on enhancing healthcare procedures and the significance of proficient communication within healthcare environments.

The word cloud depicted in Figure 8 illustrates the terms that appear most frequently in a specific dataset, most likely associated with scholarly articles or research topics found in Scopus. Every word size represents its prominence or frequency. Larger words have greater significance or frequency.

Figure 8. Word Cloud

Source: Developed by the authors (based on Scopus using Biblioshiny App)

The fact that the term "health literacy" is most frequently used suggests that the body of literature or study under analysis revolves around this idea. The ability of a person to access, comprehend, and apply health information to make well-informed decisions on their healthcare and well-being is known as health literacy.

Secondary topics:

- *Medical education:* The second most important term indicates a heavy emphasis on medical education procedures. Research on developing curricula, creative teaching strategies, and training healthcare

workers may fall under this category.
- *Mental health:* The phrase appears frequently, highlighting its significance in the study and perhaps suggesting an emphasis on the relationship between mental health and health literacy.
- *COVID-19:* The addition of "COVID-19" implies that the pandemic effects on public health and health literacy have informed current study.

It highlights the importance of health literacy in "primary care" settings, probably with an emphasis on managing chronic illnesses and patient education.

"Social determinants of health" shows interest in the ways that social determinants affect health outcomes in general and health literacy in particular. The terms "health disparities" and "health equity" imply that the study may be addressing issues of disparity in healthcare outcomes and access, which may be related to differences in health literacy across various communities. The word "education" may refer to a more comprehensive examination of how health literacy is incorporated into other educational environments, going beyond medical education. The terms "public health" and "health promotion" denote an emphasis on more comprehensive public health programs meant to raise health literacy in local communities.

A timeline-based bubble plot illustrating the historical development of particular phrases (topics) is displayed in Figure 9.
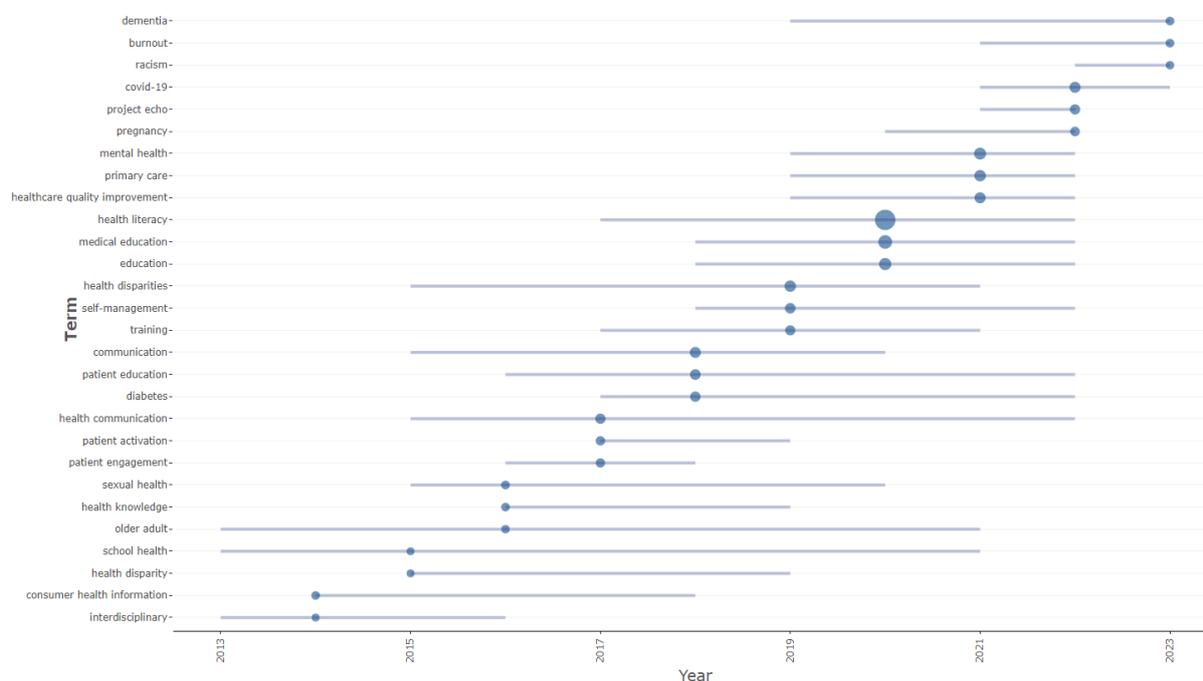
Figure 9. Trend Topics in Scopus

Source: Developed by the authors (based on Scopus using Biblioshiny App)

The topics on the vertical axis suggest that the terms are associated with public health, education, and healthcare. The bubble size on the horizontal axis, which runs from 2013 to 2023, represents the frequency or importance of certain terms appearing in research articles over time. The length of time that each term has been the topic of active discussion or research is indicated by the horizontal lines.

