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Original Article

Public Health Risk from Influenza Viruses: A Scientometric Analysis of Influenza Research

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Abstract

Background: Seasonal influenza and novel H1N1 influenza from 2009 present worldwide difficulties for public health sectors. It is difficult to distinguish between significant research output due to the rising quantity of papers mentioning this infectious disease. We aimed to identify a scientometric analysis of influenza diseases. We aimed to highlight the progress made in the discipline by the researchers affiliated with most documents.

Methods: The h-index was used to evaluate the publication performance of highly cited papers. We retrieved the scientometric data using the keywords "Influenza" OR "Flu" OR "Orthomyxoviridae" AND "Antiviral agents" OR "Antiviral drugs." In all, 59013 documents were retrieved from the Web of Science between 2011 and 2020. The exported data to Biblioshiny and Microsoft Excel tools included sources by year, active authors, active journals, and countries. Also, we made use of quantitative analysis with scientometric indicators and knowledge mapping through the VOSviewer visualization software for creating the network visualization maps.

Results: We found most papers written in English and other languages were from 402027 authors and listed in 4443 core journals. The researchers found that Palese P produced 155 and received an h-index of 55. The author Li Y has the highest contributions, with 313 publications. In global influenza research, Europe and North America are the most productive and impactful continents. The influenza research has been published in very few journals.

Conclusion: This study will help hospital librarians and other library professionals to understand the status of research on influenza at any given point in time.

Keywords: Influenza; Healthcare; Medical informatics; Clinical research; Global publications; Web of science

Introduction

Diseases are often referred to as treatment-related conditions associated with signs and symptoms. An infection may be caused by external factors (pathogens) and internal factors (dysfunction) (1). Influenza viruses are classified into three types: A, B, and C (2). Type A viruses affect adults more severely, while type B viruses often cause health problems in children. Type C viruses are relatively uncommon. The influenza virus can be a severe and potentially deadly disease among people of all ages (3).

Seasonal influenza epidemics are regular occurrences and influenza subtypes H3N2 (type A) and H1N1 (type B) viruses (4). Influenza A or influenza B virus outbreaks usually occur annually, generally in winter climates. Influenza A viruses have become isolated from many animal species, including humans, pigs, horses, mink, marine mammals, and a wide range of domestic and wild birds (5, 6). Wild birds, mainly ducks, geese, and shorebirds, create reservoirs of the influenza A viruses in nature (7). Influenza virus infection in humans from wild birds or poultry through direct transmission is relatively rare. However, since 2003, more than 600 people have been infected with the influenza A (H5N1) virus, many of which were fatal (8).

Influenza and coronavirus disease are very similar. After all, they infect both through respiratory infections transmitted via contact with infectious respiratory droplets. Influenza has a shorter incubation period and serial interval than the COVID-19 virus (9). The serial gap of the COVID-19 virus is estimated to be 5-6 days, but in the case of the influenza virus, the serial interval is three days. Influenza can spread faster than coronavirus (COVID-19) (10). A person infected with the flu applies the disease to another 1.3 people. For COVID-19, an infected person spreads the infection to 2 to 2.5 more people.

Scientometrics is the cross-disciplinary science of quantitative analysis of all knowledge carriers by mathematical and statistical methods. This method is commonly used for identifying specific field developments (11,12). The scientometric analysis is increasingly used to identify scientific advances and directions in a particular field. Scientometric analysis can give us a breakthrough in the fund's workings and further research design as it will predict how the field will move forward. Thus, we have performed an analytical approach to scientific production in influenza to identify this area's research fields and thematic maps (13).

There have been many studies conducted to map the scientometric spread of influenza research documents. We have identified several previous studies. Fricke et al. examined Influenza-related research activity and used the method of density equalizing mapping to illustrate global disparities. They obtained data from 418 records downloaded from WoS during 2000-2009 (14). Sahanaa & Mishra, (2019) observed that in the southern regions, morbidity and influenza mortality rates increase every year (15). Alryalat et al. found a significant difference in mean AAS between February and January, and March ($p < 0.001$), with mean differences of 117.4 and 460.7, respectively (16). Rathinasabapathy & Kopperundevi, (2014) noted that 4,632 publications were published, and China emerged as the largest producer of avian influenza research papers with 690 papers. Hualan Chen was identified as the author with the highest number of contributions to avian influenza (17). Amees (2020), The county of USA has the highest contributing 3720 documents; whereas the Indian country's minimum of 232 records was published (18). Mahajan & Shrivastava (2018), focused on research growth, the most productive authors, institutions, and source-based countries. Librarians can use scientometrics to identify the best resources for researching specific subjects (19).

