A BIBLIOMETRIC ANALYSIS AND VISUALISATION OF RESEARCH TRENDS IN COVID AND COMORBIDITIES

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Abstract

COVID19 is a pandemic caused by SARS COV2. Comorbidities play a significant role in the survival of COVID patients. Thus this bibliometric analysis the association of comorbidities with COVID19 and conducted to understand the active authors, organizations, journals, and countries involved in research on the association of comorbidities with COVID. All open access articles related to COVID vaccines, published in 2020, from "Scopus" were analyzed using the VOS viewer to develop analysis tables and visualization maps. This article had set the objective to consolidate the literature regarding comorbidities and COVID19 and also to find out the trends related to research association of comorbidities with COVID. The active authors are from China and the most active author is Zhang Y with seventeen articles and the highest collaboration. However, the most productive author is Cai Y with the highest citation per article. The highly networked country in the research of comorbidities associated with COVID19 is the USA and its highly cited country is China. However, the country with a higher average citation is Switzerland. The highly productive journal is JAMA Internal Medicine with the highest citation and highest average citation per documents. The highly linked research organization is the Department Of Allergology, Zhongnan Hospital of Wuhan University, but the most productive research organization is the Cardiovascular Research Institute, Wuhan University, Wuhan with the highest number of total citations and highest average citation per articles.

Keywords: COVID, vaccine, Bibliometric analysis, VOS viewer, pandemic

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1. Introduction

Coronavirus disease19 (COVID19) is a pandemic and caused by SARS-COV-2.COVID19 was first reported in Wuhan, China, and its spread across the world. COVID19 had reported with a comparatively lower mortality rate but is capable of super spreading and social spreading in a short period. Only Social distancing and self-hygiene can avoid this pandemic at this stage. COVID19 is disastrous with people having comorbidities (Heymann *et al.*, 2020)(Kobayashi *et al.*, 2020). The major comorbidities that can have an adverse impact on COVID patients are cardiovascular disease, hypertension, diabetes Mellitus, obesity, and pneumonia. Mortality rates are high among COVID patients with comorbidities. A higher degree of research is needed to control the pandemic. Till now the treatments involve drug repurposing and no effective vaccine. Remdesivir, Favipiravir,

Hydrochloroquine, and Lopinavir/Ritonavir have commonly used drugs for treating COVID19 patients across the world. This article is arranged in five sections. The first section is the introduction, followed by the discussion of the methodology by which the research was conducted. The third section deals with results and discussion. The fourth section deals with the conclusion.

2. Research Methodology

Only the Scopus source had been used in this bibliometric analysis. For the article selection, the following strategy was followed: We used the Boolean "TITLE-ABS (COVID COMORBIDITIES)" on 16/10/2020. This first round of search produced an outcome of one thousand and two hundred and thirty-two articles and we used the filters for selecting open access articles, in the English language. So, after the final screening, we had downloaded six hundred and ninety articles of which full text is available. We used this screened result to conduct bibliometric analysis using VOS Viewer. We were inspired by bibliometric analysis in its presentation style, analysis, and methodology from the works (Wang, Xu and Škare, 2020)(Soosaraei *et al.*, 2018)(Hong *et al.*, 2019)(Winkowski, 2019)(Heshmati and Hashempour, 2020)(Ivanov *et al.*, 2020)(Garrigos-simon and Botella-carrubi, 2018)(Li *et al.*, 2019)(Mas-tur and Guijarro, 2019)(Gao *et al.*, 2020)

2.1 Research Objectives

a) To consolidate the literature regarding COVID19 and comorbidities
b) To find out the trends related to research in COVID19 and comorbidities

The following research questions are framed for conducting bibliometric analysis systematically.

2.2 Research Questions

a) Which are the main journals and articles working on COVID19 and comorbidities?
b) Which are the main organizations and countries working on COVID19 and comorbidities?
c) Who are the active researchers in the field of research on COVID19 and comorbidities?

2.3 Methods and tools for evaluation

We had used the VOS viewer for conducting bibliometric analysis and visualization. Out of multiple tools available in the VOS viewer, we had used Co-authorship analysis, Co-occurrence analysis, and citation analysis for this research.

