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Jiangwei, Liu; Daud, Sity

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(*) Corresponding author

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A BIBLIOMETRIC ANALYSIS OF HEALTH DIPLOMACY RESEARCH BASED ON VOSVIEWER AND CITESPACE

Liu Jiangwei^{1*}, Sity Daud²

¹University Kebangsaan Malaysia - Selangor, Malaysia; China Three Gorges University - Yichang, China  <https://orcid.org/0009-0005-4844-0640>

✉ p113700@siswa.ukm.edu.my

²University Kebangsaan Malaysia - Selangor, Malaysia  <https://orcid.org/0000-0002-4980-7783> ✉ sitydaud@ukm.edu.my

Abstract: *Research on health diplomacy not only deepens global health governance but also enhances the sharing of information and resources in the field of public health. A bibliometric study was conducted on health diplomacy works published between 1993 and 2023 with “health diplomacy”, “medicine diplomacy”, “health and foreign policy”, or “vaccine diplomacy” as the keywords. VOSviewer and CiteSpace were used to perform the bibliometric analysis. A total of 2,216 articles from the Web of Science database were analyzed. Results found that the United States held a prominent and influential position in health diplomacy studies, followed by China, the United Kingdom, and Australia. The London School of Hygiene & Tropical Medicine, the University of Toronto, and Harvard University were the top three research institutes for health diplomacy. The article from Feldbaum et al. (2010) served as the representative and symbolic reference. These findings showed that topics including power, Covid-19, security, soft power, WHO, vaccine diplomacy, and governance, though with shorter spans, were the focal points in recent years. In addition, health diplomacy research exhibited interdisciplinary, cross-cutting, and temporal characteristics closely related to factors such as politics, economics, environment, and public goods.*

Keywords: *Health Diplomacy; Bibliometric; Developmental Trends; Research Hotspots; VOSviewer; CiteSpace*

INTRODUCTION

Public health, though regarded as a concept of the modern world, can be traced back to the beginnings of human civilization. With the help of the Industrial Revolution, the 18th century was considered the era of modern public health, which was considered a domestic issue in most cases. However, over the past few decades, frequent public health emergencies, the involvement of multi-stakeholders, and the developments of medical science have driven public health professionals and diplomats to think of health as foreign policy. In the mid-19th century, due to the rising concern about infectious diseases, international health diplomacy appeared, which, to some extent, can be regarded as the beginning of health diplomacy.

Fidler (2006) pointed out that the growing prominence of public health in all fundamental governance functions served by foreign policy underscores the need for “health as foreign policy”, which is evident in the United Nations (UN) reform proposals put forth by the Secretary-General, which recognize the crucial role of foreign policy in promoting public health as a core aspect of overall public health initiatives. It was also added that the emergence of “health as a foreign policy” presents both opportunities and risks for health promotion. Jin (2002) believed that public health diplomacy narrowly refers to diplomatic activities conducted by national representatives, including diplomatic and health departments, through peaceful means, such as negotiations, to address

transnational public health issues, while broadly, the actors involved in public health diplomacy include not only diplomatic and health departments but also intergovernmental organizations and non-governmental organizations. Feldbaum and Michaud (2010) stated that varied definitions of health diplomacy reflect different perspectives on utilizing health interventions and political neutrality. The alignment of foreign policy objectives often shapes the level of attention and resources allocated to addressing health challenges on the global stage.

According to Youde (2010), health diplomacy primarily concentrated on international cooperation to safeguard human and commercial interests from the spread of specific infectious diseases in the past, while at present, it serves as a political activity that improves both health courses and international relations. Horton (2007) suggested that the combination of “health” and “diplomacy” has the potential to shift the focus of international relations toward health as a central driver of political cooperation and advancement, while Feldbaum and Michaud (2010) believed that linking “health” and “diplomacy” can refer to the instrumental use of health for achieving foreign policy and diplomatic objectives that are unrelated to health concerns or interests. According to Kickbusch and Ivanova (2012), the transition in health diplomacy during the late 1980s and 1990s proved the recognition of the need for more effective and efficient responses to global health challenges, as well as a growing awareness of the importance of engaging non-state actors in health diplomacy efforts. Almeida (2020) proposed that in terms of international relations, foreign policy, and diplomacy, the neglect of the health field has become the barrier that blocks the capture of changes in this context. In addition to functioning as a soft power in foreign policy, health also acts as a smart power, providing resources and strategies. As for He et al. (2010), expanding the conceptual framework from “health within foreign policy” to “the influence of foreign policy and development strategies on health” will bring greater value and inclusivity to the understanding of health diplomacy. This approach allows for a more comprehensive and interconnected comprehension of health diplomacy. Chattu et al. (2019) suggested that as health diplomacy provides a platform for collaboration between stakeholders from the public health and political sectors, new skills to address the challenges of transboundary coordination are badly needed to negotiate favorable health outcomes amidst competing interests, particularly in the context of economic globalization. Afshari et al. (2020) proposed that health diplomacy serves as a political framework to improve the health of targeted populations and strengthen governmental relations between collaborating countries. By employing diplomatic strategies and negotiations, health diplomacy seeks to address health issues cooperatively and mutually beneficially, fostering partnerships and facilitating the exchange of knowledge, resources, and best practices. By examining the historical literature on health diplomacy during pandemics, Fazal (2020) posited that an exclusive reliance on localized health diplomacy would likely decrease effectiveness as pandemics occur more frequently. Fazal advocated adopting a bilateral or global cooperative approach to health diplomacy to address the imperative for global mitigation and containment endeavors. In the context of the Covid-19 pandemic, Javed and Chattu (2020) emphasized the positive usage of health diplomacy, saying that it should be used to mitigate tensions and create a possibility for political dialogue and cooperation rather than political manipulation or a trigger for geopolitical conflicts. Under the same context, Kickbusch and Liu (2022) presented two types of health diplomacy: solidarity and equity-oriented, while the other gives prior concern over geopolitical advantage.

Though the first International Sanitary Conference in 1851 witnessed the initiation of international health diplomacy, the concept of global health diplomacy (GHD) first appeared in the late 1970s when Peter Bourne proposed the term “medical diplomacy”. According to Labonté and Gagnon (2010), this concept requires the efforts of governments, multilateral organizations, and civil society actors to strategically incorporate health considerations into foreign policy negotiations. Global health diplomacy has emerged as a significant area of research and practice in international relations. Several countries, including China, Japan, South Korea, the United States, India, Indonesia, Thailand, and others, have actively engaged in global health diplomacy to enhance their international influence and cooperation with other nations. China’s health diplomacy can be traced back to the 1960s, with particular attention to Africa; considering China’s involvement in global health governance and the frequent public health emergencies, research on its health diplomacy is not rare. Youde (2010) pointed out that by offering medical assistance in African nations, China enhances its reputation among developing countries and strengthens its status as a viable alternative to Western influence.

Additionally, these efforts ensure support for China within international organizations and secure access to vital natural resources required for the country’s sustained economic growth. At the same time, Zhao and Jin (2017) and Chen and Tan (2022) regarded China’s health diplomacy as an effort to provide innovative global health governance, strengthen friendly relations, and counter Western media criticism. Japan’s global health diplomacy has also been discussed by Li and Gao (2022), Wang (2022), and Yan (2022) both in the regional and global spectrum, showing that Japan’s increased attention and investment, whatever regional or global on health diplomacy, is performed under the political strategy, aiming to either maintain its status as a leading nation or counter China’s presence. Liu (2020) and Li (2021) labeled South Korea’s Covid-19 policy as a proactive and soft power-enhancing strategy.