Objectives of the Study

In particular, the research focused on:

- ❖ What is the number of scientific publications per year from 2011-2020 in influenza research and what is the trend of growth of scientific products during that time?

- Who are the most productive and effective authors in influenza?
- Which countries most frequently collaborated with Influenza?

Materials and Methods

In scientometric investigations, tools are used to find and evaluate research. In the current study, WoS was employed as the scientometric technique between 2011 and 2020. The rationale behind the selection of WoS was that it has the most extensive database and offers all the tools required to carry out a bibliometric analysis (20, 21). WoS provides a simple or sophisticated search approach to find the needed documents. The advanced search technique was used in the current study since it offers a wide range of functionalities to retrieve documents more accurately (22).

The bibliographic data were obtained from Thomson Reuters' Web of Science database Core Collection (WOSCC), which included the Science Citation Index Expanded (SCI-EXPANDED), Arts & Humanities Citation Index (A&HCI), and Social Sciences Citation Index (SSCI) (23). As part of our search strategy, we used the keywords "Influenza" OR "Flu" OR "Orthomyxoviridae" AND "Antiviral agents" OR "Antiviral drugs" in the "Date Limit Tag" during the 2011-2020 period. We developed various search techniques, which were subsequently integrated with the primary search string to retrieve documents for data analysis on countries, organizations, authors, sources, and more. In this study, the data were downloaded from the Web of Science (WoS), resulting in a total of 59,053 global publications on Influenza (Fig. 1).

