LITERATURE REVIEW

A Big Data to Discovery: Network Analysis of COPD Research Collaborations from 2000 to 2023

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ABSTRACT

Introduction: Collaborative research is critical for advancing knowledge of chronic obstructive pulmonary disease (COPD). Over the last two decades, understanding the structure and evolution of research networks can provide insights into key contributors and trends in international cooperation. This study aimed to analyze the structure and evolution of collaborative networks in COPD research from 2000 to 2023, identifying key researchers and trends in international cooperation using co-authorship network analysis.
Methods: A dataset of 74,024 COPD-related publications indexed in the Web of Science (WoS) Core Collection was analyzed using Python (Version 3.10.5) in PyCharm (Version 2022.1.3). Macro-level metrics (network density, clustering coefficient, components, average path length) and micro-level metrics (degree centrality, closeness centrality, betweenness centrality) were calculated to evaluate collaboration intensity and researcher roles.
Results: The analysis revealed progressive growth in network density (from 0.00023 in 2000-2009 to 0.00020 in 2020-2023) and clustering coefficient (from 0.885 to 0.893), reflecting strengthened collaboration. Notable researchers, including P.J. Barnes (2000-2009), E.K. Silverman (2010-2019), and R.G. Barr (2020-2023), were identified as central figures. Despite improvements, network fragmentation remains a challenge. Many isolated components exist, and average distances between research groups remain infinite across all periods.
Conclusion: Chronic obstructive pulmonary disease research collaboration has grown significantly over the past two decades, driven by key contributors and increasingly cohesive local networks. However, the persistent fragmentation of the global network highlights the need for further integration to enhance knowledge dissemination and innovation. These findings underscore the importance of fostering broader, more inclusive international collaborations.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a persistent and progressive respiratory disorder characterized by airflow limitation and associated with significant morbidity and mortality. Globally, COPD ranks among the leading causes of death, exerting a substantial burden on healthcare systems.[1,2] According to the World Health Organization (WHO), COPD was the fourth leading cause of death globally in 2021, with approximately 3.5 million deaths.[3] Furthermore, COPD is projected to become the third leading cause of death by 2030.[4] Early diagnosis of COPD remains a critical challenge due to its asymptomatic onset. Moreover, despite advances in management strategies, current therapeutic approaches are primarily palliative, focusing on symptom control and improving quality of life, as disease progression cannot be halted effectively.[5–7]

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The global prevalence of COPD varies across regions. In Western countries, significant strides have been made in COPD research, treatment modalities, and public health policies.[8–10] In Asia, high prevalence rates are observed in nations like China, India, and Japan, driven by environmental pollution, biomass fuel usage, and aging populations.[11–13] In Japan specifically, the prevalence of COPD is increasing alongside the rapidly aging society. However, awareness of COPD remains low, and the diagnosis rate is also insufficient. Although spirometry is crucial for diagnosing COPD, it is not adequately utilized in clinical practice.[14] In contrast, Latin American countries such as Brazil report high incidence rates, with smoking and occupational exposure to dust being key risk factors.[15,16]

Scientific interest in COPD research has grown markedly over the last two decades. Analysis of Web of Science (WoS) data from 2000 to 2023 reveals a consistent increase in COPD-related publications, particularly after 2013, when the number of papers exceeded 4,000 annually. This upward trend peaked in 2020 with over 5,700 publications, followed by a slight decline, yet maintaining high output levels in subsequent years. Geographically, the United States (US) led in research output, contributing over 17,000 publications, followed by the United Kingdom/UK (10,000) and China (6,000). Other notable contributors include Canada, Germany, and the Netherlands (each with around 4,000 publications), while Japan, France, and Australia demonstrated substantial contributions (2,500-3,500 publications). Aside from China, Japan and India stand out in Asia, whereas Brazil is a prominent contributor to research output in Latin America. This global distribution highlights the dominance of a few key nations in advancing COPD research.