Jin (2012) examined the historical stages of US health diplomacy, saying that the US has long recognized the significance of health in its diplomacy and has integrated health diplomatically to maintain its global leadership. Other than that, Guan and Wan (2022) pointed out that India’s engagement in health diplomacy during the Covid-19 pandemic is the utilization of its position as the “world’s pharmacy” to engage in “vaccine diplomacy” globally, which demonstrates the interconnectedness of health, foreign policy, economy, and trade. Wu (2022) analyzed Indonesia’s health diplomacy during the pandemic, noting its achievements in vaccine coverage and highlighting limitations in comprehensive capabilities compared to traditional middle powers. Thaiprayoon and Smith (2015) explored Thailand’s experience balancing trade and health policies and proposed the INNE model for capacity development in global health diplomacy. Global health diplomacy requires cooperation and coordination among multi-stakeholders; therefore, the involvement of supra-state actors in health diplomacy from various perspectives has been discussed by many scholars. Deng et al. (2020) pointed out that globalization has led countries to prioritize global health governance as a crucial strategic concern. The BRICS nations, being representatives of emerging economies, are gaining prominence within global health governance. Lamy and Phua (2012), Du et al. (2020), and Djalante et al. (2020) emphasized the role of ASEAN in terms of GHD, saying that reinforced mechanisms and greater integration are needed to strengthen health governance in Southeast Asia. Luh and Baltag (2022) claimed the importance of health attachés in the EU considering the worldwide challenges of Covid-19.

By reviewing the previous studies on health diplomacy, there is no doubt that studies on the relationship between health and diplomacy in the context of globalization or de-globalization are and will continue to be one of the prior concerns for researchers. However, in order to identify and analyze the collaboration networks among authors, institutions, countries, emerging research trends, and evolving topics in the field of health diplomacy, additionally provide powerful visualization features that transform complex data into intuitive and easily understandable charts and graphs, the application of VOSviewer and CiteSpace is relatively rare. In order to address this research gap, this study undertook a thorough quantitative analysis and visual examination of collaborative networks involving countries and institutions, as well as the analysis of co-citation references, keyword clustering, and keyword citation bursts in the field of health diplomacy.

MATERIALS AND METHODS

Data Sources

To uphold the scientific authority and integrity of the data source, this research literature is sourced exclusively from the core collection of the Web of Science (WOS) database, the most widely used and authoritative database of research publications and citations.

The relevant data were retrieved by topic = "health diplomacy", "medicine diplomacy", "health and foreign policy", or "vaccine diplomacy", with a period from 1993-2023, and the document type was journal articles. After data retrieval and cleaning duplicated and irrelevant articles, this study obtained 2,216 published papers in the 30-year scope.

Research Method

Bibliometric methods have been utilized to quantitatively analyze written publications, providing valuable insights into the intellectual landscape of specific research fields. This approach facilitates a structured literature review, enabling the extraction of information and identification of patterns within the scholarly domain (Ellegaard and Wallin 2015). VOSviewer and CiteSpace are widely utilized tools for bibliometric visualization and analysis, offering researchers powerful capabilities to explore and understand scholarly literature (Markscheffel and Schröter 2021). VOSviewer is a software tool used for visualizing and analyzing bibliometric networks. It enables researchers to explore and understand the structure and patterns of scientific literature based on bibliographic data such as citations, co-authorships, and co-occurrence of keywords (Waltman, Van Eck, and Noyons 2010). CiteSpace is a Java-based visualization software that employs time-based and co-citation analysis to uncover intellectual landscapes and pivotal papers (Chen 2006).

In this study, VOSviewer was used to analyze the cooperation networks, where the cooperation among nations and institutes was presented, respectively. CiteSpace, which has an advantage in trend description and adaptable parameters, was applied to present the visualization of subject categories, keywords analysis, and reference co-citation analysis. Based on the VOSviewer and CiteSpace, a quantitative analysis of the literature on health diplomacy was conducted to explore the cooperation network, hotspots, and future trends in the field of health diplomacy.

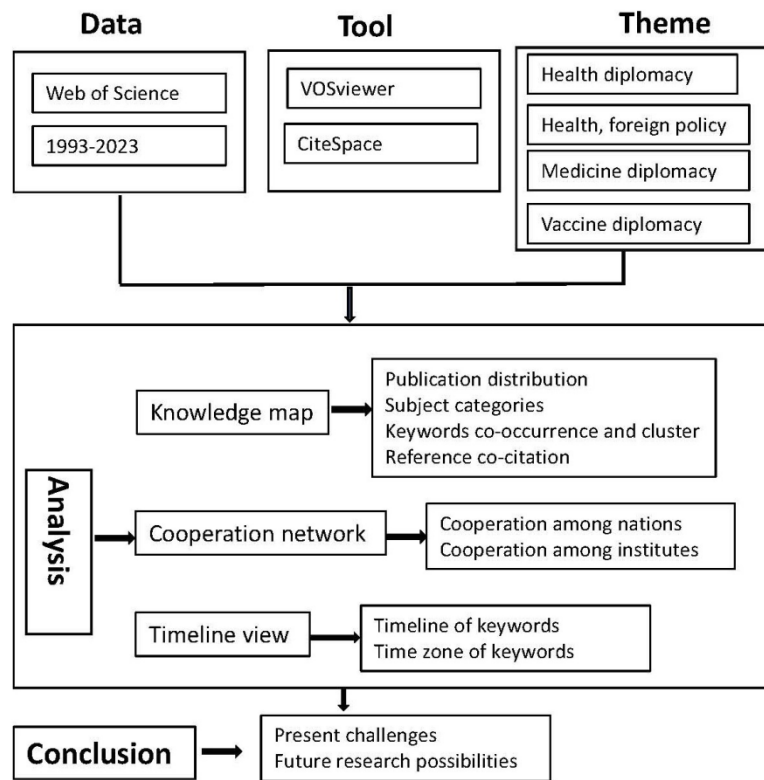


Figure 1: Technical Road Map (Source: Authors' illustration)

DESCRIPTION OF THE KNOWLEDGE MAP BASED ON STATISTICS

Literature Development Trends

According to the analysis of the statistics obtained from the Web of Science, the total number of publications in the field of health diplomacy comes to 2,216, and Figure 2 illustrates the number of its annual publications from 1993 to 2023. In general, it shows a rising trend, indicating that research on health diplomacy has gathered more attention in the past thirty years. It is found that quite limited attention was given to this field at the beginning of the 1990s, then a steady rise after 2003. Since 2014, the publication amounted to more than 100, even though with a temporary drop below 100 in 2016, illustrating an increasingly indispensable relationship between health and diplomacy. The top three years range from 2020 to 2022, a total of 715 publications were recorded, accounting for 32.27% of the sample size, with the highest publication in 2022, which, to some extent, closely attributed to the impacts to both the health governance and geopolitics brought by Covid-19 pandemic in the past three years, demonstrating that the role of health diplomacy has undergone great transformation where the demands and expectations on health diplomacy in the international community are unprecedented high.

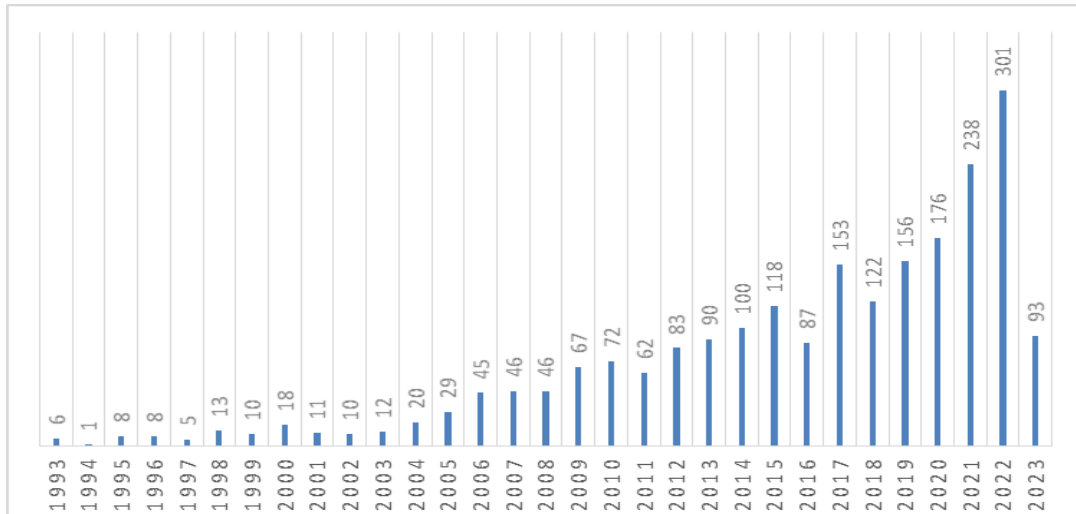


Figure 2: Diagram of Publication Trend (Source: Authors' illustration)