Co-authorship analysis measures the relatedness of items based on the number of co-authored documents. Co-authorship analysis for the selected eight hundred and thirty-eight documents can be possible with three units of analysis, namely, authors, organizations, and countries. Co-authorship analysis had been conducted by analyzing the number of co-authored documents, citations, and average citations per co-authored documents, links, and link strength to identify the closely related authors in a research area. The items with the highest links and link strength are considered for tracing the most effective researchers, journals, articles, organizations, and countries.

Co-occurrence analysis measures the relatedness of items based on the number of documents in which the keywords occur together. Co-occurrence analysis can measure the trends in research. Co-occurrence analysis for the selected eight hundred and thirty-eight documents can be possible with three units of analysis, namely, author keywords, index keywords, and all keywords. The trending keywords and the trend in research are identified by finding out keywords with the highest occurrence and link strength.

Citation analysis for the selected eight hundred and thirty-eight documents can be possible with five units of analysis, namely, authors, documents, sources, organizations, and countries. For citation analysis, citations per documents and total citations were used to identify the most effective researchers, journals, articles, organizations, and countries.

3. Results and discussion

Table 1 shows the details with active researchers in the domain of comorbidities associated with COVID19. Co-authorship analysis and citation analysis were used in the analysis. While taking authors as a unit of analysis for the co-authorship analysis, we have taken the parameters of the minimum number of documents of an author as four and the minimum number of citations of authors as one. This combination plotted the map of eighty-three thresholds out of four thousand nine hundred and thirty-five authors, in eight clusters mapping six hundred and twenty-two links with link strength of nine hundred and twenty-two. The density visualization map of co-authorship analysis plotted in figure 1, points out the major researchers with their co-authorship links. The three major clusters involved in the research with co-authorship can be identified in figure 1. Table 1 makes it clear that the most active author is Cai Y, having an average of four hundred and seventy-one citations. However,Zhang L was the most cited author but the average citation is four hundred and fifty-one. The highly collaborated author is Zhang Y, with the highest citation.From table 1 we can conclude the Chinese authors are leading in respect of collaboration and citations in research regarding comorbidities associated with COVID

Table 1: Analysis of author activity

Results of Citation analysis				Results of co-authorship analysis (Unit of analysis is authors)	
Authors	Documents	Citations	Average Citations per documents	Authors	Link Strength
Cai Y.	4	1883	470.75	Zhang Y.	70
Huang H.	4	1879	469.75	Li J.	48
Zhang L.	5	2257	451.4	Zhang X.	42
Xu J.	4	1284	321	Wang Y.	41
Chen D.	4	1276	319	Wang X.	39
Wang H.	8	2138	267.25	Lu Y.	39
Chen X.	7	1612	230.2857	Wang H.	37
Wang S.	6	1306	217.6667	Zhang S.	37

Yang D.	4	783	195.75	Yang Y.	37
Guo W.	5	850	170	Albano J.	33
Chen J.	6	939	156.5	Azmaiparashvili Z.	33
Li S.	5	723	144.6	Gul F.	33
Zhou X.	9	1301	144.5556	Lo K.B.	33
Chen T.	6	864	144	Pelayo J.	33
Huang J.	6	823	137.1667	Peterson E.	33
Yang J.	5	635	127	Liu J.	32
Chen G.	6	717	119.5	Li X.	31
Hu D.	4	388	97	Chen J.	30
Zhang Y.	17	1596	93.88235	Li Y.	30
Chen Z.	7	586	83.71429	Guo W.	29