This study employed co-authorship network analysis to better understand COPD research trends and collaboration dynamics. This method revealed the structural characteristics of research networks, identified key contributors, and provided insights into how collaboration has evolved in this field. This study investigated COPD research collaboration networks by analyzing 74,024 publications indexed in the WoS Core Collection between 2000 and 2023. These data, curated using strict filtering criteria, provided a comprehensive view of research activities and collaborative relationships within the field. The findings of this study held considerable implications for the advancement of COPD research. By identifying major contributors and influential institutions, the study offered valuable insights into the structure of COPD research collaborations. Understanding the dynamics of international collaborative networks can inform future initiatives, promoting more effective cooperation and resource allocation.

Furthermore, this study shed light on the evolution of research networks, highlighting trends, strengths, and potential gaps. It underscored the importance of fostering international collaboration, particularly in addressing region-specific challenges such as aging populations in Japan or occupational risks in Brazil. The comprehensive analysis of the study also supported strategic planning for the global research community, aiming to enhance scientific outcomes and public health initiatives.

METHODS

Data Collection

This study analyzed research collaborations in COPD research data from the WoS Core Collection between 2000 and 2023. A topic search using "COPD" yielded an initial dataset of 88,711 publications. The data refinement process involved the following steps:

1. Filtering for the period 2000-2023 reduced the dataset to 80,653 records.
2. Further refinement to include only the "Article," "Review Article," and "Meeting Abstract" document types while excluding "Correction," "Retracted Publication," and "Retraction" yielded 74,024 records. The dataset reflected records as of October 2024.

Selection Criteria

1. Language: English
2. Full text: Only full-text articles were included
3. Document types: Included "Article," "Review Article," and "Meeting Abstract"; excluded "Correction," "Retracted Publication," and "Retraction"

Analysis Tools and Environment

The analysis employed the Python programming language (Version 3.10.5) in the PyCharm integrated development environment (IDE, Software Version 2022.1.3). The implementation utilized NetworkX for co-authorship network construction and analysis, while Matplotlib facilitated data visualization.

Network Analysis Methodology

The analysis examined the structure of the co-authorship network through macro-level and micro-level metrics to evaluate collaboration dynamics and individual researcher roles within the network.

Macro-Level Metrics:

Network density: Measures the proportion of actual edges (collaborations) in the network relative to the maximum possible edges. A value of 1 indicates a fully connected network where every researcher collaborates with every other researcher, whereas a value close to 0 suggests a highly fragmented network with minimal collaboration.[17]

Clustering coefficient: This coefficient assesses the tendency of nodes to form tightly knit groups or clusters, indicating local collaboration structures. It considers the degree to which adjacent nodes are connected and helps measure the formation of small communities or clusters. A clustering coefficient closer to 1 indicates higher connectivity among neighboring nodes, while a coefficient closer to 0 indicates lower connectivity.[17]

Components: Identifies the number of connected subgraphs within the network, highlighting the degree of fragmentation.[18]

Average path length: Calculates the average shortest path between all pairs of nodes, indicating how quickly information can spread within the network.[18]

Micro-Level Metrics:

Degree centrality: Evaluates the number of direct connections (edges) a node has, reflecting its immediate influence within the network.[19]

Closeness centrality: Measures how close a node is to all other nodes in the network, representing its accessibility.[19]

Betweenness centrality: Quantifies the extent to which a node lies on the shortest paths between other nodes, highlighting its role as a broker in the network.[19]

RESULTS

2000-2009: Network Analysis of COPD Research

During the 2000-2009 period, the co-authorship network for COPD research demonstrated a sparse structure (Figure 1), characterized by a network density of 0.00023 and an average clustering coefficient of 0.885. The network was highly fragmented, with 2,601 components indicating a lack of connectivity across research groups (Table 1). The average distance was infinite, highlighting the dispersed nature of network.[20]