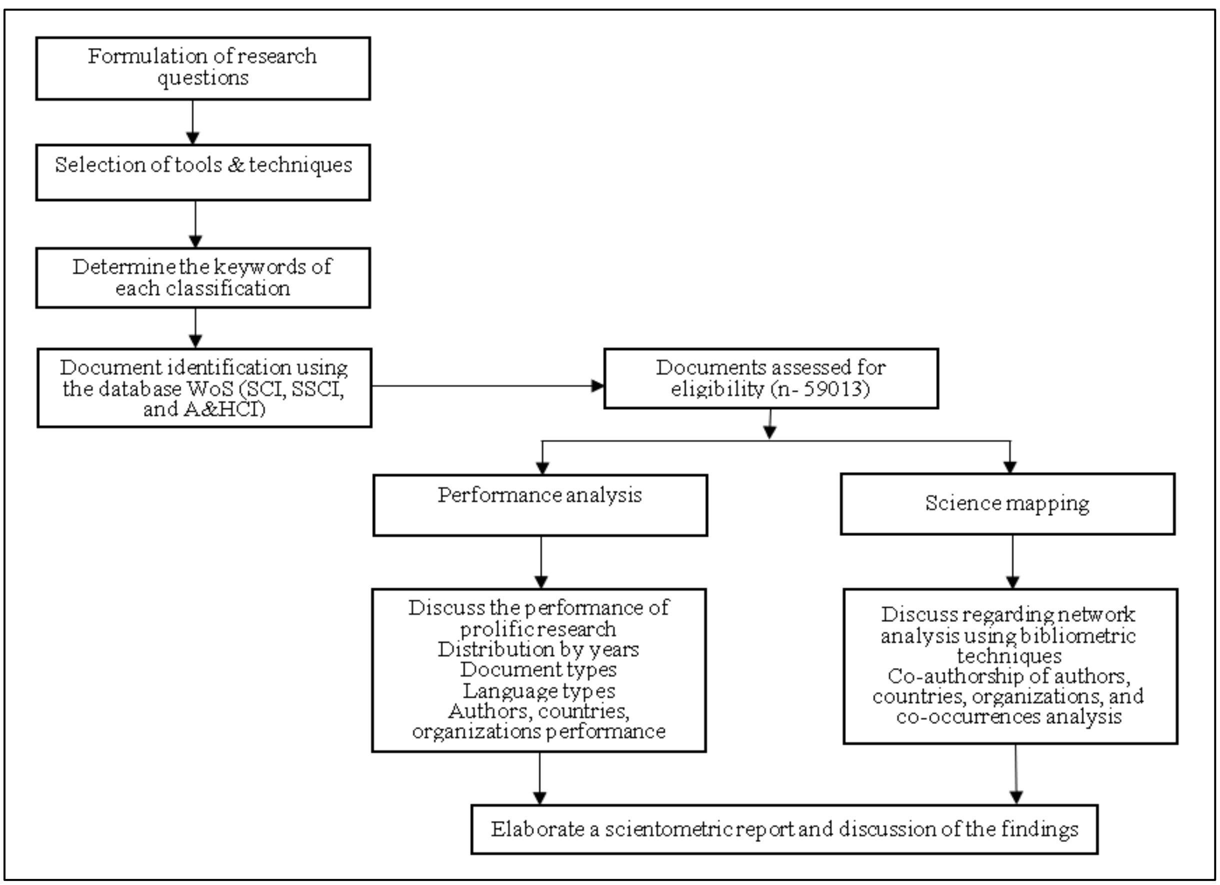

Fig. 1: The workflow criteria from the WoS

Numerous tools are available for bibliometric analysis, including CiteSpace, Bibliometrix package in R, VOSviewer, and HistCite, which offer graphical user interface-based views. The Bibliometrix package in R is based on code commands, while Pajek and Gephi (24) focus on creating network analyses. We employed data analysis from the Bibliometrix package in R (25) and BibExcel. To visualize and analyze the key hotspots and development evolution of influenza research in the form of knowledge graphs with network visualization and to present keyword co-occurrence and literature co-authorship, the present study utilizes the VOSviewer software for creating map of co-authorship of authors, co-authorship of countries, and keywords visualization (26).

Results

Years wise publications on Influenza research

Table 1 listed the distribution of the 59013 publications over the period under study, which is consistent with the publication frequency revealed in the scientometric study on influenza research in the WoSCC, published between 2011 and 2020. The average growth in the number of influenza publications indicates a positive trend. Table 1 shows that the highest number of documents published was 11.61% in 2020, with 2,936 TLCS and 36,639 TGCS.

Table 1: Years wise publications on Influenza research and relative growth rate

Publication Year	*TP**	*%*	*Cum.**	*Cum. %*	*W1*	*W2*	*R(a) W2-W1*	*TLCS**	*TGCS**
2011	6336	10.74	6336	10.74	8.75	8.75	--	62991	165868
2012	5875	9.96	12211	20.69	8.67	9.41	0.74	54305	141171
2013	5902	10.00	18113	30.69	8.68	9.80	1.12	52398	143738
2014	5773	9.78	23886	40.48	8.66	10.00	1.34	42569	120004
2015	5490	9.30	29376	49.78	8.61	10.20	1.59	32527	96698
2016	5537	9.38	34913	59.16	8.62	10.40	1.78	23267	77101
2017	5479	9.28	40392	68.45	8.60	10.60	2.00	18540	65905
2018	5768	9.77	46160	78.22	8.66	10.70	2.04	13313	49958
2019	5999	10.17	52159	88.39	8.70	10.80	2.10	6220	25398
2020	6854	11.61	59013	100.00	8.83	10.10	1.27	2936	36639
Total	59013	100							

*TP- Total Publication, Cum.- Cumulative, TLCS- Total Local Citation Score, TGCS- Total Global Citation Score

The second-highest number of documents was published (10.74%) in 2011, along with 62,991 TLCS and 165,868 TGCS. It is observed that the least number of documents were published (9.28%) in 2017, with 18,540 TLCS and 65,905 TGCS. It is revealed from the table that the relative growth rate (RGR) of year-wise publications showed a growing trend between 2012 (0.74) and 2019 (2.10). The RGR is very high in the year 2019 (2.10).

The growth in the number of publications or pages per unit of time is known as the relative growth rate (RGR). The mean relative growth rate value (R) over the given time period can be calculated using the following equation (27):

$$1 - 2^R = Log_e W_2 - \frac{Log_e W_1}{T_2 - T_1}$$

$1\text{-}2^R$ Mean relative growth rate for the given period

$Log_e W_1$ log of the initial number of papers

Log_eW_2 log of the total number of articles within a certain interval
T_2T_1 The initial time and the final time are separated by one unit.
aa^{-1} average no. of papers.