Distribution of Subject Category

Each publication in the WoS (Web of Science) database is categorized into one or more subject categories. The analysis of subject category co-occurrence helps identify interdisciplinary connections, map intellectual structure, and identify core disciplines, particularly track research trends, which facilitates interdisciplinary collaborations, thus influencing future decision-making in research and policy-making. In the case of publications on health diplomacy, they have been distributed across 155 subject categories over the past 30 years. A subject co-occurrence network was constructed to investigate the relationships between these subject categories within the field of health diplomacy, focusing on the categories themselves as research objects. CiteSpace software was used to generate a distribution map of subject categories in health diplomacy, as shown in Figure 3. The top five subjects regarding co-occurrence are public environmental and occupational health, health service and policies, international relations, economics, and health care services. In this network, these subjects are more closely connected than the other subjects, highlighting their relevance or interconnection in the field of research. Other than that, these subject categories prove that health diplomacy studies encompass a rather extended scale, closely bonded with multiple subjects, including environmental science, politics, economics, etc., suggesting a salient multidisciplinary feature in health diplomacy research.

Figure 4 presents the top 15 categories with significant burst strength at different periods. For instance, the subject category "Medicine, General, and Internal" burst from 1993 to 2007, with the longest burst recorded. The subject with the biggest strength falls on "Environmental Sciences" recorded as 15.11. Notably, the earliest and latest burst disciplines come to "Medicine, General and Internal" and "Environmental Studies", presenting the interest of previous researchers and present hotspots of subject category in the field of health diplomacy.

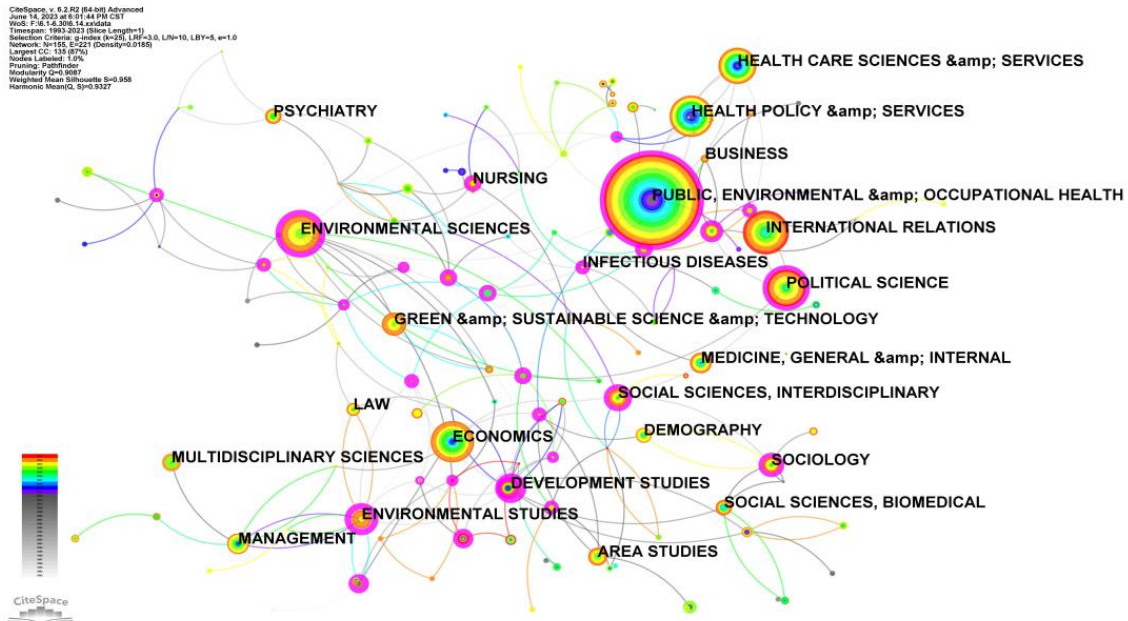


Figure 3: Subject Categories Co-occurrence Network (Source: Authors' illustration)

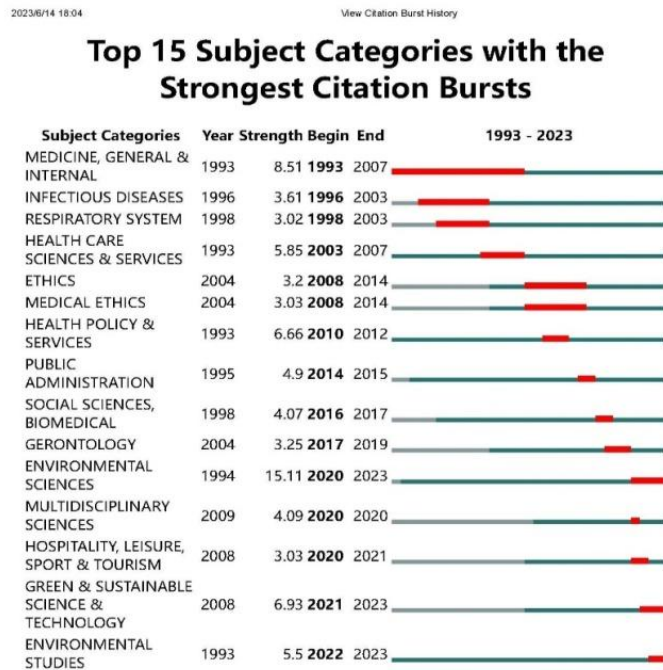


Figure 4: Subject Categories Burst in WOS (1993-2023) (Source: Authors' illustration)

Keywords Analysis

Keywords are vital in literature since they define the scope and subject matter covered in an article. Journal editors may use keywords to assess if a submission aligns with their journal's focus, and keywords can also aid in identifying appropriate peer reviewers. Keyword analysis in CiteSpace has significant implications for research. This analysis aids in mapping the intellectual structure of a field, facilitating literature reviews, identifying research gaps, and informing future research directions. The co-occurrence network of the keywords presents the research trends and hotspots in a particular discipline or journal (Li et al. 2016).

Keywords Co-occurrence

Keyword co-occurrence analysis in CiteSpace involves examining the frequency and patterns of keywords appearing together in the literature. This analysis helps identify relationships and connections between different keywords, highlighting their co-occurrence in the documents. By visualizing keyword co-occurrence networks and measuring centrality and density metrics, researchers can uncover research hotspots, emerging trends, and the intellectual structure of a field.

The co-occurrence network diagram in Figure 5 illustrates the relationships between keywords related to health diplomacy research. The nodes represent individual keywords, and the links between nodes represent their co-occurrence relationships. The size of each node corresponds to the frequency of occurrence of the respective keyword (Bruni et al. 2016). The keyword analysis reveals that "health" is the dominant keyword in health diplomacy research, appearing 264 times along with other related terms. The keyword "policy" follows closely with a co-occurrence frequency of 167 and is associated with terms such as "global health diplomacy", "foreign direct investment", "Africa", and "foreign aid". The keyword "global health" comes as the third, with a frequency of 116, and terms closely connected with it include "health diplomacy", "vaccine diplomacy", "politics", and "global health diplomacy". The distribution of these keywords, together with their surrounding terms, suggests the following conclusions:

1. Regarding health diplomacy, health is the primary concern for researchers.
2. More attention has been shifted to health diplomacy impacts that extend to other fields like economics and internal policy-making.
3. Research focusing on global health shows the indispensable relationship between health and politics, particularly under a special public health emergency.