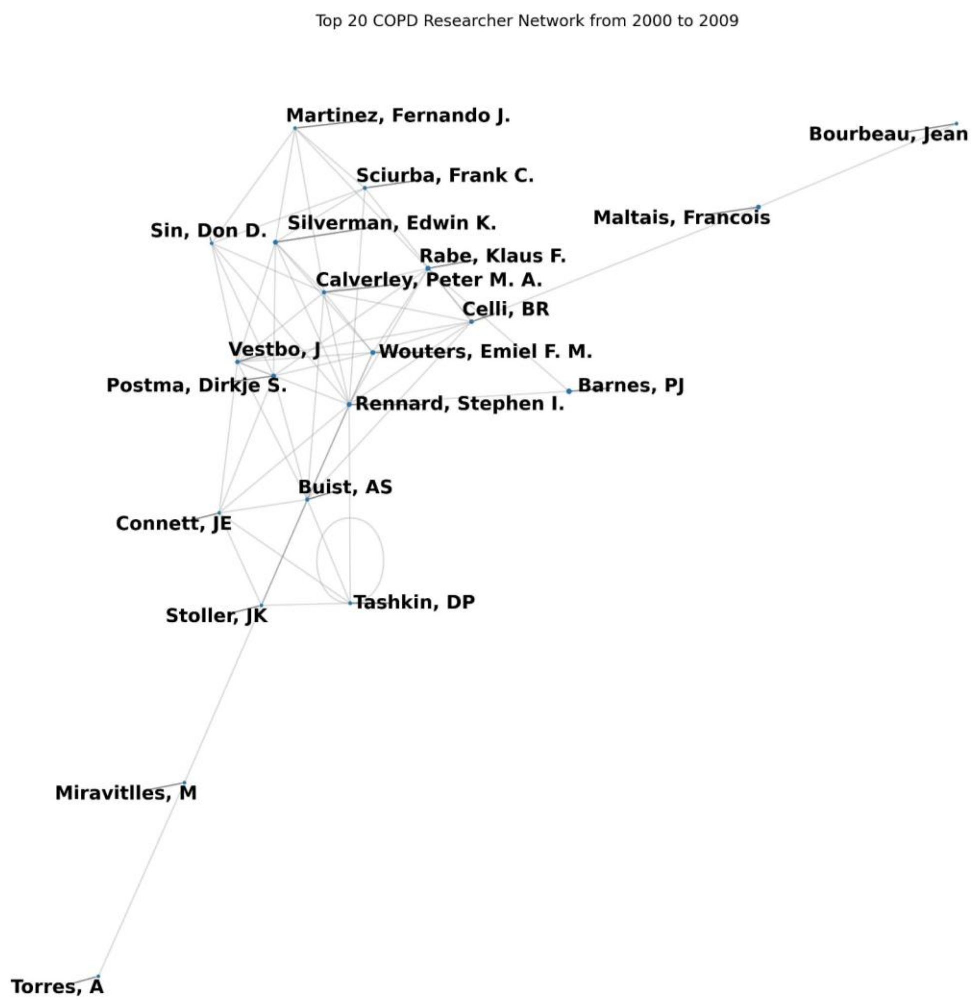

Figure 1. The top 20 chronic obstructive pulmonary disease researcher networks from 2000 to 2009

Table 1. Network metrics

Metric	2000-2009	2010-2019	2020-2023
Network density	0.0002396650	0.0001476158	0.0002046108
Average clustering coefficient	0.8856537922	0.8638176368	0.8930838438
Number of components	2,601	5,333	4,298
Average distance	Infinite	Infinite	Infinite

2000-2009: Key Researchers (Table 2-4)

Degree centrality: P.J. Barnes emerged as the most influential researcher, achieving the highest degree centrality (0.0098), followed by Klaus F. Rabe (0.0084), and Emiel F.M. Wouters (0.0075).

Closeness centrality: Klaus F. Rabe ranked highest in closeness centrality (0.1437), reflecting his central position in the network, facilitating efficient collaboration pathways.

Betweenness centrality: Klaus F. Rabe led betweenness centrality (0.0613), underscoring his role as a critical intermediary in research collaborations.