It seems that a number of terms first appeared in 2015 or 2016. They have either grown or stayed the same over time. The terminology that was first introduced, such as "interdisciplinary", "consumer health information", and "school health", seems to have a longer lifespan but becomes less popular as newer terms catch on. The years 2020 and after show a notable increase, which is consistent with more studies being done on topics like "COVID-19", "burnout", and "mental health". This is in line with the worldwide pandemic and the consequences it has had on society and healthcare.

Although they are relatively new phrases, terms like "COVID-19", "burnout", "racism", and "mental health" show a fast rise in popularity in 2020-2021. This accompanies actual occurrences like the COVID-19 pandemic and the general public's increased consciousness of social justice and mental health issues. There has been less activity in recent years on some previous topics, such as "interdisciplinary", "consumer health

information", and "school health", which may indicate saturation or changes in the study focus.

The term "COVID-19" exhibits a strong increase that culminates around 2020. This is to be expected given the attention being paid worldwide to comprehending, managing, and reducing the pandemic. "Mental health" and "burnout" also experience significant increases, which is consistent with the period's considerable focus on mental health problems. It is probably caused by pandemic effects on healthcare personnel and the general public. Terms like "primary care" and "pregnancy" appear to be continuously present without clear peaks in 2020 whereas terms like "racism" and "burnout" seem to be on the rise. This may suggest that, in contrast to more reactive topics, these are persistent but lower-priority study fields.

As a result, the graph successfully conveys the dynamic character of research trends throughout time. It shows how major influences on study focus come from worldwide occurrences like the COVID-19 epidemic. While older, more established issues keep attracting attention, albeit with less volatility, emerging topics demonstrate how responsive academics and politics are to the current global health challenges. Terms like "mental health" and "COVID-19" have become very popular, indicating how important these topics are to people both now and in future.

The clustering of topics based on influence and centrality is shown in Figure 10. Two axes of the graph stand for influence (topic contribution to the body of research literature) and centrality (topic significance within the network of relationships).


Figure 10. Clustering by Coupling

Source: Developed by the authors (based on Scopus using Biblioshiny App)

This graph shows that several clusters of issues connected to "health literacy" are present. In the upper left quadrant ("high influence – low centrality"), there are the topics "health literacy" (24.9%), "health disparities" (40%), and "health outcomes" (28.6%). Although these topics contribute significantly to research publications, they are not central to the scientific connection network. The topics "quality of life" (57.1%), "public health" (66.7%), and "health literacy" (17.1%) are in the lower left quadrant ("high centrality – low influence"). Although they are less influential than other clusters, they are highly central in the scientific connection network. The topics "health literacy" (34.3%), "ageing" (100%), and "health disparities" (40%) are prominent and have a major impact on research. They are found in the lower right quadrant ("high centrality – high influence").

Key topics that frequently occur together in the study literature are identified by the co-authorship and co-citation network shown in Figure 11. "Health literacy" is the central node in the network, connecting a number of other issues. Strong connections between topics including "self-management", "health behaviour", "diabetes", "social determinants", and "chronic disease" are shown by the network, highlighting the complexity of health literacy and its connections to a range of public health concerns. The network emphasizes the significance of topics like "equity", "health outcomes", "patient education", and "health communication" for the field research. The other network nodes that are connected to medical topics including "mental health", "public health", "primary care", and "quality improvement", highlight the significance of health literacy in enhancing a range of care-related areas.
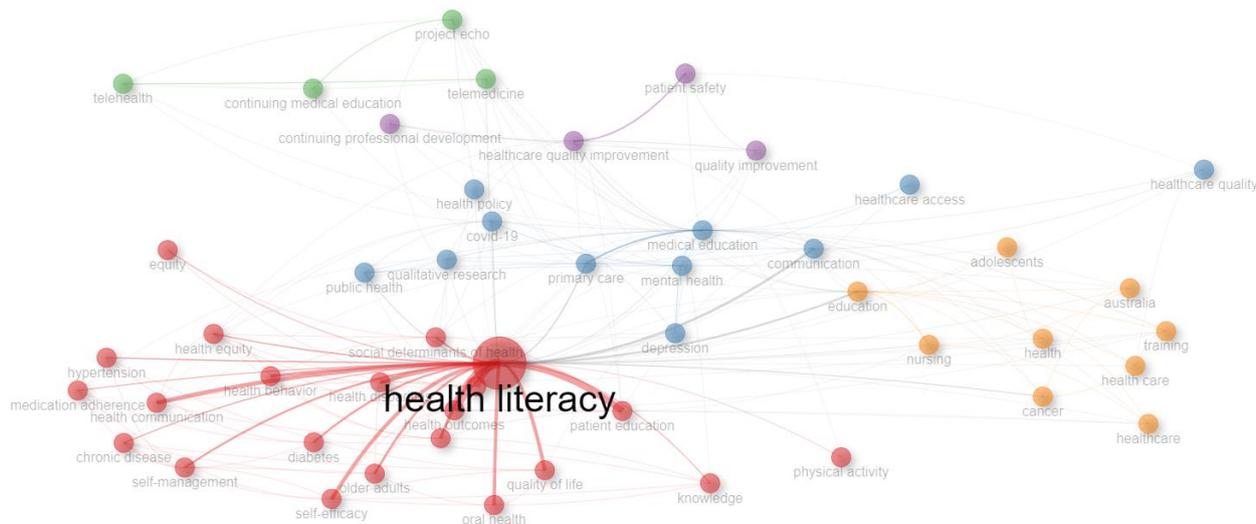
Figure 11. Co-Occurrence Network

Source: Developed by the authors (based on Scopus using Biblioshiny App)

Thus, the data highlight the centrality of health literacy as a key topic connecting diverse research areas such as disparities in access to care, chronic disease self-management, patient communication and behavioural health.