The top 10 H-index indicators of authors

Based on the h-index, various indices have been developed to evaluate individual scholars' careers according to their scientific productivity. The document's authors were categorized based on the category of the first author and the corresponding author. Reporting to the author's department is not the gold standard method for reporting this variable because an author may have some documents in areas other than their department's field, especially in the field of influenza and diseases-related education. We used this method of classification because it was the best available method. The top 10 authors (Table 2) with the highest h-index have been analyzed to measure the authors' impact. Overall, the authors have contributed 59,013 documents in 4,443 journals on influenza research. It is found that Palese P produced 155 documents with 7,858 citations and received an h-index of 55. Next, the three authors (Kawaoka Y, Garcia-Sastre A, and Krammer F) have received the same h-index of 49. The last author has received an h-index of 41 from 266 records among the top 10 authors in the field of influenza research.

Table 2: The top 10 H-index indicators of authors in influenza research

Sl. No.	*Author*	*Records*	*Citation*	*H-index*
1	Palese P	135	7858	55
2	Kawaoka Y	275	8650	49
3	Garcia-Sastre A	229	8879	49
4	Krammer F	190	7287	49
5	Gao GF	179	8131	47
6	Wilson IA	101	6996	44
7	Webby RJ	227	6124	43
8	Fry AM	187	5446	43
9	Fouchier RAM	168	8794	42
10	Wang J	266	5752	41

Visualization map of top 50 active authors in influenza research

The Visualization Map of citations for Authors (88176) presents a comprehensive view of author networks and their collaborative relationships. In this map, each node represents an author, and the node's size corresponds to the number of citations they have received. Links between nodes denote collaborative connections, with the distance and thickness of these links indicating the strength of the relationship. To generate these visualizations, we employed a VOSviewer that utilizes network data for mapping.
For instance, in the context of influenza research, we can refer to Fig. 2 for the author's network visualization. Here, each circle symbolizes an author, and the size of the circle reflects the number of documents they have published. The connecting lines between circles signify collaborative bonds, and the thickness of these lines indicates the intensity of the collaboration. As circles draw closer, it signifies a stronger collaborative relationship.
Notably, we observed that authors such as Krammer, Florian, Gao, George F., and Shu, Yuelong have notable link strengths between each other, despite having a comparatively lower number of published documents (184, 161, and 150 documents). On the other hand, some top-ranking authors have a higher volume of papers

published (262, 231, 221, and 215 documents), but their collaborative link strength is not as pronounced for each author.
One standout finding is the strong collaborative relationship of Gao, George F. (represented in green color), who boasts a link strength of 6519, indicating the robustness of their collaborative relationships within the author network.