Table 2. Top 20 nodes by degree centrality

Rank	2000-2009	Degree Centrality	2010-2019	Degree Centrality	2020-2023	Degree Centrality
1	Barnes, PJ	0.0098	Sciurba, Frank C	0.0140	Barr, RG	0.0106
2	Rabe, Klaus F	0.0084	Wise, Robert A	0.0137	Silverman, Edwin K	0.0095
3	Wouters, Emiel FM	0.0075	Criner, Gerard J	0.0134	Han, MeiLan K	0.0094
4	Silverman, Edwin K	0.0074	Martinez, Fernando	0.0118	van Boven, Job FM	0.0093
5	Rennard, Stephen I	0.0071	Wouters, Emiel FM	0.0115	Martinez, Fernando J	0.0086
6	Postma, Dirkje S	0.0071	Barr, R. Graham	0.0099	Mahesh, PA	0.0081
7	Maltais, Francois	0.0069	Silverman, Edwin K	0.0095	Singh, Dave	0.0079
8	Celli, BR	0.0059	Agusti, Alvar	0.0085	Liu, Wei	0.0078
9	Vestbo, J	0.0053	Maltais, Francois	0.0081	Cho, Michael H	0.0078
10	Calverley, Peter MA	0.0050	Vestbo, J	0.0078	Koyanagi, Ai	0.0075
11	Buist, AS	0.0046	Soriano, Joan B	0.0073	Park, Eun-Kee	0.0075
12	Sciurba, Frank C	0.0042	Make, Barry	0.0070	Ullah, Irfan	0.0074
13	Tashkin, DP	0.0038	Tal-Singer, Ruth	0.0070	Rahim, Fakher	0.0073
14	Miravitlles, M	0.0033	Miravitlles, Marc	0.0070	Ortega, Victor E	0.0073
15	Bourbeau, Jean	0.0031	Sin, Don D	0.0068	Alahdab, Fares	0.0073
16	Stoller, JK	0.0031	Cho, Michael H	0.0068	Bhattacharyya, Krittika	0.0073
17	Martinez, Fernando J	0.0030	Singh, Dave	0.0066	Butt, Zahid A	0.0073
18	Torres, A	0.0029	Han, MeiLan K	0.0064	Faro, Andre	0.0073
19	Connett, JE	0.0028	Dransfield, Mark T	0.0064	Fischer, Florian	0.0073
20	Sin, Don D	0.0028	Crapo, James D	0.0063	Jakovljevic, Mihajlo	0.0073

Table 3. Top 20 nodes by closeness centrality

Rank	2000-2009	Degree Centrality	2010-2019	Degree Centrality	2020-2023	Degree Centrality
1	Rabe, Klaus F	0.1437	Wouters, Emiel FM	0.2594	Miravitlles, Marc	0.2050
2	Rennard, Stephen I	0.1405	Criner, Gerard J	0.2490	Singh, Dave	0.2046
3	Calverley, Peter MA	0.1376	Agusti, Alvar	0.2490	Han, MeiLan K	0.2045
4	Celli, BR	0.1371	Maltais, Francois	0.2479	Martinez, Fernando J	0.2040
5	Barnes, PJ	0.1359	Vestbo, J	0.2468	Agusti, Alvar	0.2038
6	Vestbo, J	0.1354	Sciurba, Frank C	0.2452	Wedzicha, Jadwiga A	0.2022
7	Wouters, Emiel FM	0.1345	Martinez, Fernando	0.2437	Sin, Don D	0.2018
8	Postma, Dirkje S	0.1324	Calverley, Peter MA	0.2435	Tal-Singer, Ruth	0.2017
9	Silverman, Edwin K	0.1320	Sin, Don D	0.2430	Papi, Alberto	0.2008
10	Rossi, A	0.1307	Wise, Robert A	0.2428	Hurst, John R	0.2008
11	Donner, Claudio F	0.1285	Miravitlles, Marc	0.2425	Criner, Gerard J	0.2003
12	Buist, AS	0.1276	Barr, R. Graham	0.2418	Vogelmeier, Claus F	0.1994
13	Levy, Robert D	0.1256	Decramer, Marc	0.2413	Watz, Henrik	0.1986
14	Make, Barry J	0.1253	Wedzicha, Jadwiga A	0.2409	Franssen, Frits ME	0.1980
15	Martinez, Fernando J	0.1253	Papi, Alberto	0.2406	Silverman, Edwin K	0.1970
16	Agusti, Alvar GN	0.1252	Watz, Henrik	0.2404	Vestbo, Jorgen	0.1968
17	Fabbri, Leonardo M	0.1248	Tal-Singer, Ruth	0.2401	Roche, Nicolas	0.1962
18	Coxson, Harvey O	0.1247	Coxson, Harvey O	0.2401	Bakke, Per	0.1961
19	MacNee, W	0.1246	Jones, Paul W	0.2398	Garcia-Aymerich, Judith	0.1960
20	Pare, Peter D	0.1246	Silverman, Edwin K	0.2397	Bhatt, Surya P	0.1955