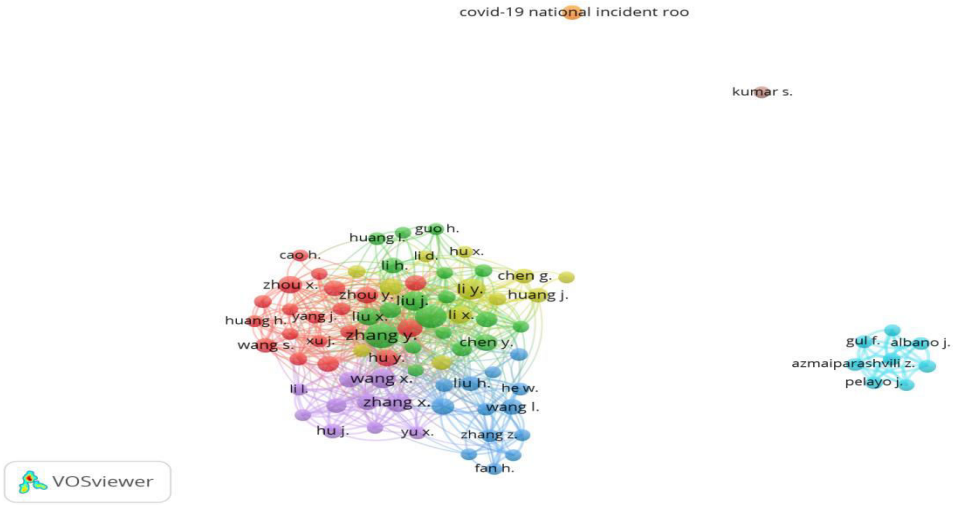

Figure 1: Co-authorship analysis on basis of authors

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrence of a keyword as thirty-five. This combination plotted the map of ninety-one thresholds out of four thousand two hundred and forty-nine keywords, in four clusters mapping four thousand and eighty links. The density visualization of co-occurrence analysis using all keywords has been shown in figure 2. Figure two identifies the major comorbidity keywords used in research as cardiovascular disease, hypertension, diabetes mellitus, obesity, lymphocyte count, and pneumonia.

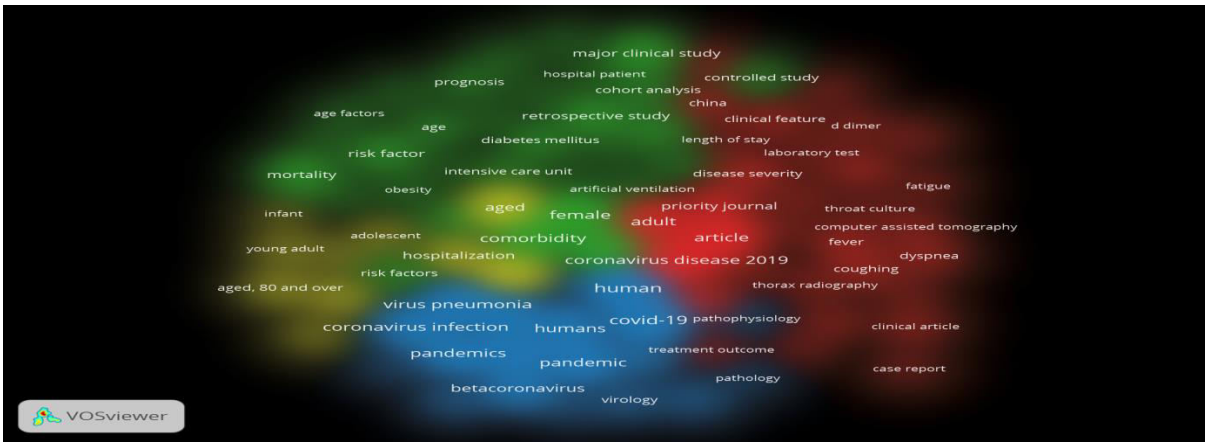

Figure 2: Co-occurrence analysis on basis of all keywords

Table 2 shows the active organizations engaged in a vaccine for COVID19.Co-authorship analysis and citation analysis were used in this analysis. While taking organizations as a unit of analysis for the co-authorship analysis, we have taken the parameters of the minimum number of documents of an author as three and the minimum number of citations of organizations as two. This combination plotted the map of ten thresholds out of three thousand three hundred and seventy-eight organizations, in six clusters mapping five links with a link strength of thirteen. The network visualization map of co-authorship analysis plotted in figure 3, points out the major research organizations with their co-authorship links. The major clusters involved in the research with co-authorship can be identified in figure 3. Figure three makes it clear that there is poor linkage between top organizations involved in the research on comorbidities associated with COVID. Similarly, ten leading research organizations in the area of the comorbidities associated with COVID had been highlighted in table 2. The results in table 2 make it clear that highly linked research organization are the Department Of Allergology, Zhongnan Hospital Of Wuhan University and Swiss Institute Of Allergy And Asthma Research, University Of Zurich, but the most productive research organization is the Cardiovascular Research Institute, Wuhan University, Wuhan and Swiss Institute Of Allergy And Asthma Research the University Of Zurich with the highest number of total citation and highest average citation per articles. From table 2 we can conclude the Chinese domination in research organizations regarding comorbidities associated with COVID, but the remarkable performance bythe Swiss Institute Of Allergy And Asthma Research (Siaf), the University Of Zurich in the parameters of collaborations and citations.

