Co-Occurrence Analysis of COVID-19 Publications with an Emphasis on the Global Health Governance (GHG)

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Abstract

Background: Analyzing co-occurrence is an effective way to monitor the overview of topic spreading. The present study aimed to conduct a co-occurrence analysis of scientific publications related to COVID-19, emphasizing Global Health Governance (GHG).

Materials and Methods: This applied research with an analytical approach was carried out on all the scientific publications related to COVID-19, emphasizing GHG (51056 records), extracted from PubMed Central on 26/01/2022. The research population consisted of all the scientific publications related to COVID-19, emphasizing GHG (51056 records), extracted from PubMed Central on 26/01/2022. The data were analyzed using BibExcel, UCINET, Excel, and SPSS software, and Spearman's test was used to confirm correlations.

Results: The co-word network of the thematic area of COVID-19 includes 226 nodes and 7292 edges. COVID-19 and the pandemic formed the most co-word pairs with 2224 connections. The COVID-19* mental health and COVID-19* anxiety, with 1019 and 925 connections, are ranked next, respectively. The term COVID-19 is ranked first with a centrality index of 225. The keywords of pandemic and public health are ranked second and third with the centrality index of 217 and 206, respectively.

Conclusion: The global approach of studies related to COVID-19 is more inclined to the epidemiological and public health fields. Assuming the GHG, detailed and comprehensive planning should be performed to strengthen these studies and pave the way for international cooperation, determining research requisites, and developing applied research studies.

Keywords: COVID-19, global health, co-occurrence, analysis, publications, scientometrics

INTRODUCTION

The novel coronavirus (2019-nCoV or COVID-19) epidemic first broke on December 31, 2019, in the city of Wuhan, China, and quickly put the world in a state of crisis and high alert until the World Health Organization (WHO) declared COVID-19 as a pandemic on March 11, 2020.[1] According to Worldometers reports (https://www.worldometers.info/coronavirus), on December 27, 2022, 662391407 people were infected with the COVID-19 virus in the world, of which 63496045 recovered and 668753 passed away.[2] Today, this pandemic is relatively stable, probably due to international organizations such as WHO and Centers for Disease Control and Prevention (CDC) and other organizations that could manage and control COVID-19 internationally in more than 200 countries based on the components of GHG.[3]

The rapid spread of COVID-19 is a first-hand example of ignoring threats that may spread worldwide. The unity of the world countries is very important to develop coherent responses and provide capacities to control such threats, a

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concept that can be defined as interdependence governance. Different societies must direct their resources to organizations that facilitate shared global governance to respond coherently to these threats.[4]

The impact of the COVID-19 crisis could decline, and nations may become more resistant to possible challenges and crises in the future through the common global governance and its health-centered approach. Nevertheless, the COVID-19 pandemic has detected deep gaps in GHG.[5] Despite global determination and international health management, there are some obstacles in preventing and dealing with this virus. In other words, some countries, governments, and international organizations face some barriers from nationalist governments to manage this threat. This disease has questioned the GHG and has shown that required structures do not exist for comprehensive coordination and sharing of required resources to fight epidemic diseases. Countries that act alone may not possibly plan effectively and make policies to control this pandemic.[6]

Infected cases and casualties increased exponentially around the globe in less than three months after the WHO declared COVID-19 as a public health emergency of international concern and within a month after being declared a global pandemic (WHO, 2020), further demonstrating that the world needs responsible political leadership, evidence-based decision-making, and coordinated global health actions.[7] Governance for Global Health refers to the institutions and mechanisms at national and regional levels that contribute to global health governance and/or to governance for global health—such as national global health strategies or regional strategies for global health. However, COVID-19 revealed deep gaps in GHG as international organizations encountered some obstacles from nationalist governments in managing a common threat; hence, the experience of the COVID-19 pandemic is changing the structure of global health.[7]