The topical evolution of research subjects spanning four time periods (2013-2015, 2016-2018, 2019-2021, 2022-2023) is depicted in the Sankey diagram (Figure 12). Based on Scopus information, the diagram shows progression of topics within the health-related research.
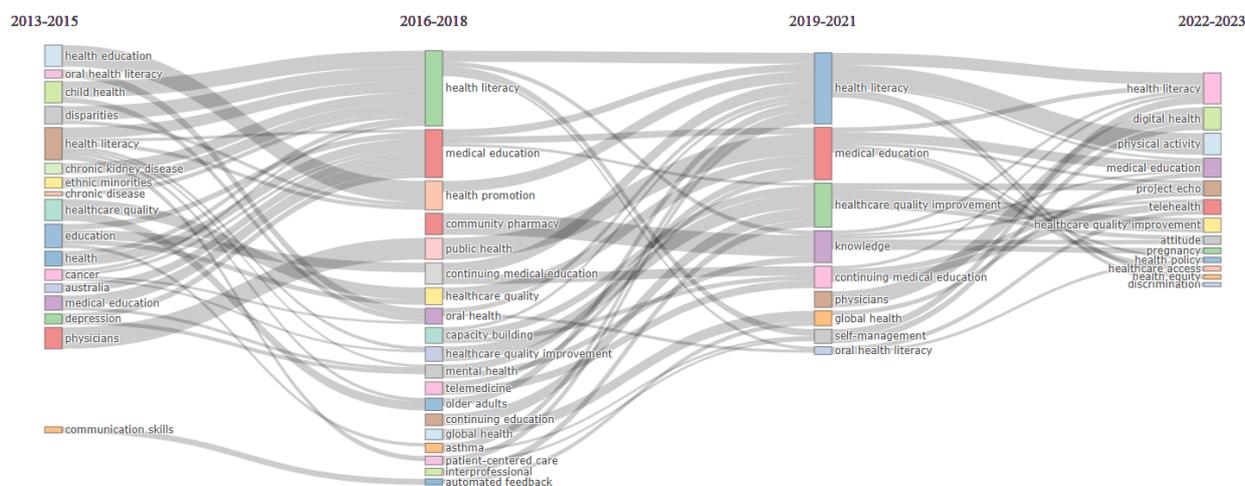
Figure 12. Topical Evolution

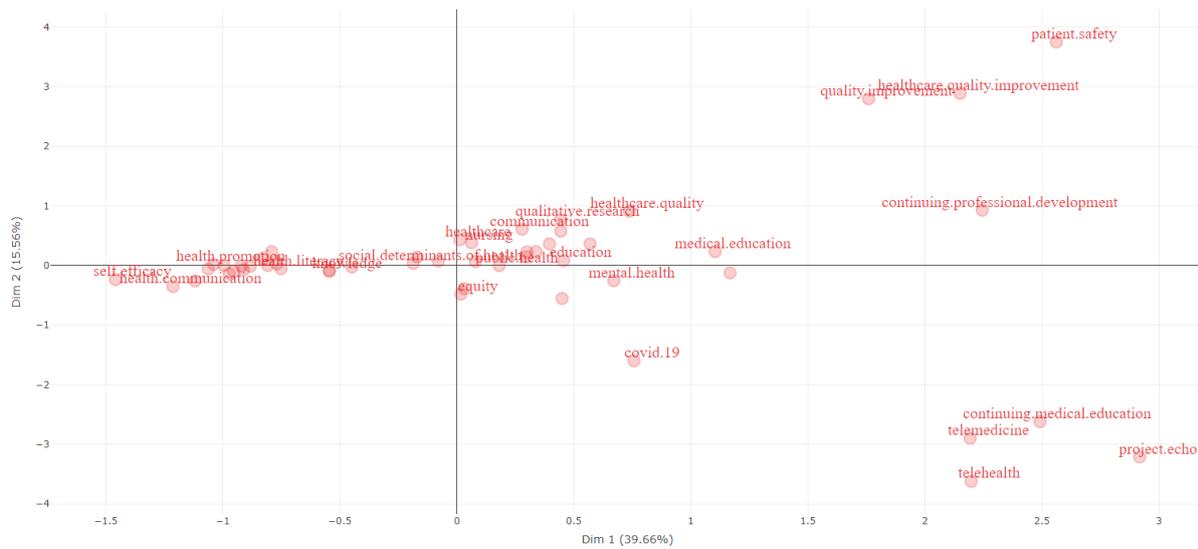*Source: Developed by the authors (based on Scopus using Biblioshiny App)*