Table 1: Data for Top 3 Keywords in the Co-occurrence Network (Source: Authors' illustration)

Keywords	Frequency	Centrality	Year
Health	264	0.23	2000
Policy	167	0.39	1998
Global Health	116	0.11	2009

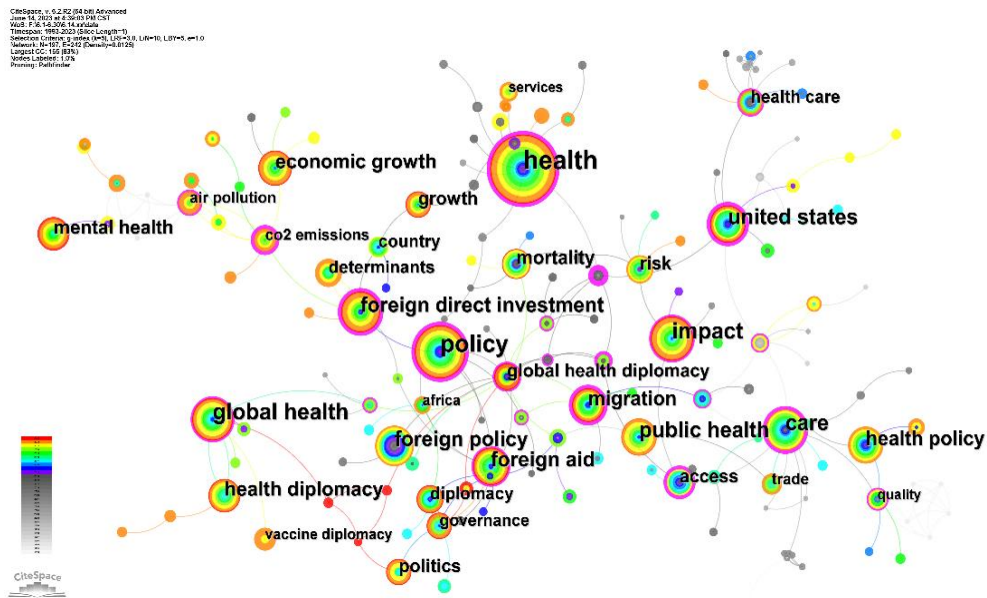


Figure 5: Keywords Co-occurrence (Source: Authors' illustration)

Keywords Clustering

In the context of CiteSpace, keywords clustering refers to a functionality that generates node and link graphs. The clustering helps to visualize the relationships and connections between these nodes, providing a comprehensive overview of the research landscape (Chen and Liu 2022). Strong internal connections exist among the keywords, and certain keywords can form distinct clusters based on their similarity. Identifying these clusters can better represent the various trending subfields (Tan et al. 2022).

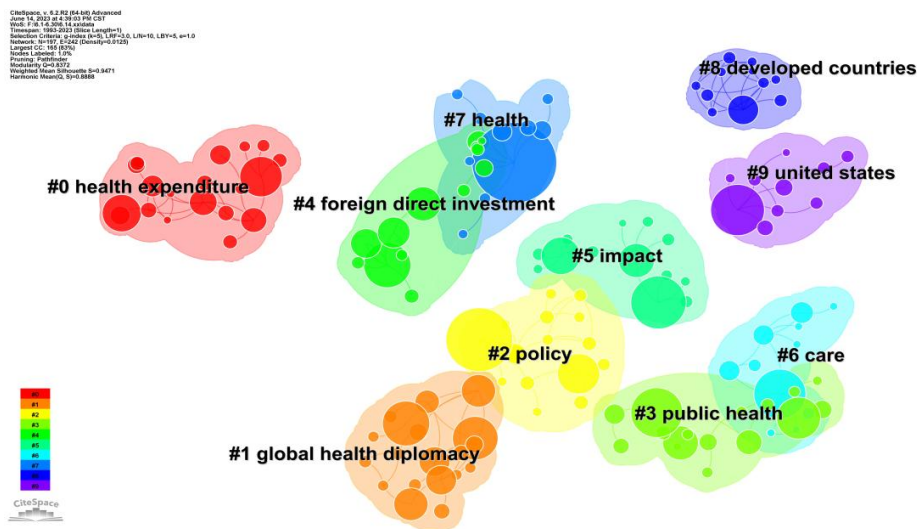


Figure 6: Keywords Clustering (Source: Authors' illustration)

As can be seen in Figure 6, the clustering modularity and silhouette value of the keywords clustering are 0.8372 and 0.9471, respectively, which both meet the requirements of the Q value greater than 0.3 and S value bigger than 0.7, indicating a significant clustering structure and the clustering results are reliable and convincing. According to the clustering map, there are nice clusters in total, which are health expenditure, global health diplomacy, policy, public health, foreign direct investment, impact, care, health, developed countries, and the US, demonstrating that health diplomacy is closely related to policy-making, economics, politics, the impact of big powers and contribution of developed countries, etc.

According to Table 2, each of the clusters covers 5 items. The S value ranges from 0.981 (Cluster #0) to 0.846 (Cluster #2), of which Cluster #1, #2, #3, #5, and #6, and Cluster #4 and #7 present two intertwined clusters, illustrating deeper and closer interaction among these items in the field of health diplomacy.

Table 2: Data for Keywords Clustering (Source: Authors' depiction)

Label	N	S	Year	Terms and Scale
0	20	0.981	2009	health expenditure (18.87, 1.0E-4); CO2 emissions (18.87, 1.0E-4); environmental pollution (14.43, 0.001); air pollution (12, 0.001); economic growth (10.42, 0.005)
1	19	0.893	2014	global health diplomacy (56.71, 1.0E-4); foreign policy (32.77, 1.0E-4); global health governance (22.74, 1.0E-4); foreign aid (15.51, 1.0E-4); lessons (12.03, 0.001)
2	17	0.846	2009	policy (18.21, 1.0E-4); migration (12.08, 0.001); experiences (8.56, 0.005); health diplomacy (7.75, 0.01); institutions (6.61, 0.05)
3	16	0.973	2008	public health (50.05, 1.0E-4); health policy (49.69, 1.0E-4); rehabilitation (13.33, 0.001); health insurance (10.6, 0.005); physiatry (8.88, 0.005)
4	13	0.893	2009	foreign direct investment (25.82, 1.0E-4); risk factors (14.67, 0.001); economic freedom (9.77, 0.005); political economy (9.77, 0.005); international monetary fund (8.3, 0.005)
5	13	0.975	2012	impact (10.73, 0.005); health care disparities (9.43, 0.005); vulnerability (9.43, 0.005); health diplomacy (6.16, 0.05); peacebuilding (5.81, 0.05)
6	11	0.986	2001	care (19.1, 1.0E-4); sector (11.04, 0.001); epidemiology (10.4, 0.005); children (7.54, 0.01); USA (7.35, 0.01)
7	11	0.936	2009	health (8.74, 0.005); behavior (8.7, 0.005); gender (7.29, 0.01); Europe (6.81, 0.01); aid (5.12, 0.05)
8	11	0.98	2006	developed countries (15.09, 0.001); emigration and immigration/trends (15.09, 0.001); brain drain/trends (15.09, 0.001); Australia (15.09, 0.001); developing countries (14.5, 0.001)
9	10	0.978	2008	USA (30.3, 1.0E-4); tuberculosis (9.33, 0.005); obesity (7.3, 0.01); global health (6.82, 0.01); epidemiology (5.82, 0.05)

Keywords Citation Burst

The keyword burst index can summarize keywords with significantly high-frequency changes, thereby providing insights into the forefront of research in health diplomacy. By employing burst-detection algorithms, it becomes possible to recognize emerging terms or concepts, irrespective of the frequency with which their associated articles are cited (Chen 2006).

By analyzing keyword burst patterns, this study identifies active topics in the field of health diplomacy throughout the period from 1993 to 2023. A total of 197 keywords exhibited bursts at different time points, and the top 25 keywords with the strongest burst strength are presented in Figure 7. A longer burst duration and higher burst intensity indicate increased attention to a particular keyword during a specific period. Notably, the keyword "vaccine diplomacy" had the highest burst strength of 8.88 between 2021 and 2023, suggesting this term's influential role in health diplomacy. The term "foreign policy" experienced a burst between 2006 and 2015 with a burst strength of 8.38, highlighting the high relevance between foreign policy and health issues.