COVID-19 has become the main focus of international medical institutions since being detected in December 2019. Extensive efforts have been made in using financial and human resources to publish important data in the fight against the pandemic. Quick and accurate access of the medical community to high-quality and reliable data is the first primary step to dealing with the disease. Distribution and publication of the results of all scientific activities on COVID-19 are crucial for identifying different aspects of COVID-19, and significant publications have been indexed in international reference databases. Investigations show that such a high volume of scientific publications has not been observed in a short period in any scientific field.[8] Numerous scientometric studies have been conducted worldwide on COVID-19, each of which evaluates the most important issues from different perspectives and identifies scientific progress trends through scientometric indices and various methods and tools.[9,10]

The global handling of COVID-19 offers lessons for ensuring better performance in the face of future outbreaks. Deficiencies such as poor coordination and monitoring overlap, the fragile system of GHG, and the unfair distribution of vaccines in its current system re-emerged during the COVID-19 pandemic. These deficiencies provoked researchers and policymakers to seek the underlying causes and suggest changes for better outcomes in the future.[11]

The response to COVID-19 is the cumulative result of all the policies and actions of governments and various organizations active in global health, falling under the umbrella of the GHG based on different definitions of researchers. Therefore, procedures in response to COVID-19 should be assessed globally, including actors and factors affecting their performance, such as interests and capacities and various components of the GHG system, including the legal framework.[12]

These international public health events and human efforts to control them have demonstrated the uncertainty of decision-making and further problems in this case. Governance challenges for global health have long attracted the attention of researchers in various fields. With the outbreak of COVID-19, it is time to re-examine the current perspective of international health collaborations, which is the foundation of various legal norms, processes, and institutions.[13]

The outbreak of COVID-19 has broadly re-evaluated the effectiveness of global health studies, particularly the ethical and legal legitimacy of WHO as a global health organization, and has once again brought the issue of GHG into the focus of the international community.

One of the most common methods for mapping and analyzing the structure of different knowledge domains is the relationship between words used in different parts of scientific research publications. The co-occurrence of words assesses the degree of cognitive connection between a set of documents and shows the intellectual link among researchers in that research field.[14] Visualization of logical structure in a specific scientific field is one of the main features of co-word analysis based on conceptual mapping.

Therefore, co-word analysis reveals thematic clusters under a research domain (such as the coronavirus) as one of the most common and effective methods in scientometric studies, taking into account its conceptual and semantic relationships and mapping the intellectual structure of knowledge; hence, researchers who are interested in the field will be significantly helped. Taking into consideration the COVID-19 pandemic, the need for detection of its various dimensions, the widespread publication of relevant research, and the fact that paying attention to the GHG components can effectively influence planning and policymaking for its control, the current research set to conduct a co-word analysis of COVID-19 studies, emphasizing the dimensions of GHG and mapping its co-word network. The results of this study can help to show a more emphasized domain of COVID-19-related publication regarding GHG aspects and be effective in policymaking to manage future pandemics at a global level.

MATERIALS AND METHODS

This was applied research, and co-occurrence analysis of words was used for data analysis. Co-occurrence analysis focuses on analysing counts of co-occurring entities within a collection of unit. The statistical population consisted of all publications indexed in PubMed Central (PMC) until the time of data collection (26/01/2022). Early in the COVID-19 pandemic, the National Library of Medicine (NLM) collaborated with publishers and scholarly societies to expand access to coronavirus-related journal articles in PubMed Central (PMC) and a digital archive of peer-reviewed biomedical and life sciences literature has been provided. The data required for COVID-19 scientific publications was equal to 51056 records emphasizing GHG. A search strategy was designed for data extraction. For this purpose, 30 subject matter experts and specialists were asked to extract keywords related to the research topic. In the first stage, 109 keywords were received; duplicate and overlapping items were removed after checking and matching them with MeSH. A list of selected keywords was provided by three experts for searching and retrieving the desired documents, including:

2019 Novel Coronavirus Disease, 2019 Novel Coronavirus Infection, 2019-nCoV Disease, 2019-nCoV Infection, COVID-19 Pandemic, COVID-19 Virus Disease, COVID-19 Virus Infection, COVID19, Coronavirus Disease 2019, Coronavirus Disease-19, SARS Coronavirus 2 Infection, SARS-CoV-2 Infection, Severe Acute Respiratory Syndrome Coronavirus 2 Infection.