Table 2: Analysis of Organisations

Results of Citation analysis				Results of co-authorship analysis (Unit of analysis is organizations)	
Organizations	Documents	Citations	Average Citations per document	Organizations	Link Strength
Cardiovascular Research Institute, Wuhan University, Wuhan, China	3	788	262.7	Department Of Allergology, Zhongnan Hospital Of Wuhan University, Wuhan, China	6
Swiss Institute Of Allergy And Asthma Research (Siaf), University Of Zurich, Davos, Switzerland	3	723	241.0	Swiss Institute Of Allergy And Asthma Research (Siaf), University Of Zurich, Davos, Switzerland	5
Department Of Radiology, Zhongnan Hospital Of Wuhan University, Wuhan, China	3	710	236.7	Department Of Radiology, Zhongnan Hospital Of Wuhan University, Wuhan, China	5
Department Of Allergology, Zhongnan Hospital Of Wuhan University, Wuhan, China	4	726	181.5	Department Of Medicine, Einstein Medical Center Philadelphia, Philadelphia, Pa, United States	3
Hubei Key Laboratory Of Cardiology, Wuhan, China	3	184	61.3	Sidney Kimmel College Of Thomas Jefferson University, Philadelphia, Pa, United States	3
Department Of Clinical And Experimental Sciences, University Of Brescia, Brescia, Italy	3	35	11.7	Cardiovascular Research Institute, Wuhan University, Wuhan, China	2
Department Of Medicine, Icahn School Of Medicine At Mount	3	20	6.7	Hubei Key Laboratory Of Cardiology, Wuhan, China	

Sinai, New York, NY, United States					2
Servicio De Nefrología, Hospital Del Mar, Barcelona, Spain	3	6	2.0	Department Of Clinical And Experimental Sciences, University Of Brescia, Brescia, Italy	0
Department Of Medicine, Einstein Medical Center Philadelphia, Philadelphia, Pa, United States	3	5	1.7	Department Of Medicine, Icahn School Of Medicine At Mount Sinai, New York, NY, United States	0
Sidney Kimmel College Of Thomas Jefferson University, Philadelphia, Pa, United States	5	5	1.0	Servicio De Nefrología, Hospital Del Mar, Barcelona, Spain	0

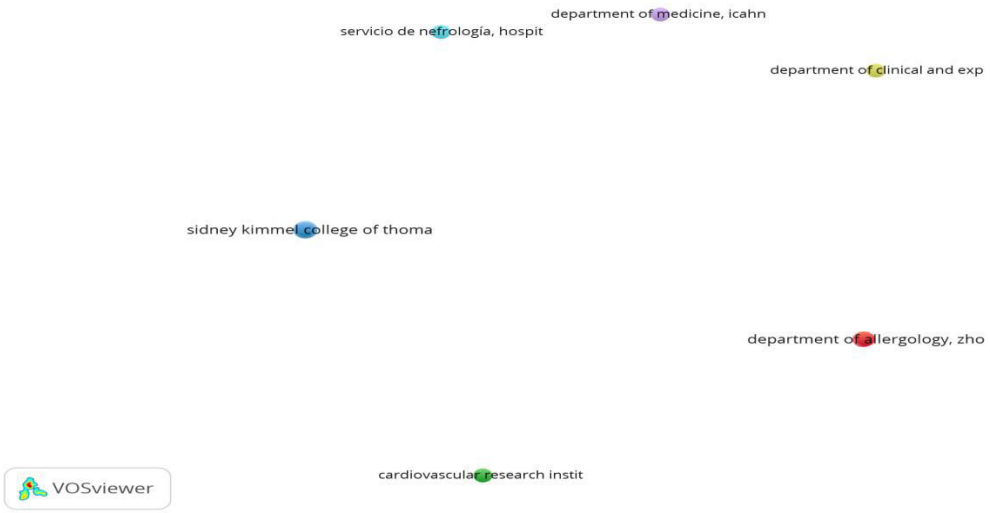

Figure 3: Co-authorship analysis on basis of Organisations

Table 3 shows the countries actively engaged in a vaccine for COVID19.Co-authorship analysis and citation analysis were used in this analysis. While taking countries as a unit of analysis for the co-authorship analysis, we have taken the parameters of the minimum number of documents of a country as eleven and the minimum number of citations of a country as two. This combination plotted the map of eighteen thresholds out of one hundred and twenty-six countries, in two clusters mapping one hundred and thirty-eight links with a link strength of six hundred and thirteen. The network visualization map of co-authorship analysis plotted in figure 4, points out the major research countries with their co-authorship collaborations. The major clusters involved in