The longest burst occurred with “access” between 2003 and 2018, having a burst strength of 6.95, demonstrating that as a public good, access to health resources is of great concern for researchers in this field. In recent studies, access to public goods policies made by countries in terms of health have turned out to be hotspots in recent years.

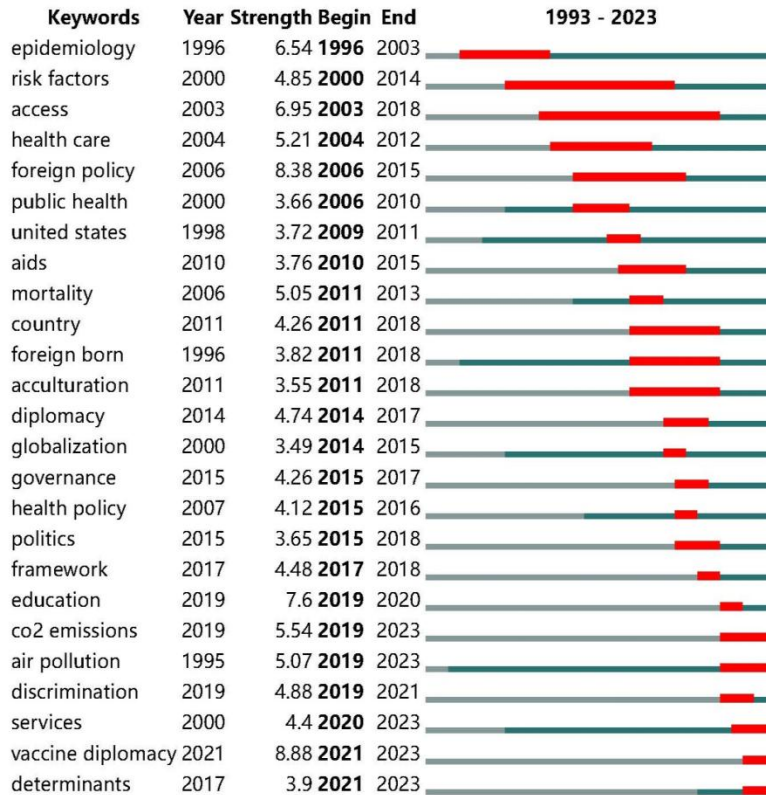


Figure 7: Top 25 Keywords with Strongest Citation Burst (Source: Authors’ illustration)

Reference Analysis

Reference Co-citation Network Analysis

Figure 8 presents the co-citation analysis of 2,216 related research papers in the Web of Science (WOS) from 1993 to 2023. The following information can be derived from the analysis: there are 1147 network nodes (N = 1147) and 2990 connections (E = 2990) between these nodes. The density of the total cited literature network is 0.0045 (Density = 0.0045), indicating a relatively low level of cross-referencing among the literature. In the figure, the size of each circle represents the “cited frequency” of the corresponding document. The distance between circles indicates the level of relatedness between the works. Strong connections imply that this literature frequently appears together in subsequent research publications. In the top 10 document citation list provided in Table 3, two documents have been cited more than 20 times, and eight documents have been cited more than 10 times. Of the top ten cited works, Feldbaum et al. (2010), Labonté et al. (2010), Katz et al. (2011), Kickbusch et al. (2007), Riggiozzi (2014) emphasized the role of health diplomacy in terms of

global health cooperation and governance in macro scope. At the same time, Fazal (2020) and Javed and Chatu (2020) researched health diplomacy under the context of Covid-19. Among the analyzed literature, the top ten co-cited documents are presented in Table 3.

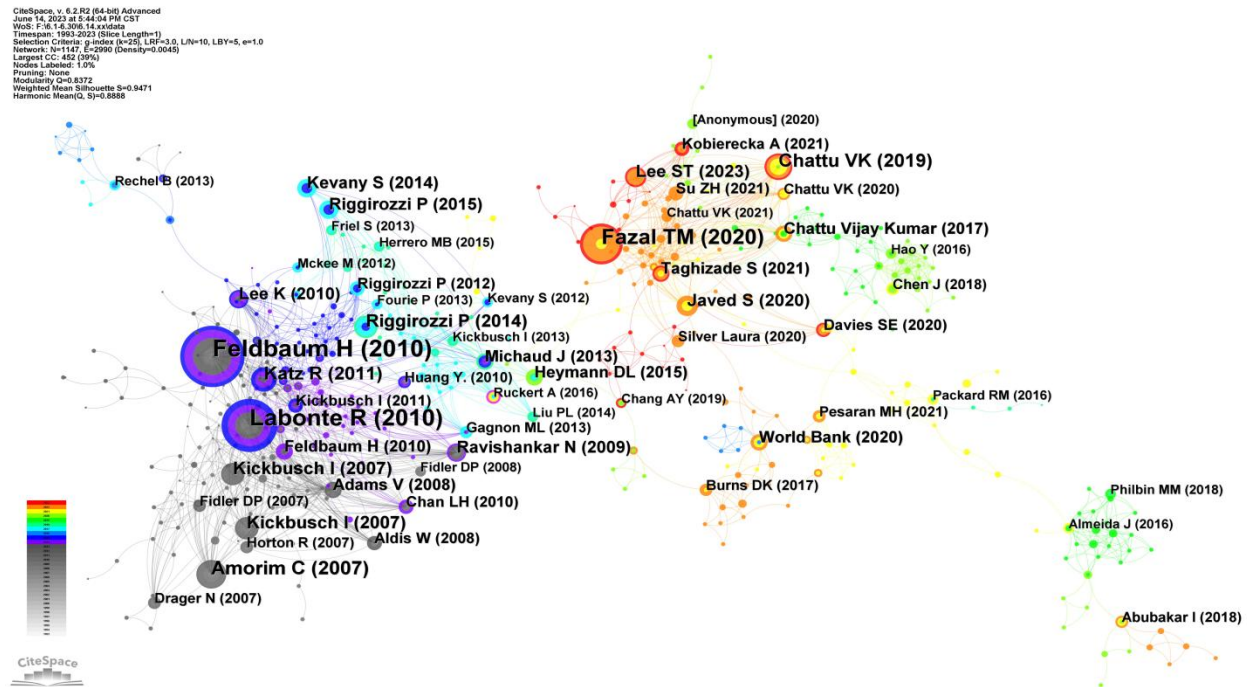


Figure 8: Co-citation Network Map of References (Source: Authors' illustration)

Table 3: Top Ten Cited Documents (Source: Authors' depiction)

Title	Author	Frequency	Source
Health diplomacy and the enduring relevance of foreign policy interest	Feldbaum et al.	30	PLoS medicine
Framing health and foreign policy lessons for global health diplomacy	Labonté et al.	26	Globalization and Health
Health diplomacy in pandemical times	Fazal	20	International Organization
Oslo Ministerial Declaration- global health: a pressing foreign policy issue of our time	MOF of Brazil, France, South Africa, Senegal	14	The Lancet
The emerging role of blockchain technology applications in routine disease surveillance systems to strengthen global health security	Chatu et al.	13	Big Data and Cognitive Computing
Defining health diplomacy: changing demands in the era of globalization	Katz et al.	12	MILBANK Q
Global health diplomacy: the need	Kickbusch et al.	11	World Health Organization

for new perspectives, strategic approaches, and skills in global health			
Global health diplomacy: training across disciplines	Kickbusch et al.	11	Bulletin of the World Health Organization
Regionalism through social policy: collective action and health diplomacy	Riggiozzi	11	Economy and Society in South America
Strengthening the Covid-19 pandemic response, global leadership, and international cooperation through global health	Javed, Sumbal, and Vijay Kumar Chattu	10	Health Promotion Perspective

Reference Co-citation Clustering

Regarding reference co-citation clustering based on CiteSpace, the Node (N) represents the total number of citations received by a particular document. It serves as a measure of the document’s academic visibility and citation impact. A higher N-value indicates that the document has been widely cited, suggesting greater influence and significance. The silhouette score (S), serving as a cluster homogeneity measure, indicates a certain degree of thematic or research domain similarity. The characteristics of the 9 largest clusters are summarized in Table 3. As can be found in Table 4, the N value of the top three clusters are 111, 65, and 40, respectively. According to the terms and scale of the top one cluster, terms including foreign policy, global health, the Covid-19 pandemic, foreign policy architecture, and literature review often emerged together, suggesting that these topics are closely intertwined and have become hotspots in health diplomacy research.

