

Characterizing Pandemic-related Publications: A Retrospective Study Using Spatial Citation Network Analysis

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Abstract:

The COVID-19 pandemic catalyzed a rapid expansion of academic research across various disciplines, with significant contributions from studies focused on urban environments and their responses to the public health crisis (Biro et al., 2021; Phil Yang et al., 2022). This study provides a comprehensive retrospective analysis of 7,641 pandemic-related publications, emphasizing their spatial citation networks and community structures (Avramescu, 1979). By leveraging citation network analysis, we aim to unravel the spatiotemporal patterns of academic collaboration, the thematic evolution of research topics, and regional disparities in citation impacts (Fatima et al., 2021; Liu et al., 2024).

We curated a dataset of 7,641 pandemic-related articles from PubMed (December 2019–September 2023), excluding irrelevant documents, retractions, and duplicates. Citation relationships and author affiliations were extracted using PubMed metadata, DOI links, and ORCID records.

The internal network consisted of nodes representing articles and directed edges denoting citation relationships (Chiranjeevi et al., 2023). The extended network incorporated references cited by these articles, providing a more comprehensive view of citation dynamics (Jiang et al., 2020). We analyzed network properties and community structures using key metrics (see Table 1). Geographic analysis mapped author affiliations, revealing spatial patterns in academic contributions and citations .

Properties	Properties of citation network composed of articles	Properties of citation network composed of articles and their references
Communities	5,045	5,444
Min Community Size	1	1
Max Community Size	293	9,970
Avg. Community Size	1.51358	41.3472
Imbalance	146.5	237.381
Edge Cut	654	27,689
Edge Cut (Portion)	0.148199	0.101634
Gamma Index	7.58E-05	5.38E-06
Clustering Coefficient	0.041457637	0.000266142
Network Diameter	22 (Effective diameter)	1.89464943837391 (Average Effective Diameter of All Components)
Modularity	0.772011	0.879041

Number of Nodes	7,641	225,094
Number of Edges	4,413	272,438

Table 1. Analysis results of two citation networks.

This study introduces a novel cartographic approach to visualizing academic citation networks, integrating spatial and network analysis to uncover global research inequities. The map in Figure 1 visualizes the geographical distribution of authors' affiliations for articles on urban COVID-19, with nodes representing publication origin locations and line segments indicating citation relationships between regions (Lv et al., 2019). Node importance, defined here as the density of nodes reflecting the volume of publication activity, highlights regions such as the Eastern United States, Europe, and East Asia as major contributors (Skopec et al., 2020). These areas exhibit dense clusters of nodes, with the Eastern US (e.g., New York, Boston), Western Europe (e.g., UK, Germany), and East Asia (e.g., China, Japan) showing significant publishing output. South Asia (e.g., India), the Middle East (e.g., Saudi Arabia), and Brazil's coastal regions (e.g., São Paulo) also display moderate node density, while Australia and New Zealand, despite their advanced research institutions, have sparse nodes, possibly due to limited local epidemics. In contrast, Inner Asia, Central Africa, and sparsely populated regions like North Asia and North American permafrost show little to no node presence, indicating minimal intellectual contributions (Hallinger, 2020; Rockliffe, 2022).

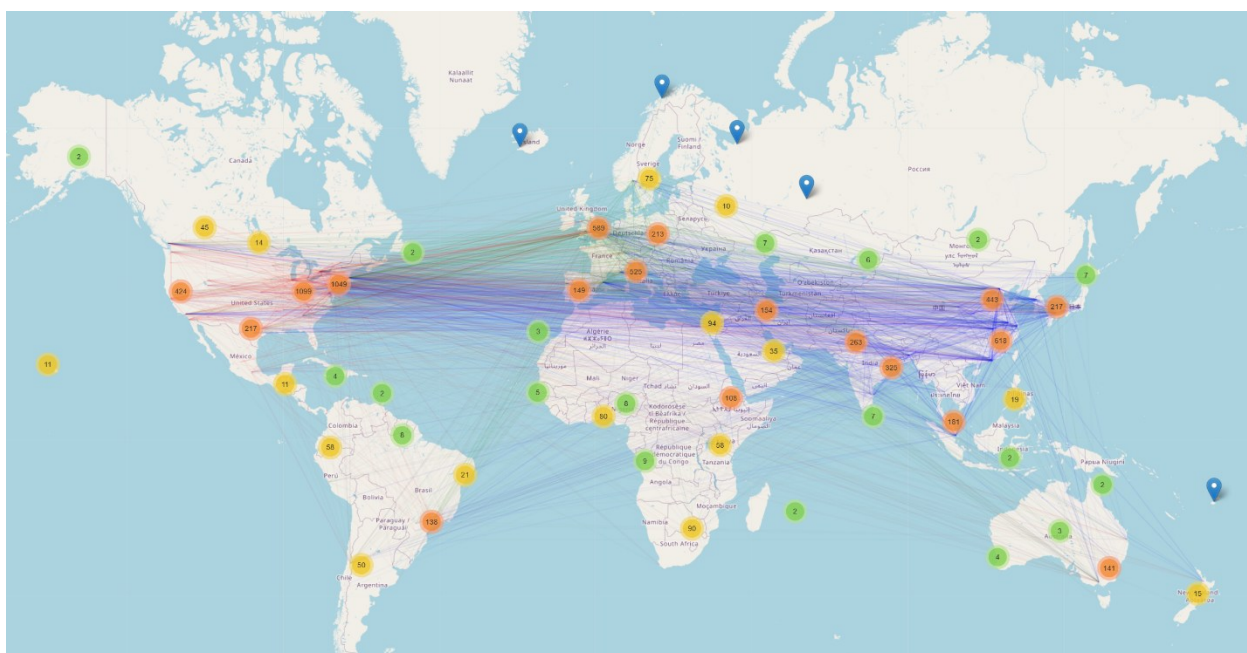


Figure 1. Affiliation locations when articles focusing on ‘urban COVID-19’ published and citation links.