Topic emergence and persistence

- *Health literacy:* This topic has demonstrated a remarkable tenacity. It first appeared in 2013-2015 and maintained a prominent position until 2022-2023. This implies a long-term, increasing desire to comprehend and enhance health literacy.
- *Medical education:* "Medical education" is another recurring issue that shows up frequently between 2016 and 2018. It is still relevant in 2022 and 2023. This may be a reflection of continued efforts to improve medical education methods, for example in reaction to quick developments in medical knowledge and technology.
- *Healthcare quality improvement:* This issue is still very alive, moving from broad conversations about healthcare quality in 2013-2015 to more narrowly focused conversations on strategies for improvement

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since 2019.

The dynamic nature of health-related research, which is driven by socio-political variables, educational needs, and technology improvements, is reflected in the topical evolution illustrated by Figure 12. The introduction of new topics and the survival of existing ones indicate that research goals adapt according to changing global health opportunities and problems.

Based on Scopus information, the scatter plot in Figure 13 shows the Multiple Correspondence Analysis (MCA) of several study topics. Using the initial two dimensions as a reference, MCA is a dimensionality reduction approach that may be used to investigate the interactions between categorical variables. In this case, the distribution and associations of various topics are visualized in a two-dimensional space.

Figure 13. Factorial Analysis (Multiple Correspondence Analysis)

Source: Developed by the authors (based on Scopus using Biblioshiny App)

The first dimension (39.66%) is responsible for most data fluctuations. Patient safety, quality improvement, and ongoing professional development are among the most technical and applied aspects of healthcare that are associated with topics on the positive side of this dimension (right side). Topics such as health communication and self-efficacy, on the negative side (left), are more centred on personal and social aspects.

A lesser variation amount is explained by the second dimension (15.55%). Strongly related topics to this dimension are self-efficacy (negative side) and patient safety (positive side). It points to a difference between system-level and individual-level interventions in terms of safety.

The upper right quadrant: Topics like patient safety and healthcare quality improvement are the most prevalent. These topics are also closely related to one another. It shows that efforts to raise healthcare quality are closely linked to studies on patient safety, potentially indicating an emphasis on systemic changes in healthcare systems.

The lower right quadrant: There is a strong correlation between topics of telemedicine, telehealth, and the ECHO project, which are clustered together in this quadrant. The close proximity of these topics suggests a tendency towards remote and digital healthcare solutions, which has become particularly pertinent in light of the epidemic in recent years.

The centre: Topics such as health education, mental health, and medical education are positioned centrally, implying that these topics are broadly connected to a variety of other topics, serving as foundational elements in the field of health research.

The left-side clusters: There are topics related to social determinants of health, health promotion, and health literacy clustered on the left side. This highlights a focus on public health and preventive strategies that are more socially and behaviourally oriented.

The COVID-19 topic is positioned in the lower central part. This topic is rather isolated, indicating although it crosses numerous locations, it does not dominate any one cluster. That probably reflects how the epidemic has affected many different facets of health research. The COVID-19 topic occupies a fairly

dominant but isolated position, reflecting the multiple pandemic issues. While it has touched numerous areas of research, it does not dominate any one area. Being connected to telemedicine and telehealth, the ECHO project is positioned as an outlier in the lower right quadrant, suggesting that it has a distinct niche. The possible reason for this is a particular focus on enhancing healthcare access through collaboration and education.

Geographical cooperation analysis of publications

In Figure 13, the MCA plot clearly illustrates the intricate connections between different health study issues by highlighting discrete groups of linked topics. The analysis highlights the significance of quality improvement, technical breakthroughs, and educational initiatives within contemporary health research. Furthermore, it is clear the COVID-19 pandemic has had a widespread effect, impacting but not surpassing current research paradigms. This analysis has implications for both research and policy-making, offering insightful information about how the field of health research is changing.