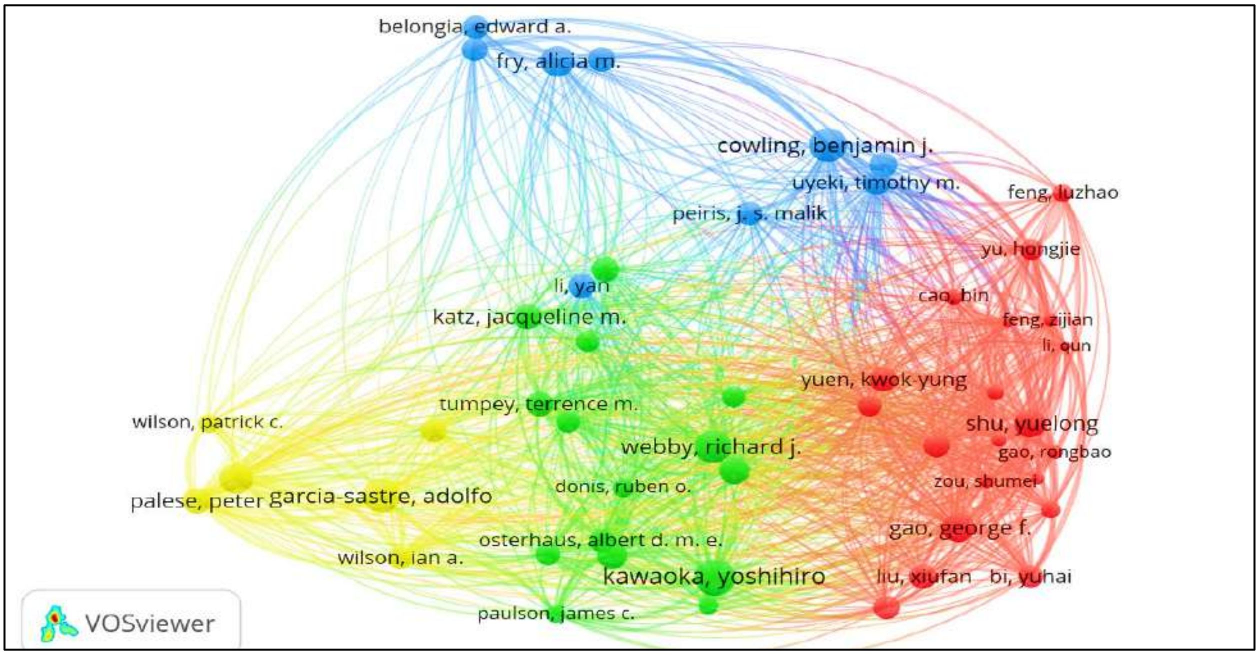

Fig. 2: Visualization map of the top 50 active authors in influenza research

Active Journals

In our research, we discovered that articles related to influenza are being published across a diverse range of scientific journals, underscoring significant advancements in the field. A total of 59,013 articles were found in 4,443 different scientific journals. The top ten journals in terms of publishing volume, responsible for 5,750 papers on this subject, are listed in Table 3. Notably, our analysis revealed that two journals, Vaccine and PloS One, were prominent contributors according to data retrieved from the WoS database. Among the remaining journals, Scientific Reports stood out with 654 publications, followed by the Journal of Virology with 591, and Human Vaccines & Immunotherapeutics with 508 publications. This suggests a growing body of literature dedicated to influenza research from a variety of sources. Detailed information regarding the top ten most productive journals is summarized in Table 3, including their record counts, TGCS, and TLCS. Vaccine, with 5,837 TLCS and 10,050 TGCS, emerged as the leading journal in terms of publication volume. PloS One and the Journal of Virology also demonstrated substantial contributions, particularly in terms of TGCS.

Table 3: Top 10 active journals on influenza research

Rank	*Journal*	*Recs*	*TLCS*	*TGCS*
1	Vaccine	1241	5837	10060
2	PloS One	1031	4205	7337
3	Scientific Reports	654	3128	5198
4	Journal of Virology	591	3549	7143
5	Human Vaccines & Immunotherapeutic	508	1446	2751
6	The Journal of Immunology	382	627	1961
7	Frontiers in Immunology	368	725	2695
8	Influenza and Other Respiratory Viruses	342	1499	1946
9	The Journal of Infectious Diseases	330	2664	3868
10	The American Journal of Respiratory and Critical Care Medicine	303	194	548

The country of the collaboration network

As vividly depicted in Fig. 3, the United States, China, and England play crucial roles in influenza research and exhibit the closest correlations in the network. The thickness and quantity of connections between various nodes signify substantial cooperation among developed countries with the highest publication rates, as indicated by a linked strength of 28. Notably, Bangladesh (243 publications) and Kenya (208 publications) have made comparatively modest contributions, yet their remarkable link strengths, with values of 11,508 and 10,251 respectively, stand out. These countries can be categorized into three groups: the first group comprises 21 countries (highlighted in green), the second group comprises 17 countries (highlighted in red), and the third group consists of 3 countries. This underscores the significant influence of geographical location in shaping international cooperation, with international exchanges serving as catalysts for scholarly communication.