GHG was another vital variable considered in this article. Similarly, subject experts did the selection and edition process of the keywords related to this variable, and finally, the following keywords were selected:

Global health governance, global health equity, international cooperative governance, Policy disparities, global emergency medicine, Public health, World Health Organization, Sustainable Development Goal, public health concern, health indicator, health system public service, risk management.

The search strategy was below without considering the time limitation to retrieve the documents. Bibexcel, NetDraw, UCINET, and Excel. 16 were used for data analysis.

(global health governance[Title] OR global health equity[Title] OR international cooperative governance[Title] OR Policy disparities[Title] OR global emergency medicine[Title] OR Public health[Title] OR World Health Organization[Title] OR Sustainable Development Goal[Title] OR public health concern[Title] OR health indicator[Title] OR health system public service[Title] OR risk management 2019 Novel Coronavirus Disease[Title] OR 2019 Novel Coronavirus Infection[Title] OR 2019-nCoV Disease[Title] OR 2019-nCoV Infection[Title] OR COVID-19 Pandemic[Title] OR COVID-19 Virus Disease[Title] OR COVID-19 Virus Infection[Title] OR COVID19[Title] OR Coronavirus Disease 2019[Title] OR Coronavirus Disease-19[Title] OR SARS Coronavirus 2 Infection[Title] OR SARS-CoV-2 Infection[Title] OR Severe Acute Respiratory Syndrome Coronavirus 2 Infection [Title]).

Degree of centrality is the number of direct links that a particular agent or node has with other agents, regardless of the strength of the link. Each direct link is considered a unique co-occurrence. The centrality of a factor means that this particular keyword has occurred with many other keywords. Centrality is the average shortest distance that a particular agent has from other nodes in a network.

The values of the indices were calculated using UciNet software. Bibexcel and NetDraw software were also used to draw the co-occurrence network. After identifying the subject clusters in the co-occurrence network, the keywords of each cluster were placed in an Excel sheet and available to experts in related fields, and according to their opinions, the names of the clusters were determined.

Another analysis technique used in this study was the strategic diagram which the x-axis represents the degree of centrality, and the y-axis represents the density. The strategy diagram can be delivered with four quadrants (Q), each with a different centrality and density. The clusters located in that have different positions. More precisely, the clusters located in the first quadrant have high centrality and density, are mature, and are placed in the core of the study area.

RESULTS

The co-word network of the thematic domain of COVID-19 contained 226 nodes and 7292 edges. Nodes represent each word in the scientific network, and edges are the links between the two words. It can be said that edges are co-word pairs in the scientific network. The density of the co-word network was equal to 0.287 based on the co-occurrence relationship of feature keywords within the topic.

Table 1 provides co-word pairs of COVID-19's scientific network, emphasizing global health governance.

COVID-19 and the pandemic formed the most frequent co-word pairs with 2224 links, followed by the pairs of COVID-19*mental health and COVID-19*anxiety ranking next with 1019 and 925 links, respectively [Table 1]. The co-word network of COVID-19 researchers with an emphasis on GHG has been shown in Figure 1.

Each node in Figure 1 represented one of the keywords. Larger nodes indicated that these keywords had more influence and power, with a greater influence on other nodes in the network. Keywords with higher centrality index have been shown with large circles.

The centrality, closeness, and betweenness indices of the words in the field of COVID-19 in their scientific network have been provided in Table 2.