Based on cooperative publications across nations, Figure 14 describes the worldwide network of international collaboration in health research. Countries that cooperate on research are connected by lines on the map. The density and quantity of lines show the frequency and intensity of these contacts.
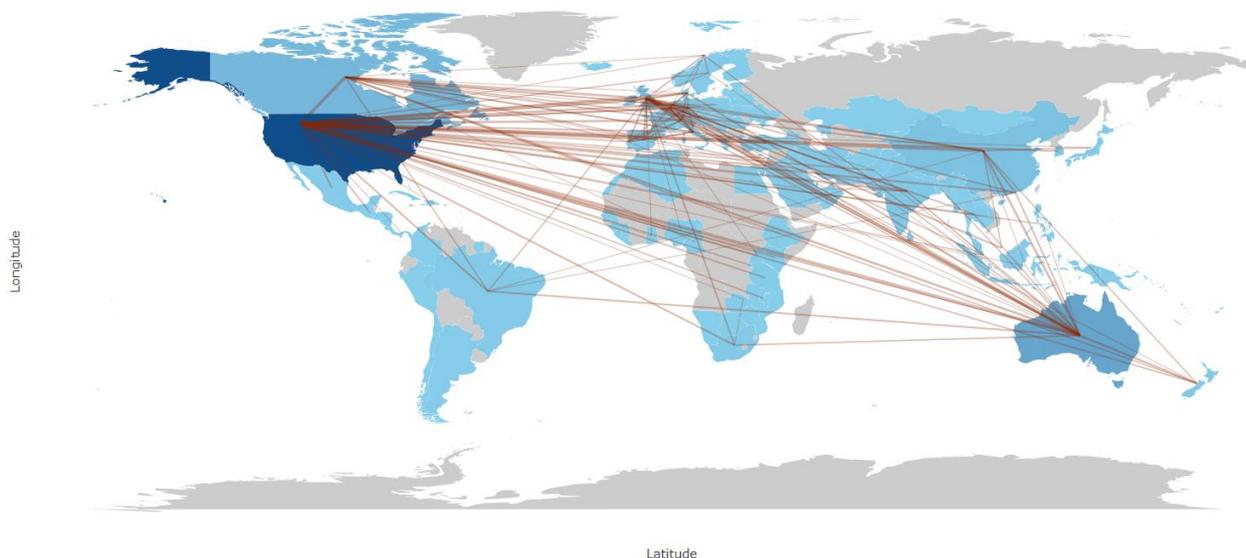
Figure 14. Countries' Collaboration World Map

Source: Developed by the authors (based on Scopus using Biblioshiny App)

With numerous connections across several continents, the USA serve as the primary hub of this international network. The United States' extensive and intricate links with Europe, Asia, and Oceania highlight its prominent position as a pioneer in global health research. The United States' dark blue colour also denotes a high level of scientific production and active global cooperation.

Europe has a complex network of internal connections, particularly among nations like the UK, Germany, France, and Italy. These countries have strong scientific linkages to the US and others, in addition to their active mutual interaction. The European Union's objective to promote scientific cooperation among its member states is probably what creates this extensive intercontinental network.

Australia also stands out as a significant hub, especially considering its connections to the US, Europe, and adjacent Asian countries. Due to its unique geographic location and interest in global health challenges, Australia has strong ties to these regions and actively participates in global health research. Asian connections with the USA and Europe, in particular, are noteworthy and demonstrate the growing importance of China, India, and Japan in the world of research.

Even if there are less direct connections between Africa and South America, there are still important partnerships between South Africa and the US as well as Brazil and Europe. These collaborations could be the result of targeted initiatives to address particular health issues in these regions, frequently via assistance from nations with a more developed scientific infrastructure.

Vast global connections highlight how health research is becoming increasingly collaborative. Global responses are often necessary to address issues like pandemics, non-communicable illnesses, and building

health systems, which encourage international cooperation. Global health issues, the need for an organized international response to emergencies like COVID-19, and increasing support for international research projects from foundations and organisations impact the growth of these collaborations.

The map demonstrates how the international scientific community in healthcare is intertwined and how working together across borders is frequently necessary to solve complicated health issues. It is expected that the trend of more globalisation in health research would continue, driven by the need for collaboration as well as accessibility of technology and financial incentives.

Factors affecting competitiveness in healthcare include:

- *Quality of health services:* The primary metric used to assess a healthcare system's competitiveness is the quality of its medical services. Accurate diagnosis, effective treatment, high standard of patient care, and general patient satisfaction are all indicators of the medical service quality.
- *Innovation and technology:* Using cutting-edge medical advances and technologies boosts competitiveness. Nations and healthcare facilities that aggressively adopt the most recent advancements in medicine and pharmaceuticals typically hold the top spots in rankings of competitiveness.
- *Qualification of medical personnel:* Two important determinants of competitiveness are the educational background and professional training of medical personnel. The quality of services and the healthcare system's capacity to meet new challenges are directly impacted by the high education standard and ongoing professional development received by medical personnel.
- *Financial sustainability and accessibility of services:* Financial resources and their use performance also significantly impact service accessibility and sustainability. The general public can access and benefit from high-quality healthcare because of sustainable healthcare financing.
- *Governance and organisational structure:* Competitiveness also depends on well-managed healthcare facilities as well as defined policies and procedures for care rendering.