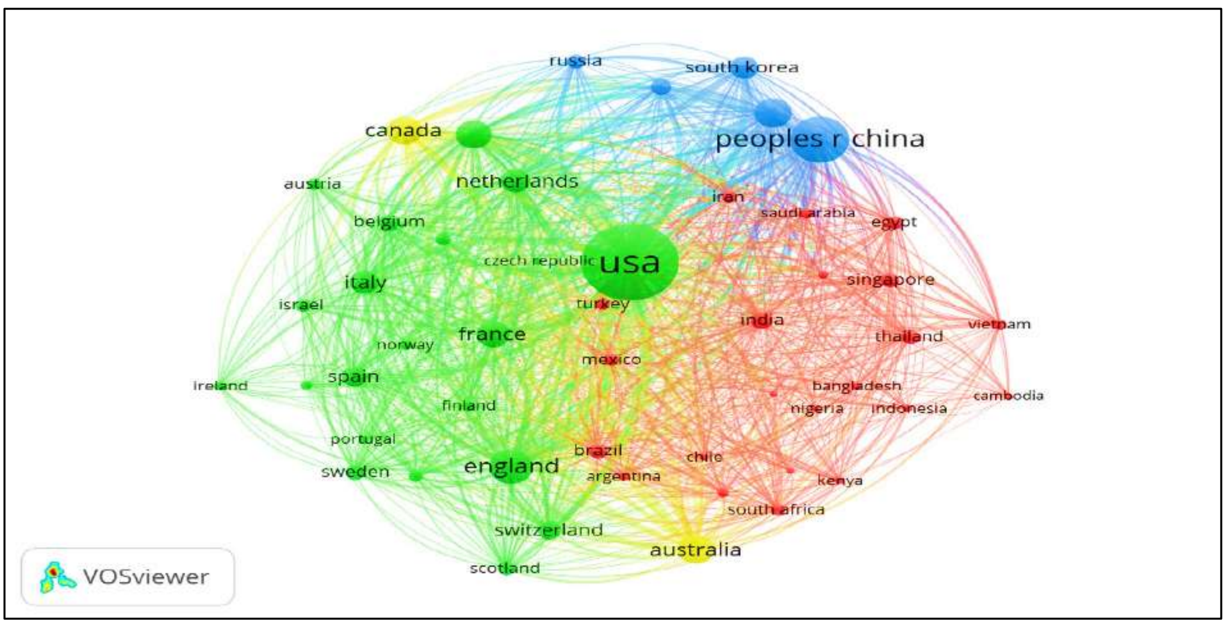

Fig. 3: The country of the collaboration network for influenza research

Co-occurrence network visualization of most frequent keywords

Keywords play an essential role in comprehending the central themes of research papers. In our investigation, we conducted keyword co-occurrence analysis, which resulted in the identification of 50 keywords (as illustrated in Fig. 4) out of a total pool of 19,714. In analyzing the connectivity within the influenza research landscape, we noticed that the term 'Influenza' appeared most frequently, with 23,539 documented occurrences. These keywords were further grouped into clusters. The first cluster, denoted by the color green, encompassed keywords such as 'Influenza,' 'Vaccination,' 'Virus,' and 'children,' among others. The second cluster focused on 'Infections,' 'Viruses,' and 'Vaccines,' and the third cluster, represented in blue, included keywords related to 'Transmission,' 'Avian Influenza,' and 'Surveillance,' and so forth.