Degree centrality refers to the times a word is used with other words in research and is related to each other. Table 2 shows that COVID-19 was ranked first with a centrality index of 225.
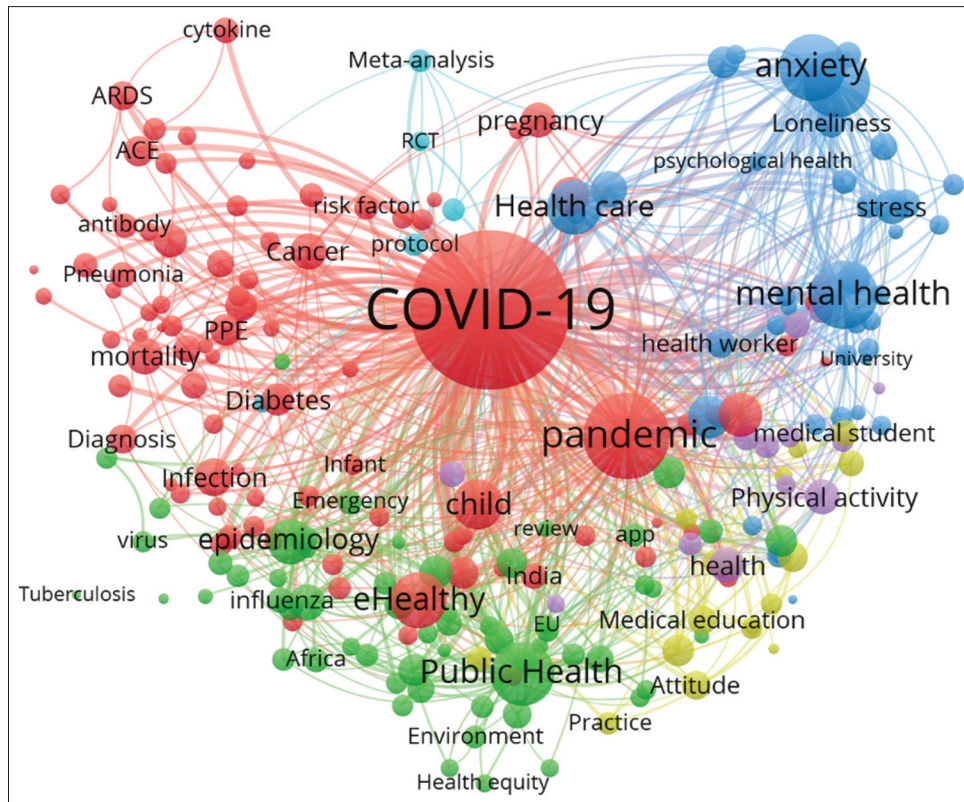
Figure 1: The co-word network of COVID-19 based on GHG

Table 1: Co-word pairs of the COVID-19 scientific network

	Co-word pairs		Number of relation
1	COVID-19	Pandemic	2224
2	COVID-19	Mental health	1019
3	Anxiety	COVID-19	925
4	COVID-19	Depression	845
5	COVID-19	eHealthy	832
6	Anxiety	Depression	674
7	COVID-19	Health care	666
8	Child	COVID-19	637
9	COVID-19	Public health	569
10	COVID-19	Lockdown	433
11	COVID-19	Epidemiology	380
12	COVID-19	Life satisfaction	308
13	Cancer	COVID-19	305
14	COVID-19	Mortality	298
15	COVID-19	Infection	282
16	Aging	COVID-19	280
17	COVID-19	Nurse	264
18	ACE	COVID-19	260
19	COVID-19	PPE	229
20	COVID-19	Intensive care unit	221

The keywords pandemic and Public Health were ranked second and third with centrality indices of 217 and 206, respectively. COVID-19 had a closeness centrality of 225, followed by pandemic and Public Health with closeness centrities of 233 and 244.

Therefore, these words were closer to other keywords in the co-word network and accessed the other nodes with the shortest path length. COVID-19 had the highest betweenness centrality (1504.87), followed by pandemic and Public Health with 1118.56 and 984.48, respectively.

Twelve clusters were extracted from the co-word network based on the analysis done by SPSS regarding COVID-19 with an emphasis on GHG. The name of each cluster was determined using the cluster words and regarding the COVID-19 and GHG experts' suggestions. Table 3 presents the names of the clusters, the number of keywords in each cluster, the degree centrality index, and the network density of each cluster.