Bibliometric analysis findings obtained with CiteSpace are shown in Figures 15-16. Degree centrality, citation counts, burst detection, clustering, and sigma metrics are included in the analysis, which provides a thorough look at the state of the field. Ten unique clusters are revealed by the network analysis. Each cluster represents an important area of research. The size, silhouette scores, and labels produced from different techniques, including Mutual Information (MI), Log-Likelihood Ratio (LLR), and Latent Semantic Indexing (LSI), are defining factors for these clusters. The most cited papers are included in the major clusters. It is summarised in Table 1 and offers insight into the main ideas guiding this field of study.
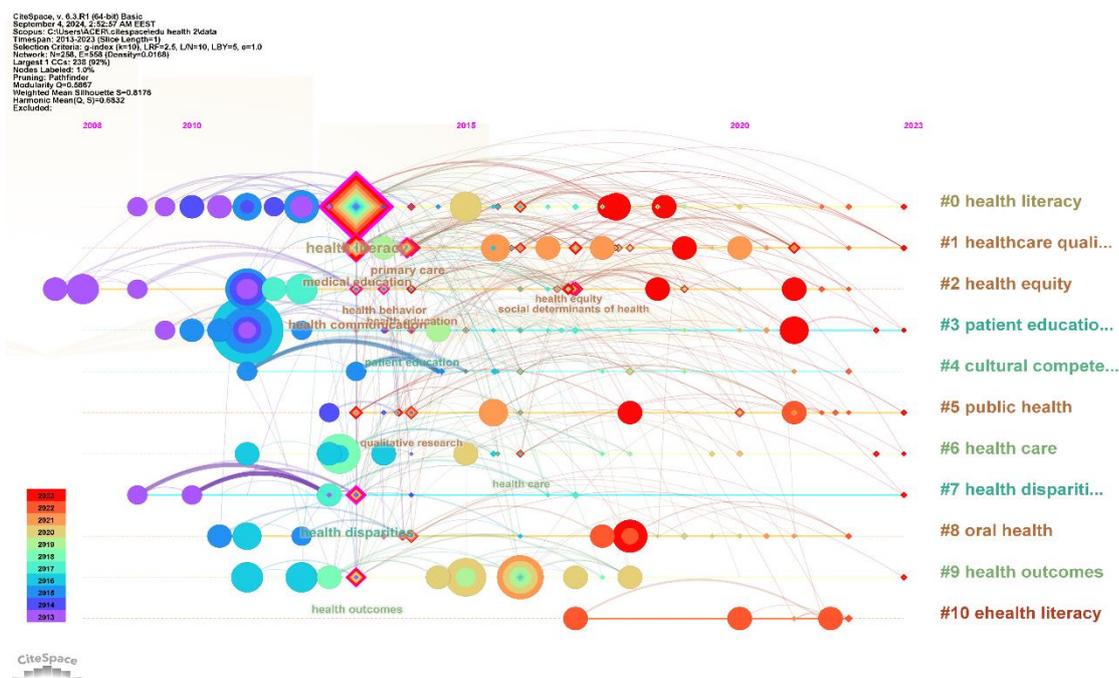
Figure 15. Network Overview

Source: Developed by the authors (based on Scopus using CiteSpace App)

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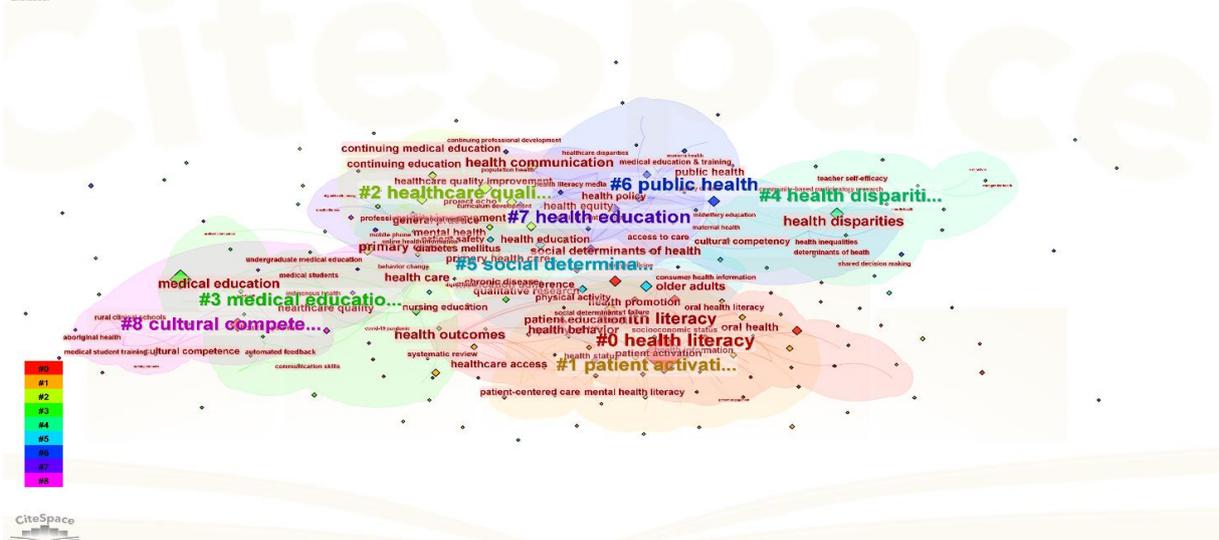
Figure 16. Network Overview

Source: Developed by the authors (based on Scopus using CiteSpace App)

"Health literacy" is the most cited topic (Cluster #0) with 675 citations, according to the citation counts study (Table 4). The next two categories are "mental health" in Cluster #2 with 74 citations and "medical education" in Cluster #3 with 155 citations. There is also a major emphasis on "health outcomes", "primary care", and "health disparities". The important study fields that have attracted a lot of interest and influence from the academic world are highlighted by the citation count indicator.