Table 4: Top 9 Largest Reference Co-citation Clusters (Source: Authors’ depiction)

Label	N	S	Year	Terms and Scale
0	111	0.908	2009	foreign policy (113.83, 1.0E-4); global health (69.93, 1.0E-4); Covid-19 pandemic (63.36, 1.0E-4); foreign policy architecture (57.98, 1.0E-4); literature review (57.98, 1.0E-4)
1	65	0.962	2020	covid-19 pandemic (140.52, 1.0E-4); global health (79.73, 1.0E-4); political economy (78.05, 1.0E-4); India’s neighborhood vaccine diplomacy (64.48, 1.0E-4); geopolitical perspective (64.48, 1.0E-4)
2	40	0.977	2016	economic growth (60.26, 1.0E-4); anthropogenic factor (53.49, 1.0E-4); spatial-temporal analysis (53.49, 1.0E-4); major urban agglomeration (53.49, 1.0E-4); heterogeneous effect (46.73, 1.0E-4)
3	38	0.977	2012	South America (100.54, 1.0E-4); locating regional health policy (60.56, 1.0E-4); institutions politics (60.56, 1.0E-4); theory politics history (55.01, 1.0E-4); south-south cooperation (55.01, 1.0E-4)
4	38	0.969	2011	public-private partnership (53.04, 1.0E-4); politics power (53.04, 1.0E-4); sugar-sweetened beverage industry (53.04, 1.0E-4); post-2015 development agenda (53.04, 1.0E-4); resource-scarce setting (47.1, 1.0E-4)
5	37	0.951	2012	national policies (190.5, 1.0E-4); policy design (63.93, 1.0E-4); adapting public policy theory (58.97, 1.0E-4); public health research (58.97, 1.0E-4); inserting health (54.01, 1.0E-4)
6	33	0.994	2017	providing care (64.34, 1.0E-4); health insurance coverage (57.1, 1.0E-4); foreign-born sexual minorities (57.1, 1.0E-4); social determinant (49.88, 1.0E-4); health disparities (49.88, 1.0E-4)
7	32	0.995	2018	catalyzing aid (58.33, 1.0E-4); donor behavior (58.33, 1.0E-4); aid allocation (58.33, 1.0E-4); female legislator (52.99, 1.0E-4); policy maker (52.99, 1.0E-4)
9	17	0.955	2020	donors role (35.02, 1.0E-4); qualitative analysis (35.02, 1.0E-4); rights partnership (35.02, 1.0E-4); strengthening health system (35.02, 1.0E-4); Ugandan case studies (35.02, 1.0E-4)

COUNTRY AND RESEARCH INSTITUTION ANALYSIS

From 1993 to 2023, 2,334 research institutions were involved in health diplomacy studies. Among them, 133 research institutions reached a threshold of 5 or more publications in this field. Figure 9 shows that the most influential research institution is the London School of Hygiene & Tropical Medicine, with a total link of 46, considering its published documents and citations. The second and third are the University of Toronto and Harvard University, with a total link of 46 and 39, respectively. The map also illustrates that institutional collaboration in health diplomacy research exhibits regional characteristics, with key institutions primarily located in countries such as the United States, the United Kingdom, and Australia. In addition to the top three institutions, notable contributors include the University of Oxford, the University of Michigan, the University of Ottawa, and Columbia University. This reflects the close association between health diplomacy research and the respective countries' advancements and investments in healthcare technologies. Furthermore, the two prominent Asian institutions are Tsinghua University in China and the National University of Singapore, indicating their strong collaborative ties with institutions worldwide.

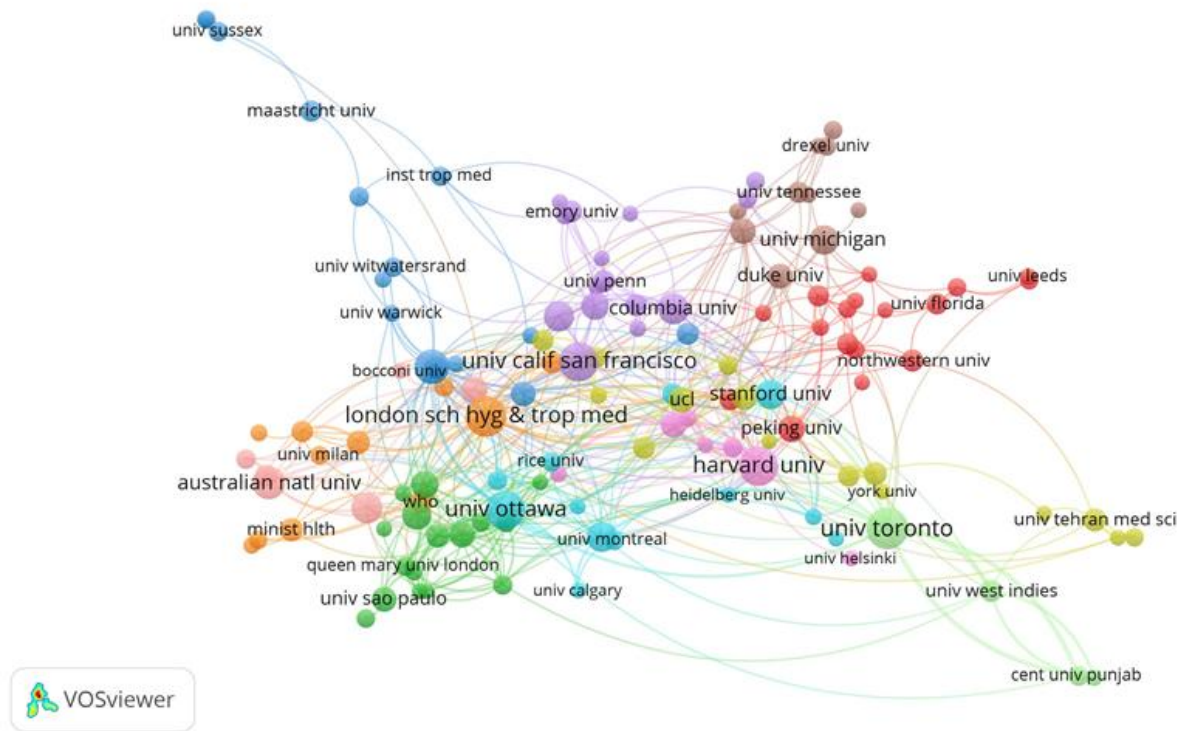


Figure 9: Map of the Cooperation among Institutions (Source: Authors' illustration)

In the study of health and diplomacy from 1993 to 2023, a total of 141 major research countries were involved. Among them, 45 countries reached a threshold of 10 or more publications in this field. The density visualization diagram (Figure 10) is used to identify countries' cooperation in health diplomacy research.

Darker colors indicate higher levels of impact and connection in the field with other countries. As can be seen in Figure 10, the United States has emerged as the leading research country with the highest absolute collaborative influence. The United Kingdom, the People’s Republic of China, Canada, and Germany are the rest top five countries for cooperation in health diplomacy. The links between these countries demonstrate their collaborative relationships in researching health diplomacy.