Table 4. Top 20 nodes by betweenness centrality

Rank	2000-2009	Degree Centrality	2010-2019	Degree Centrality	2020-2023	Degree Centrality
1	Rabe, Klaus F	0.0613	Wouters, Emiel FM	0.0696	Miravitlles, Marc	0.0207
2	Barnes, PJ	0.0487	Maltais, Francois	0.0388	Barr, RG	0.0176
3	Rennard, Stephen I	0.0336	Barr, R. Graham	0.0291	Wang, Wei	0.0171
4	Silverman, Edwin K	0.0276	Miravitlles, Marc	0.0167	Singh, Dave	0.0161
5	Celli, BR	0.0255	Criner, Gerard J	0.0166	Kauczor, HU	0.0151
6	Calverley, Peter MA	0.0212	Sciurba, Frank C	0.0153	Franssen, FME	0.0149
7	Wouters, Emiel FM	0.0197	Agusti, Alvar	0.0149	Pistenmaa, Carrie L	0.0145
8	Vestbo, J	0.0197	Vestbo, J	0.0134	Chung, Kian Fan	0.0143
9	Postma, Dirkje S	0.0168	Wise, Robert A	0.0134	Hoffman, Eric A	0.0123
10	Maltais, Francois	0.0140	Calverley, Peter MA	0.0109	Watz, Henrik	0.0121
11	Fukuchi, Y	0.0092	Singh, Dave	0.0109	Vogelmeier, Claus F	0.0112
12	Rossi, A	0.0092	Jones, Paul W	0.0106	Martinez, Fernando J	0.0104
13	Donner, Claudio F	0.0069	Barnes, PJ	0.0105	Comellas, AP	0.0103
14	MacNee, W	0.0068	Soriano, Joan B	0.0101	Sin, Don D	0.0101
15	Verkindre, C	0.0067	Sin, Don D	0.0090	Agusti, Alvar	0.0098
16	Vogelmeier, Claus	0.0066	Roche, Nicolas	0.0087	Zhang, Jing	0.0096
17	Buist, AS	0.0063	Watz, Henrik	0.0085	Tal-Singer, Ruth	0.0092
18	Troosters, Thierry	0.0060	Decramer, Marc	0.0084	Franssen, Frits ME	0.0091
19	Anzueto, A	0.0059	Martinez, Fernando	0.0078	Hurst, John R	0.0085
20	Huchon, G	0.0058	Bourbeau, Jean	0.0075	Han, MeiLan K	0.0083

2010-2019: Network Analysis of COPD Research

The 2010-2019 network exhibited a slight decrease in network density (0.00014), coupled with a marginally lower average clustering coefficient (0.863). Despite these decreases, the number of components rose to 5,333 (Table 1), suggesting an increase in isolated research groups (Figure 2). The average distance remained infinite, indicating continued fragmentation.[20]