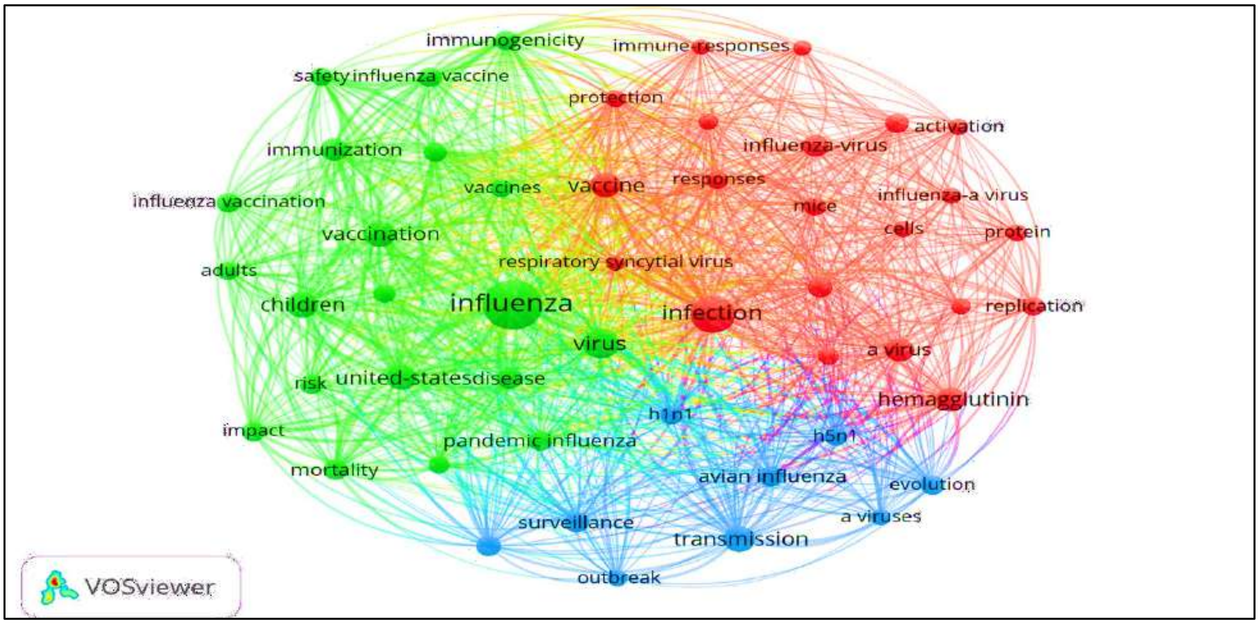

Fig. 4: Co-occurrence network visualization of keywords in influenza research

Discussion

The scientometric study of Influenza research delves into the evolving landscape of studies related to Influenza viruses, presenting a comprehensive overview of the scientific discourse in this field. It assesses trends in research topics, publication outputs, and influential authors, thereby shedding light on the knowledge dynamics within the influenza research community. This analysis provides valuable insights into the priorities and emerging areas of interest, helping to guide future research directions and resource allocation in the battle against influenza.

According to the current analysis, publications on influenza research are distributed across a variety of document types. Most papers published in serials are articles, followed by reviews, meeting abstracts, and conference papers. These serials were the most significant source of information for scientists engaged in advancing influenza research. Among scientists involved in the rise of influenza research, the study conducted by Gureyev et al. found that serials publishing articles, reviews, editorials, letters, and news continue to be the most significant source of information (28).

Influenza research is a crucial field that has garnered significant attention from the scientific community due to its public health implications. A scientometric analysis of this research landscape provides valuable insights into the trends and developments in this field (29). For instance, one key observation is the increasing interdisciplinary nature of influenza research (30). Researchers from various domains, such as virology, immunology, epidemiology, and computational biology, have been collaborating to gain a comprehensive understanding of the influenza virus. This collaboration has led to the development of innovative diagnostic tools, antiviral drugs, and vaccines. For example, the growth of new vaccine technologies like mRNA-based vaccines, as seen with the rapid response to the COVID-19 pandemic, can be attributed to cross-disciplinary knowledge transfer from influenza research (31).

Additionally, a scientometric analysis can shed light on the impact of influential publications and researchers in the field. It may reveal how certain breakthroughs, such as developing antiviral drugs like Tamiflu, have shaped the trajectory of influenza research and inspired subsequent investigations.

Strengths and limitations of the study

The strength of a scientometric analysis of influenza research lies in its ability to quantitatively assess the breadth and depth of scientific output in the field, providing valuable insights into the evolution and impact of influenza research over time. It can help identify key trends, influential authors, and research hotspots, aiding in allocating resources and developing evidence-based public health strategies. However, this approach may have limitations in capturing the quality and relevance of research, as it predominantly relies on bibliometric data, potentially overlooking important contextual factors. Its retrospective nature may only partially account for emerging trends or immediate public health risks, making it essential to complement scientometric analysis with other forms of scientific assessment and expert judgment in the case of rapidly evolving health threats like influenza viruses.

Conclusion

Concluded that influenza research and management practices become one of the most important tasks for effective management and clinical care for a patient in any country. So, it was felt that there was a need for a national consensus to manage and treat various diseases. Furthermore, scientometric analysis can reveal how research efforts have shifted, including focusing on surveillance and forecasting to manage influenza outbreaks. By tracking the number of publications, citations, and research networks, scientometric analyses can pinpoint influential researchers and institutions driving advancements in this field. These analyses provide a retrospective view and can guide future research priorities, resource allocation, and policymaking to mitigate the impact of seasonal and pandemic influenza outbreaks.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of Interests

The authors have no conflicts of interest to declare.

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