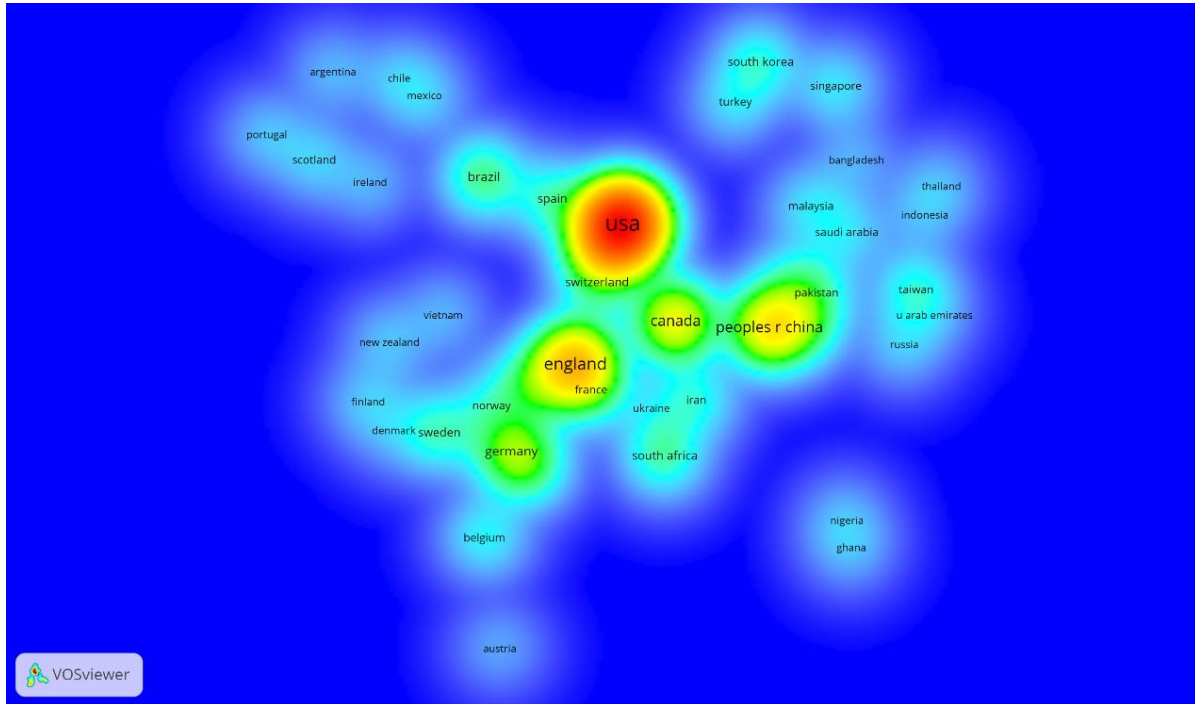


Figure 10: Map of the Cooperation among Countries (Source: Authors’ illustration)

TIMELINE AND ANALYSIS

Keywords Timeline Analysis

To gain deeper insights into the progression of health diplomacy, it is essential to examine additional information through time series analysis. Figure 11 illustrates the temporal evolution of each cluster, where the horizontal axis represents the timeline with publication years displayed from left to right. The vertical axis depicts the noteworthy literature constituting the knowledge base at different times. This visualization aids researchers in promptly comprehending the research advancements within the field and its evolving landscape. In order to gain a deeper understanding of the dynamic trends in development, this subsection presents a timeline view (Figure 11) that showcases the progression of these clusters over time. This view allows for the classification of all keywords into nine distinct clusters, providing valuable insights into the evolving landscape of the research domain, i.e., health expenditure, global health diplomacy, policy, public health, foreign direct investment, impact, care, health, developed countries, and the United States.

Cluster 1 is the category with the longest time. Cluster 2 reaches current with financial development, Covid-19, security, power, financial development, etc., as the most appeared keywords, highlighting the most concerned aspects in health diplomacy in recent years. In addition, as can be found from the timeline view, keywords besides the core topic "health", cover health policy, community policy, growth, political economy, tobacco control, regulations, economic growth, and so on, ranging from 1995 to 2023, which presents the period of various key terms in the field of this research. Other than that, the most recently appeared terms include power, Covid-19, security in Cluster 1, undocumented immigrants in Cluster 4, and social determinants of health in Cluster 5, illustrating the interest of researchers in the field of health diplomacy in the past three years.

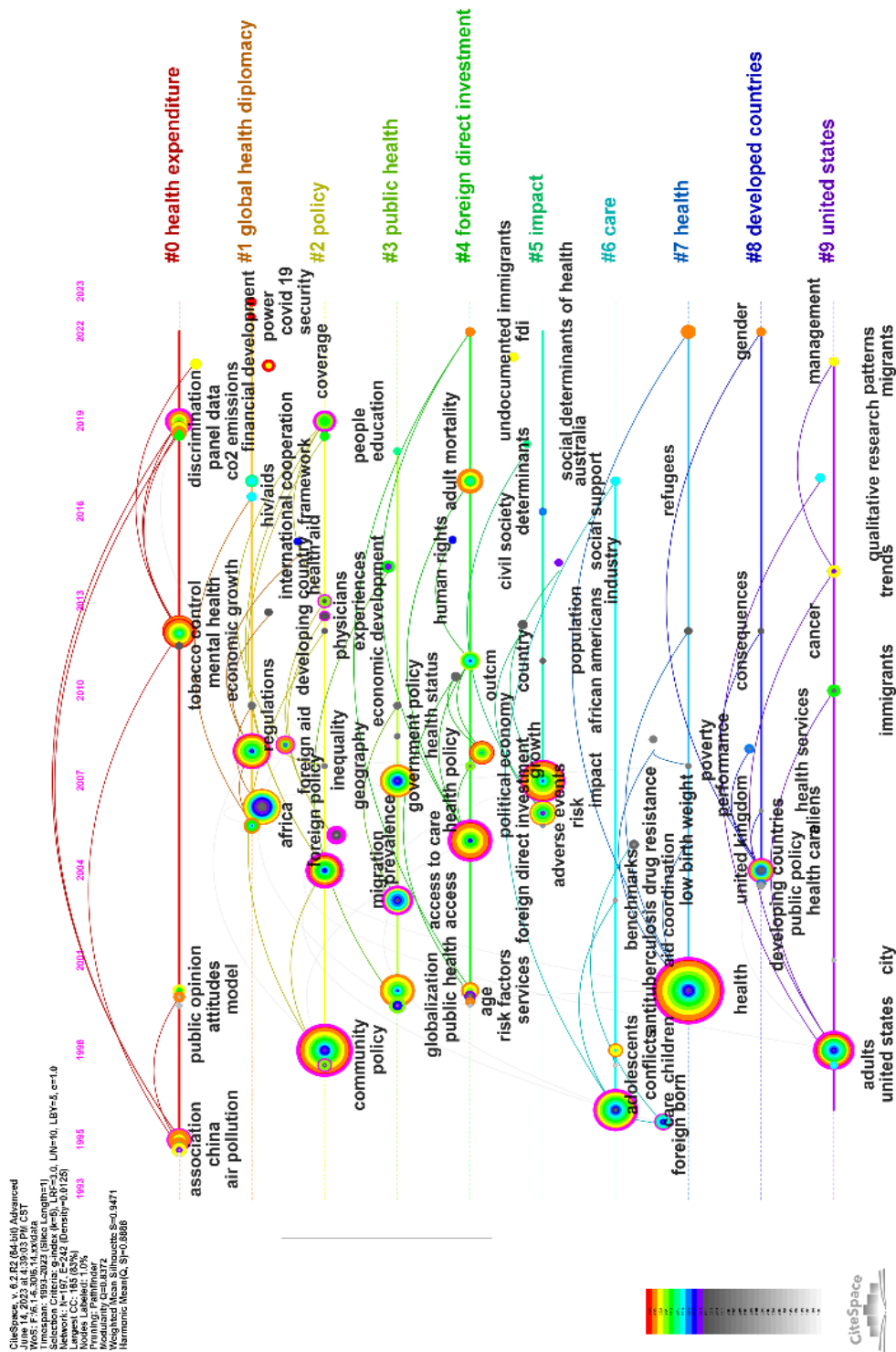


Figure 11: Keywords Timeline (Source: Authors' illustration)

Time Zone

CiteSpace II provides a time-zone view feature that emphasizes the temporal patterns between a research front and its intellectual base. A Time Zone serves as a visual representation of the temporal dynamics and connections between research fronts and their intellectual base, thus helping researchers understand the historical development and evolution of a research field and identify key influences and trends over time (Chen 2006).