the research with co-authorship can be identified in figure 4. Similarly, eighteen leading countries in the area of the comorbidities associated with COVID had been highlighted in table 3. From table three it's clear that the highly networked country in the research of comorbidities associated with COVID19 is the USA and its highly cited country is China. However, the country with a higher average citation is Switzerland.

Table 3: Analysis of activities of countries

Results of Citation analysis				Results of co-authorship analysis (Unit of analysis is countries)	
Country	Documents	Citations	Average Citations per documents	Country	Link Strength
Switzerland	23	1437	62.5	United States	160
China	157	8012	51.0	United Kingdom	120
Canada	27	1027	38.0	Italy	119
Belgium	20	571	28.6	China	105
France	34	727	21.4	Spain	96
Australia	22	398	18.1	Canada	88
Spain	44	770	17.5	Switzerland	72
United States	199	2984	15.0	Australia	69
Iran	18	233	12.9	Belgium	63
United Kingdom	67	859	12.8	Germany	63
Italy	100	1144	11.4	France	61
South Korea	15	137	9.1	Brazil	46
Germany	32	287	9.0	India	33
India	29	89	3.1	Sweden	28
Poland	11	32	2.9	Iran	27
Brazil	36	95	2.6	Poland	27
Turkey	24	30	1.3	Turkey	25
Sweden	11	7	0.6	South Korea	24

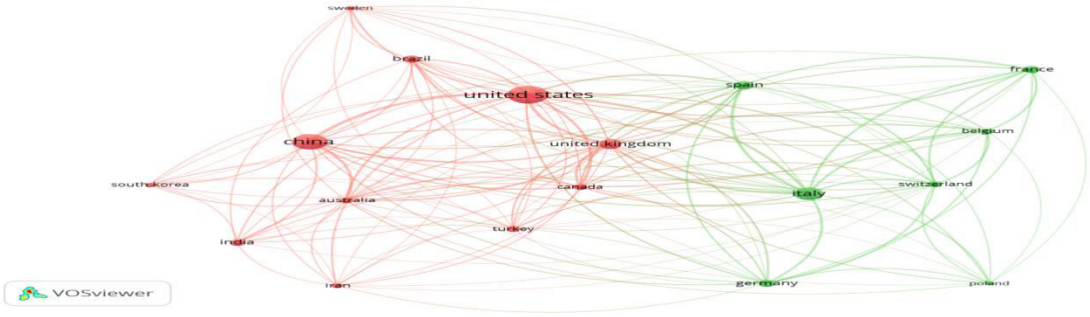

Figure 4: Co-authorship analysis on basis of Country

Table 4: List of highly cited articles

Table 4 shows the highly cited articles, engaged in research on comorbidities associated with COVID19.Link analysis and citation analysis were used in this analysis. We have taken the parameters of the minimum number of citations as two. This combination plotted the map of two hundred and sixty-eight thresholds out of six hundred and ninety-eight documents, in one hundred and seventy-eight clusters mapping one hundred and thirty-two links.

Articles	Citations	Articles	Link Strength
Wu C. (2020)	1275	Richardson S. (2020)	21
Richardson S. (2020)	921	Zhang J.-J. (2020b)	18
Zhang J.-J. (2020a)	702	Wu C. (2020)	11
Chen T. (2020b)	642	Grasselli G. (2020)	11
Shi S. (2020a)	604	Yang J. (2020)	10
Guo T. (2020a)	597	Reddy R.K. (2020)	10
Yang J. (2020)	517	Chen T. (2020b)	7
Guan W.-J. (2020)	441	Meng Y. (2020a)	6
Lechien J.R. (2020a)	423	Zhang J.-J. (2020a)	5
Lei S. (2020)	270	Guo W. (2020)	5
Zhang P. (2020)	245	Jiang G. (2020)	4
Wang Z. (2020)	236	Guan W.-J. (2020)	3
Guo W. (2020)	198	Zhao Q. (2020)	3
Wang L. (2020a)	184	D'adamo H. (2020)	3
Mo P. (2020)	176	Palaiodimos L. (2020)	3
Li K. (2020)	156	Roncon L. (2020)	3
Du Y. (2020)	145	Louapre C. (2020)	3
Docherty A.B. (2020)	144	Imam Z. (2020)	3
Deng Y. (2020)	141	Huang J. (2020)	3
Menter T. (2020)	126	Del Valle D.M. (2020)	3