According to Table 3, the highest centrality index was related to Cluster 2 with an index of 16.3, Cluster 5 with an index of 11.4, and Cluster 9 with an index of 7. The highest dispersion index was related to cluster 1 with a density index of 0.85, followed by clusters 4 and 2 with dispersion indices of 0.73 and 0.57, respectively.

As shown in Figure 2, all the formed clusters were located in the first, second, and third quadrants, so clusters 8, 6, and 10 were in the third quadrant, and the rest in the second quadrant. According to this figure, clusters 1, 4, 7, 9, 11, and 12 are in the first quadrant with more density.

DISCUSSION

The present results showed that the density of the co-word network has a favorable status, and the keywords were

Table 2: Keywords with the highest index of degree centrality, closeness, and betweenness

	Label	Degree	Label	Closeness	Label	Betweenness
1	COVID-19	225	COVID-19	225	COVID-19	1504.877
2	Pandemic	217	Pandemic	233	Pandemic	1118.561
3	Public health	206	Public health	244	Public health	984.489
4	Mental health	180	Mental health	270	Mental health	605.207
5	eHealthy	168	eHealthy	282	eHealthy	519.168
6	Child	168	Child	282	Child	532.924
7	Health care	163	Health care	287	Health care	477.003
8	Epidemiology	156	Epidemiology	294	Epidemiology	435.209
9	Depression	155	Depression	295	Depression	398.307
10	Anxiety	153	Anxiety	297	Anxiety	379.047
11	Life satisfaction	151	Life satisfaction	299	Life satisfaction	374.755
12	Lockdown	135	Lockdown	315	Infection	356.884
13	Infection	133	Infection	317	Lockdown	319.573
14	Infectious disease	132	Infectious disease	318	Prevention	306.97
15	Prevention	131	Prevention	319	Infectious disease	253.865
16	Aging	126	Aging	324	Aging	229.456
17	Health	126	Health	324	Health	234.61
	Cancer	119	Cancer	331	Cancer	228.904
	Patient	115	Patient	335	Mortality	193.589
	Hospital	112	Hospital	338	Patient	168.002

Table 3: Cluster name, number of keywords and centrality of the degree, and density of each cluster

	Name of cluster	No. of keywords	Degree centrality	Density
Cluster1	COVID-19 pandemic	7	5.143	0.857
Cluster2	Mental health	28	15.5	0.574
Cluster3	Health and E-health and global health	45	16.578	0.377
Cluster4	Age groups	6	3.667	0.733
Cluster5	Comorbidities and viral infection and mortality	32	11.438	0.369
Cluster6	Health policy and WHO	21	5.238	0.262
Cluster7	Education and educational virtual realities	13	5.538	0.462
Cluster8	Treatment and prevention and nutritional status	20	5.400	0.284
Cluster9	Emergencies, hospitals and health personnel	14	7	0.538
Cluster10	Studies	14	2.857	0.220
Cluster11	Diagnosis and clinical laboratory techniques	9	3.333	0.417
Cluster12	Gender identity and women	5	1.600	0.400
Total of the network	-	219	33.995	0.309
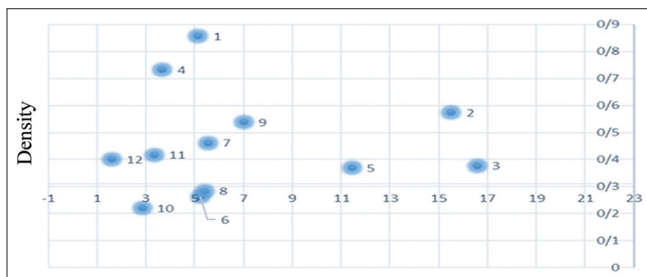
Figure 2: The strategic diagram of the formed clusters

acceptably related in the co-word network. COVID-19 and pandemic formed the most frequent co-word pairs, followed by COVID-19*mental health and COVID-19*anxiety pairs in the next positions, respectively, revealing the higher significance of paying attention to psychological disorders during the

pandemic. Regarding the centrality index, the word COVID-19 in pandemic and public health are ranked first to third.