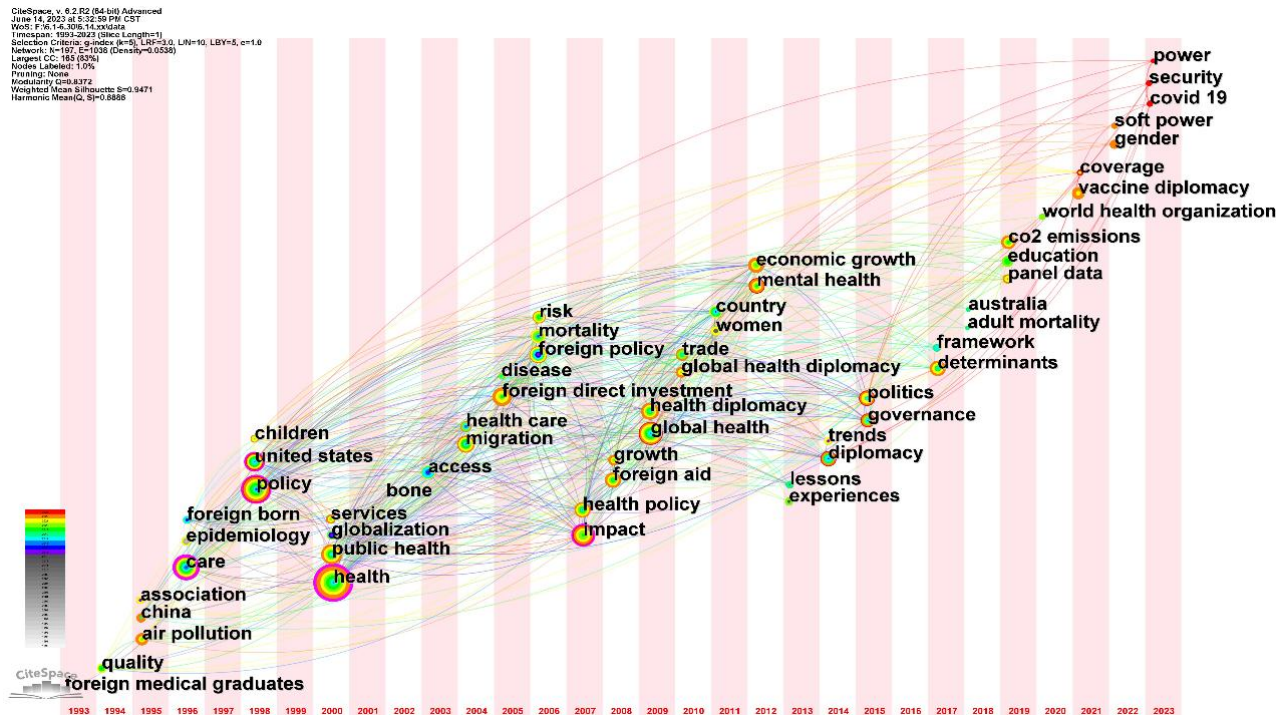


Figure 12: Time Zone of Keywords (Source: Authors' illustration)

The study imported standardized data from the research samples into the CiteSpace software. The time range selected was from 1993 to 2023, with the top 50 research institutions retained for each period (Top N = 50). The analysis project focused on “keywords”, generating a co-occurrence network of keywords. The Time Zone function was then utilized to visually represent the time-based view of the relationship between health and diplomacy or health and foreign policy in the past three decades, as shown below. This figure clearly illustrates the evolution of research hotspots and frontiers in the field, providing valuable insights for analyzing the dynamic development of health diplomacy on a global scale.

According to the Time Zone, as shown in Figure 12, the developing trend of this field can be divided into four phases. Phase one is the gap phase (1993-2000), meaning that the connection between health and diplomacy was limited. Cahill (1993), Derikson (1997), Morin et al. (2000) stated and illustrated interactions between health and foreign policy from the American view, which quite matches the two biggest nodes shown in this map. Phase two is the beginning phase (2001-2006); the main keywords that emerged include globalization, public health, foreign policy, services, migration,

foreign direct investment, etc., demonstrating that studies on health became multidisciplinary and diversified, where connections among health, foreign policy, economics, and global order were built. The third phase is the developing phase (2007-2013). It can be summarized that health and diplomacy were indispensable from then according to the keywords that appeared during this period, including impact, global health diplomacy, health diplomacy, global health, trade, foreign aid, and so on. The last phase is the multifaceted development phase (2014-2023). From the map, it is evident that the number of keywords in this phase is more diversified compared to that of the other three phases, including power, Covid-19, security, soft power, WHO, vaccine diplomacy, and governance were newly emerged, illustrating that researches between health and diplomacy have been extended to a rather large scope with salient features of the era.

CONCLUSION

Bibliometric analysis shows that health diplomacy has gradually become a research hotspot since 1993, highlighting the increasing connections between health, diplomacy, and other fields. The analysis of topic distribution and growth data reveals the interdisciplinary nature of health diplomacy research, intersecting with public environmental health, health services and policies, international relations, and economics. Through keyword co-occurrence, clustering, and growth analysis, it is found that while health remains the main focus of health diplomacy research, its scope has expanded to include its impact on various aspects such as the economy, national policy-making, foreign aid, and health resource allocation. The research is no longer limited to the health sector alone but encompasses the influence of health on other areas, particularly in the context of global health emergencies. Keywords such as vaccine diplomacy, Covid-19, access, tobacco control, health governance, etc., are closely related to specific health events.

Analysis of the timeline and temporal distribution of keywords reveals noticeable differences in the periods of health diplomacy-related terms, which have increased over time, reflecting the increasing importance given by researchers to health diplomacy research. While some terms such as power, Covid-19, security, soft power, WHO, vaccine diplomacy, and governance have shorter spans, they have become focal points and hot topics in recent years. This reflects the significant influence of global public health crises as important factors driving the surge in health diplomacy research, providing a substantial basis for future research in health diplomacy and the relationship between health and diplomacy.

There is relatively close collaboration among research institutions in different countries, focusing primarily on developed countries such as the US, the United Kingdom, Canada, and Australia, and Asian countries like China and Singapore. This reflects the close relationship between the research of health diplomacy and the strength of health technologies and resources, exhibiting distinct regional characteristics. The field is characterized by the US holding a prominent and influential position, followed by China, the United Kingdom, and Australia. This ranking corresponds to the level of collaboration observed among research institutions. Close collaborations are observed between the United States, the United Kingdom, Australia, China, and France.

At the beginning stage, research on health diplomacy mainly focused on internal policy studies, as traditional health issues centered on national interests, including health and the environment, tobacco control, globalization, and public health. With the increasing number of public

health emergencies, health diplomacy research has expanded beyond national policy-making to encompass practices that protect national public health interests and promote global health governance. Research in health diplomacy has shifted towards regional health governance, global health governance, biosecurity, health aid, the role of major powers in health diplomacy, and the relationship between health diplomacy and sustainable development goals, all closely related to the common interests of the international community.

However, this study also has some limitations. The study relies on the Web of Science database, overlooking some literature from Scopus, Elsevier Science, and Google Scholar. Only English articles were selected during the literature screening process, leading to some data gaps. Additionally, the study covers 30 years, but data for the year 2023 is not fully included. These limitations in sample selection and author knowledge may result in insufficient depth and comprehensiveness in certain parts of the analysis.

Overall, compared to similar literature review studies, this research provides an in-depth analysis of the literature in the field of health diplomacy using the Web of Science database and visualization software such as VOSviewer and CiteSpace. The study analyzes publication trends, the evolution of research topics, keyword clustering, co-occurrence, temporal distribution, and collaboration among countries and institutions in health diplomacy. By organizing the literature using visualization analysis software, this study provides a reference for scholars to gain a macro-level understanding and analysis of the current state of health diplomacy research and a micro-level understanding of specific evolutionary processes and to grasp future research trends. It represents a new attempt in the field.

CRediT AUTHOR STATEMENT

Liu Jiangwei: Conceptualization, methodology, software, writing - original draft.

Sity Daud: Supervision, writing - reviewing.

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