Table 5 shows the journals actively engaged in the research on comorbidities associated with COVID19.Link analysis and citation analysis were used in this analysis. We have taken the parameters of the minimum number of documents of a journal as two and the minimum number of citations of a journal as one. This combination plotted the map of one hundred and seven thresholds out of four hundred and two journals, in forty-six clusters mapping one hundred and forty links with a link strength of one hundred and eighty-two. JamaInternal Medicine and Jama Cardiology were the productive journals with the highest citation and highest average citation per documents.

Table 5: Analysis of journal activity

Results of Citation analysis				Results of analysis of Links	
Journals	Documents	Citations	Average Citations per documents	Journals	Link Strength
Jama Internal Medicine	4	1355	338.75	Allergy: European Journal Of Allergy And Clinical Immunology	39
Jama Cardiology	4	1238	309.5	Journal Of Medical Virology	27
Allergy: European Journal Of Allergy And Clinical Immunology	4	726	181.5	Jama Internal Medicine	26
The BMJ	6	939	156.5	International Journal Of Infectious Diseases	25
Clinical Infectious Diseases: An Official Publication Of The Infectious Diseases Society Of America	4	549	137.25	The BMJ	20
American Journal Of Respiratory And Critical Care Medicine	2	254	127	Jama Cardiology	15
Diabetes/Metabolism Research And Reviews	2	199	99.5	Plos One	12
International Journal Of Infectious Diseases	7	526	75.14286	Diabetes Research And Clinical Practice	12
Journal Of Infection	5	366	73.2	Clinical Infectious Diseases: An Official Publication Of The Infectious Diseases Society Of America	10
Histopathology	2	140	70	American Journal Of Respiratory And Critical Care Medicine	9
International Forum Of Allergy And Rhinology	2	127	63.5	Diabetes/Metabolism Research And Reviews	8
Journal Of Infection In Developing Countries	2	115	57.5	Frontiers In Public Health	8
Eclinicalmedicine	5	274	54.8	Journal Of Hematology And	7

				Oncology	
Radiology	3	141	47	Journal Of Infection	6
Journal Of Clinical Virology	3	137	45.66667	The Lancet	6
The Lancet	5	215	43	Frontiers In Medicine	6
Annals Of The Rheumatic Diseases	2	70	35	Journal Of Clinical Virology	5
The Lancet Gastroenterology And Hepatology	2	69	34.5	International Journal Of Environmental Research And Public Health	5
The Lancet Oncology	2	58	29	Plos Pathogens	4
Journal Of The American Geriatrics Society	2	54	27	Journal Of Infection And Public Health	4

4. Conclusion

By analyzing the results from the analysis by using VOS viewer and discussion in the above section, we conclude that the most active authors are from China and the most active author is Zhang Y with seventeen articles and the highest collaboration. However, the most productive author is Cai Y with the highest citation per article. The highly networked country in the research of comorbidities associated with COVID19 is the USA and its highly cited country is China. However, the country with a higher average citation is Switzerland. The highly productive journals were Jama Internal Medicine and Jama Cardiology with the highest citation and highest average citation per documents. The highly linked research organization are the Department Of Allergology, Zhongnan Hospital Of Wuhan University and Swiss Institute Of Allergy And Asthma Research, University Of Zurich, but the most productive research organization is the Cardiovascular Research Institute, Wuhan University, Wuhan and Swiss Institute Of Allergy And Asthma Research, the University Of Zurich with the highest number of total citation and highest average citation per articles. We can conclude the Chinese domination in research organizations regarding comorbidities associated with COVID, but the remarkable performance by Swiss Institute Of Allergy And Asthma Research (Siaf), the University Of Zurich in the parameters of collaborations and citations.

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