Table 4. Clusters and Related Terms

Clusters	Ranked Terms
#0: health literacy; US-Mexico border; health service responsiveness; digital literacy; knowledge translation / health information; systematic literature review introduction; health insurance; digital health communications; early childhood health	health; literacy; quality; life; youth patient; communication; analysis; conversation; participation
#1: medical education; medication safety; medication reconciliation; limited English proficiency patients; medical interpretation / healthcare quality improvement; quality improvement; quality improvement methodologies; quality measurement; electronic prescribing	education; health; continuing; development; mental; medical; medication; reconciliation; medicine; family
#2: health literacy; health education; multiple sclerosis; communication confidence; womens health / social determinants; health behavior; primary healthcare; cultural competency; minority health	health; care; social; determinants; behavior literacy; education; communication; knowledge; multiple
#3: health literacy; patient education; hospital-based education; inpatient education; video-based education / patient activation; racial disparities; medication safety; pancreatic diseases; medical education	health; education; social; nursing; determinants patient; literacy; chronic; condition; video-on-demand
#4: cultural competence; cultural safety; rural clinical schools; medical student training; chronic back pain / medical education; automated feedback; clinical consultation; non-verbal communication; affective computing	health; bias; decision-making; disparity; cultural screening; rural; schools; screening; smartphone
#5: qualitative research; medical education; health policy; health economics; human resource management / public health; primary care; paediatric dermatology; mental health; health education	health; education; research; training; qualitative care; quality; infantile; countries; developing
#6: healthcare; affordable care act; patient protection; medical care; complex chronic conditions / health literacy; home care worker; complex chronic conditions; musculoskeletal pain; patient education materials	physician; record; electronic; safety; documentation self-diagnosis; intention; intelligence; decision-making; integrated

Table 4 (cont.). Clusters and Related Terms

Clusters	Ranked Terms
*#7: health disparities; urban health; cardiovascular diseases; socio-ecological model; disaster response	health literacy; community-based participatory research; immigrant women; refugee women; ischemic heart disease*	decision; making; shared; implementation; aids design; heath; sciences; action; promotion
*#8: health literacy; dental care; health knowledge; racial disparities; health disparities	oral health; oral health literacy; oral health knowledge; oral health disparities; poor oral health*	health; oral; literacy; knowledge; disparities; adults; care; dental; communication; practice
*#9: health literacy; health status; economic co-operation; self report; socioeconomic factors	health outcomes; non-communicable diseases; socioeconomic development; sub-Saharan Africa; parental health literacy*	spatial; model; econometrics; durbin; matrix refugees; healthcare; parental; immigrants; Asian
*#10: health information; online health information; social media; health knowledge; information dissemination	health literacy; assessment tool; digital health information; health knowledge; information quality*	information; dissemination; knowledge; infodemiology; COVID-19; digital; critical; adolescents; Internet; inequalities

Source: Developed by the authors (based on Scopus using CiteSpace App)

The burst detection tool finds notable spikes in citations, which indicate how popular topics gain traction over time. With a value of 5.66, "health disparities" in Cluster #4 shows the biggest burst, suggesting a recent interest increase. There have also been noteworthy bursts in "health communication", "ECHO project", and "continuing professional development". These bursts attract an expanding study interest.

"Health literacy" in Cluster #0 emerges as the most connected node, with a degree of 51. Degree centrality is a tool used to quantify node connectedness within the network. "Health disparities" (Cluster #4) and "medical education" (Cluster #3) follow, emphasising their pivotal positions within the network. A high degree of centrality indicates that these topics function as important nodes in the research landscape, bridging different subfields and adding to the general framework of knowledge domain.

The betweenness centrality is used to find nodes that serve as links between various research topics or clusters. With a value of 0.62, "health literacy" in Cluster #0 has the highest betweenness, demonstrating its significance as a key node in the network. Significant centrality is also displayed by other topics, such as "health disparities" and "medical education". It highlights their significance in promoting information flow throughout the network.

Nodes that are both central and show notable bursts are reflected by the sigma metric, which combines betweenness centrality and burst detection. With a sigma value of 3.50, "health disparities" in Cluster #4 leads, followed by "patient activation" in Cluster #1 and "health communication" in Cluster #7. Topics that are dynamic and influential are identified by the sigma metric, which takes into account their changing influence on the research field.

A thorough understanding of the research field is offered by the CiteSpace analysis. It demonstrates significant clusters, hot-button issues, and new trends. A multifaceted topic knowledge is provided by the combination of citation-based and network-based measures. They can be used to identify areas of considerable scholarly activity to guide future research directions.

In general, visualisations of scientific publication clusters created with the CiteSpace tool and based on the Scopus database are displayed in Figures 15-16. These visualisations give a summary of the research network by illustrating connections between many topics and important terms that the cluster analysis found.