The keywords COVID-19, pandemic, and public health had the highest centrality, were closer to other keywords in the co-word network, and had access to other network nodes with the shortest path length.

As a result, they had the least distance from other factors in the network, so these keywords are the closest to other words regarding connection and communication. The betweenness centrality index was the index of information flow control in the network by an agent. A node's larger betweenness centrality index indicated that this word had higher influence, power, and impact on other words of the network. COVID-19, the pandemic, and Public Health had a higher betweenness centrality index, which was not far from expected considering

the main focus of this study, which was the components of GHG.

Many studies have been done on the publications related to COVID-19, but as we know none of them have emphasized the aspects of GHG. Pourhatami *et al*. performed a study in 2021 and showed that the main topics of publications related to COVID-19 in the past were antibody-virus interactions, emerging infectious diseases, designing drugs based on protein structure and antiviral drug discovery, coronavirus detection methods, viral pathogenesis and immunity, and animal coronaviruses. Nevertheless, researchers believed that although considerable studies have been done on the coronavirus, this unique field has not yet reached sufficient maturity, and antibody-virus interactions, emerging infectious diseases, and coronavirus diagnosis methods were considered as the research gaps in this field.[15] Danesh *et al*. showed in 2020 that the frequency of the most frequent keyword related to severe acute respiratory syndrome was 276, and 19 thematic clusters resulted from hierarchical clustering analysis. Also, this study exhibited that the intellectual structure of COVID-19 research enables the discovery of complicated conceptual relationships of valid international research on the coronavirus in the form of thematic clusters and determining the degree of cluster cohesion.[16]

Moradi and Khademi conducted a study on mapping the scientific productions of COVID-19 and psychological damages on the Web of Science database. They showed that scientific productions related to COVID-19 regarding psychological damages have been growing and have increased in the last 2 years,[17] consistent with the results of the present study.

Mobin *et al*. analyzed the keywords and revealed that most publications related disease prevalence, diagnosis, selected drugs, and treatment. Also, considerable significant attention has been given to discovering the relationship between the current viral disease and its previous variants and COVID-19-induced anxiety and stress problems. Drawing the knowledge structure with topic mapping suggested that mental health studies had a specialized research topic in addition to public health issues, which is the main topic, which is inconsistent with the present results.[18]

Santose *et al*. conducted word analysis and revealed that numerous studies have focused on several aspects related to public health, while others examined the mental and psychological effects of the COVID-19 pandemic (mental health, anxiety, stress, depression, and mortality). Moreover, many studies have demonstrated opinions about vaccines, assessed the role of health professionals during the pandemic, and examined several methods to prevent the spread of COVID-19, including quarantine, social distancing, online training, telemedicine, and telehealth.[19]

Being aware of the scientific studies results in the field of strategic issues such as the COVID-19 pandemic can be useful for researchers and policymakers in the health and treatment fields to make better decisions and provide a roadmap for strategic planning to control and eradicate this pandemic and provide effective strategic plans and solutions. GHG is "the use of formal and informal institutions, rules, and processes by states, intergovernmental organizations, and non-state actors to deal with health challenges that require cross-border collective action to address effectively." The health system governance is the government's responsibility, which includes formulating laws, policymaking, determining the priorities of health services, coordinating the provision of services, and monitoring and evaluating the services provided.[20]

Studies showed that the leading general strategies in the fight against the COVID-19 disease in many successful countries include attempts to find preventive measures, strengthen public health education, and find effective health measures to deal with this virus, requiring increased health-related research. Based on the present findings, the epidemiological aspects of the disease and public health are the main focus of the studies.

CONCLUSION

According to the results, the betweenness centrality index of the words COVID-19, pandemic, and public health was higher. Since this study focused on the health system governance components, the importance of epidemiological studies and addressing public health can be highlighted. Thus, emphasizing international scientific studies and collaborations for global planning and policies has seemed essential. The present study results allow governments to be aware of the important aspects of GHG to make appropriate policies and take effective approaches in management of the future pandemics.

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Conflicts of interest
There are no conflicts of interest.

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