The network depicted is imbalanced, characterized by uneven publication density and citation connectivity across regions (Kowal et al., 2022). Massive citation lines between East Asia and the US indicate a high volume of academic exchange, while considerable lines connect Europe to the US, reflecting similar scholarly achievements. South American publications, particularly from Brazil, are predominantly cited in Europe rather than North America. However, Africa and the Middle East, despite some publication activity, have sparse nodes and infrequent citation lines, signaling their isolation from the global academic network. This imbalance—where certain regions dominate publication and citation activity while others are marginalized—reduces diversity in scholarly discourse. Such disparities pose risks to future global health responses by limiting the integration of regional perspectives, making it challenging to assess cross-regional influences during historical events like the COVID-19 pandemic. Notably inconsistent locations, such as Central Africa and Inner Asia, which are not sparsely populated like North Asia or Western Australia, still exhibit nearly nonexistent contributions, underscoring the uneven global academic landscape.

This study pioneers the use of spatial citation network analysis to uncover geographic disparities in pandemic-related research, offering a novel cartographic perspective on global academic collaboration. By highlighting regional disparities and thematic shifts, the study provides valuable insights for enhancing global research equity and interdisciplinary

cooperation. The findings advocate for more inclusive and collaborative approaches to addressing complex global challenges, ensuring that diverse perspectives and experiences are represented in the academic discourse.

References

- Avramescu, A. (1979). Actuality and Obsolescence of Scientific Literature. *Journal of the American Society for Information Science*, 30(5), 296-303. <https://doi.org/10.1002/asi.4630300509>
- Biro, T., Austin, C. C., Pickering, B., Bernier, A., Bezuidenhout, L., Casorrán, C., Crawley, F. P., David, R., Engelhardt, C., Mitrea, G., Mochmann, I. C., Nagrani, R., O'Brien-Uhlmansiek, M., Parker, S., Wang, M., Castro, L. J., Cournia, Z., Dharmawardena, K., Diallo, G.,...Tovani-Palone, M. R. (2021). Radical collaboration during a global health emergency: Development of the RDA COVID-19 data sharing recommendations and guidelines. *Open research Europe*, 1, 69-69. <https://doi.org/10.12688/openreseurope.13369.1>
- Chiranjeevi, M., Dhuli, V. S., Enduri, M. K., & Cenkeramaddi, L. R. (2023). ICDC: Ranking Influential Nodes in Complex Networks Based on Isolating and Clustering Coefficient Centrality Measures. *IEEE access*, 11, 126195-126208. <https://doi.org/10.1109/ACCESS.2023.3328345>
- Fatima, M., O'Keefe, K. J., Wei, W. J., Arshad, S., & Gruebner, O. (2021). Geospatial Analysis of COVID-19: A Scoping Review. *International Journal of Environmental Research and Public Health*, 18(5), Article 2336. <https://doi.org/10.3390/ijerph18052336>
- Hallinger, P. (2020). Science mapping the knowledge base on educational leadership and management from the emerging regions of Asia, Africa and Latin America, 1965–2018. *Educational management, administration & leadership*, 48(2), 209-230. <https://doi.org/10.1177/1741143218822772>
- Jiang, X., Zhu, X., & Chen, J. (2020). Main path analysis on cyclic citation networks. *Journal of the Association for Information Science and Technology*, 71(5), 578-595. <https://doi.org/10.1002/asi.24258>
- Kowal, M., Sorokowski, P., Kulczycki, E., & Żelaźniewicz, A. (2022). The impact of geographical bias when judging scientific studies. *Scientometrics*, 127(1), 265-273. <https://doi.org/10.1007/s11192-021-04176-7>
- Liu, C., Fan, C., & Mostafavi, A. (2024). Graph attention networks unveil determinants of intra- and inter-city health disparity. *Urban informatics*, 3(1), 18. <https://doi.org/10.1007/s44212-024-00049-5>
- Lv, Z., Zhao, N., Xiong, F., & Chen, N. (2019). A novel measure of identifying influential nodes in complex networks. *Physica A*, 523, 488-497. <https://doi.org/10.1016/j.physa.2019.01.136>
- Phil Yang, C., Bao, S., Guan, W., Howell, K., Hu, T., Lan, H., Li, Y., Liu, Q., Smith, J., Srenganathan, A., Trefonides, T., Wang, K., & Wang, Z. (2022). Challenges and opportunities of the spatiotemporal responses to the global pandemic of COVID-19. *Annals of GIS*, 28(4), 425-434. <https://doi.org/10.1080/19475683.2022.2141396>
- Rockliffe, L. (2022). Including non-English language articles in systematic reviews: A reflection on processes for identifying low-cost sources of translation support. *Research synthesis methods*, 13(1), 2-5. <https://doi.org/10.1002/jrsm.1508>
- Skopec, M., Issa, H., Reed, J., & Harris, M. (2020). The role of geographic bias in knowledge diffusion: a systematic review and narrative synthesis. *Research Integrity and Peer Review*, 5(1), 2. <https://doi.org/10.1186/s41073-019-0088-0>