The network is depicted in the first figure as consisting of many clusters, each identified by a distinct colour and number. Every cluster is associated with a certain study topic or set of related topics. For instance, phrases like "digital literacy", "knowledge translation", and "US-Mexico border" are included in Cluster #0 ("health literacy"). This suggests that the terms have many associations in the literature.

The initial visualisation reflection of the evolution of major topics throughout time is a significant element. The way the clusters and their core phrases change from 2004 to 2023 on the time axis illustrates this. For instance, phrases related to Cluster #7 ("health disparities") have been more common in recent years, which might be a sign of growing interest.

Complex relationships between several clusters and their phrases are displayed in the visualisation. These relationships can be understood as interdisciplinary connections between various fields of study. For instance, there are several links between Cluster #0 ("health literacy") and Cluster #1 ("healthcare quality

improvement"), which highlights the significance of these topics within the related research. Communities, or collections of related topics, are depicted in the second figure. This graphic aid makes it easier to comprehend which topics are most frequently covered together and which fields of knowledge have the strongest connections. For instance, the close location of the clusters pertaining to medical education (Cluster #3) and cultural competency (Cluster #4) suggests a close relationship between them in the literature.

The structure and dynamics of research in health and medical education are better-understood thanks to these visualisations. They support the identification of important study fields, their historical development, and connections between various topics. Large-scale bibliometric data analysis can be effectively accomplished via technologies like CiteSpace, which allows for making more informed decisions and identifying new areas of inquiry.

The CiteSpace analysis paints a complex and thorough picture of the research field. It represents new trends and complicated patterns of academic activity that are actively influencing the research discourse. The analysis provides deeper insights into the underlying mechanisms that propel the evolution of research topics over time in addition to identifying important clusters. This bibliometric study becomes a vital tool for scholars that try to consider topic challenges. It identifies areas of noteworthy academic involvement and defines relationships between different topics.

CONCLUSIONS

The discovery of important clusters, including those focused on medical education, mental health, and health literacy, highlights the fundamental significance of these fields in healthcare research. Health literacy appears not just as a recurrent topic but also as a key notion influencing many other research areas. Given its prominence within the network, improvements in health literacy are probably going to impact significantly on a wide range of issues: from treatment outcomes to the creation of public health policies and strategies. This realisation emphasizes the need for funding health literacy research going forward because it acts as a vital link across different health science subfields.

Similar efforts to address urgent issues within the healthcare system are reflected in the core topics of mental health and medical education. The importance of mental health research indicates that people are becoming more aware of the need to comprehend and treat population's psychological well-being, especially in light of the rising prevalence of mental health illnesses worldwide (Mboweni et al., 2023). On the other hand, as the healthcare sector develops, medical education will continue to be a crucial area of concentration. New methods of professional growth and training will be required to guarantee that practitioners are prepared to handle the demands of the modern healthcare system.

In addition to these well-established clusters, the analysis highlights newer fields of study that are gaining momentum and are expected to become more significant in the future. Focus is shifting towards these important concerns, as evidenced by the discovery of notable citation bursts in areas such as health communication and health disparities. A larger social movement towards justice and equity in healthcare is reflected in the increased attention being paid to health disparities, with academics attempting to identify and resolve the underlying causes of injustices that impact marginalized groups (Braveman et al., 2021). In a similar vein, the growing prominence of health communication as a field of study emphasizes the significance of efficient communication techniques in enhancing health outcomes, especially in times when health literacy issues and misinformation are growing more common (Jackson et al., 2020).

Compared with earlier research, the results confirm the significance of topics like health literacy, mental health, and health education. For instance, studies on medical education have already underlined how crucial it is to prepare professionals for a new healthcare environment (Shaw et al., 2021). Our research expands on these conclusions by highlighting the necessity of creating fresh approaches to professional growth and training in reaction to developments in the medical industry.

At the same time, our study reveals new patterns that have not been clearly highlighted in previous work. For example, the significant increase of interest in healthcare communication and inequalities suggests a shift in scholarly interest towards more equitable and efficient ways of rendering health services. This may reflect the higher emphasis on social and behavioural aspects of medicine that has been observed in recent years (Braveman et al., 2021; Jackson et al., 2020).

As a result, our findings support and expand current hypotheses, offering new research prospects, particularly in healthcare communication.

Despite unfolding valuable scientific insights, this study has certain drawbacks. If Scopus is the only database used for the review, some potentially relevant studies may not be included. Furthermore, because the

review mainly focused on journal articles, books, chapters, and conference papers, it did not incorporate additional relevant sources of information. Since the results were obtained from a specific set of keywords that the authors chose, they need to be confirmed by empirical methods such as expert interviews and surveys.

The results offer significant prospects for investigating educational adaptability in the face of armed conflicts. A more complex understanding of how educational systems adjust and recover is represented by the notion of educational resilience. Resilience and recovery strategies are frequently customized to unique circumstances and obstacles of a particular area. Another important sphere of study is consequences for policy, with studies showing the necessity of inclusive and responsive policies.

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Conflict of Interest
The author declares no conflicts of interest.

Data Availability Statement
Not applicable.

Informed Consent Statement
Informed consent was obtained from all individual participants included in the study.

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