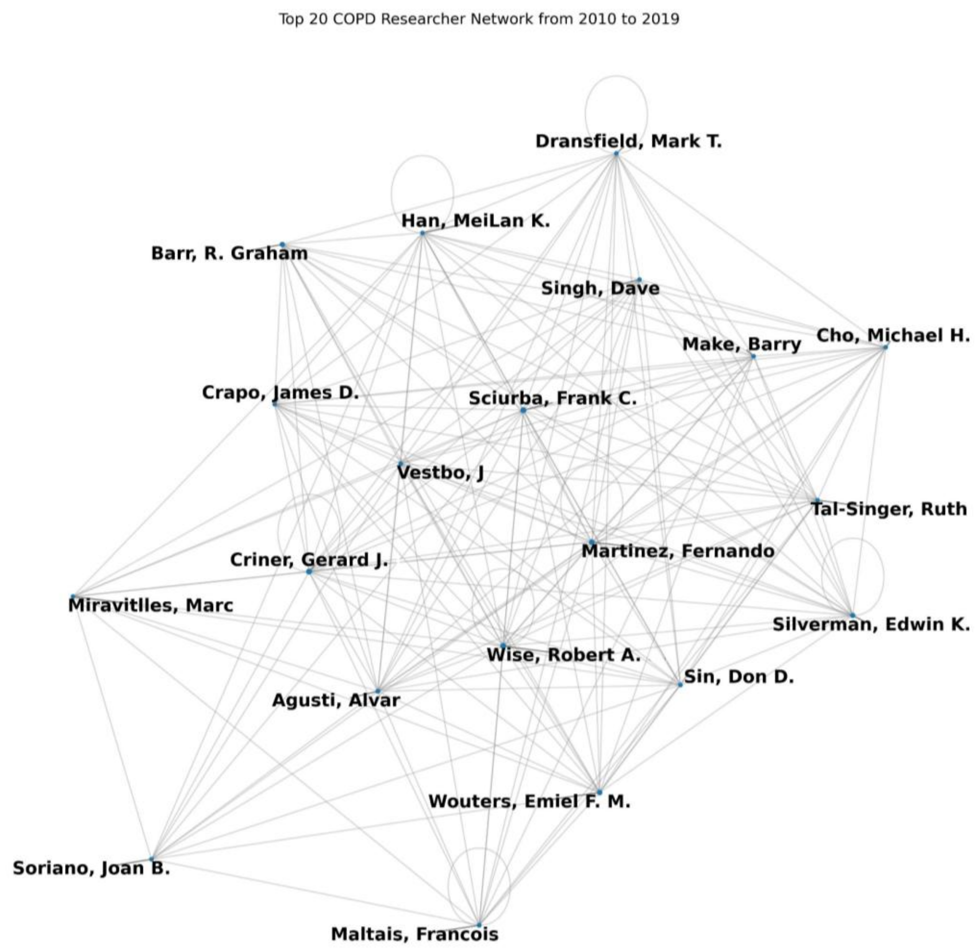

Figure 2. The top 20 chronic obstructive pulmonary disease researcher networks from 2010 to 2019

2010-2019: Key Researchers (Table 2-4)

***Degree centrality*: ** Frank C. Sciurba (0.0140) and Robert A. Wise (0.0137) were prominent, demonstrating their critical roles in fostering collaboration.

***Closeness centrality*: ** Emiel F.M. Wouters (0.2594), Gerard J. Criner (0.2490), and Alvar Agusti (0.2490) stood out for their central positions within the network.

***Betweenness centrality*: ** Emiel F.M. Wouters led betweenness centrality (0.0696), highlighting his influence as a connector across disparate research groups.

2020-2023: Network Analysis of COPD Research

In the most recent period (2020–2023), the network density slightly increased to 0.00020, and the average clustering coefficient rose to 0.893, reflecting improved collaboration. However, the number of components slightly decreased to 4,298 (Table 1), suggesting some consolidation of research efforts (Figure 3). The average distance remained infinite, indicating continued but reduced fragmentation.[20]

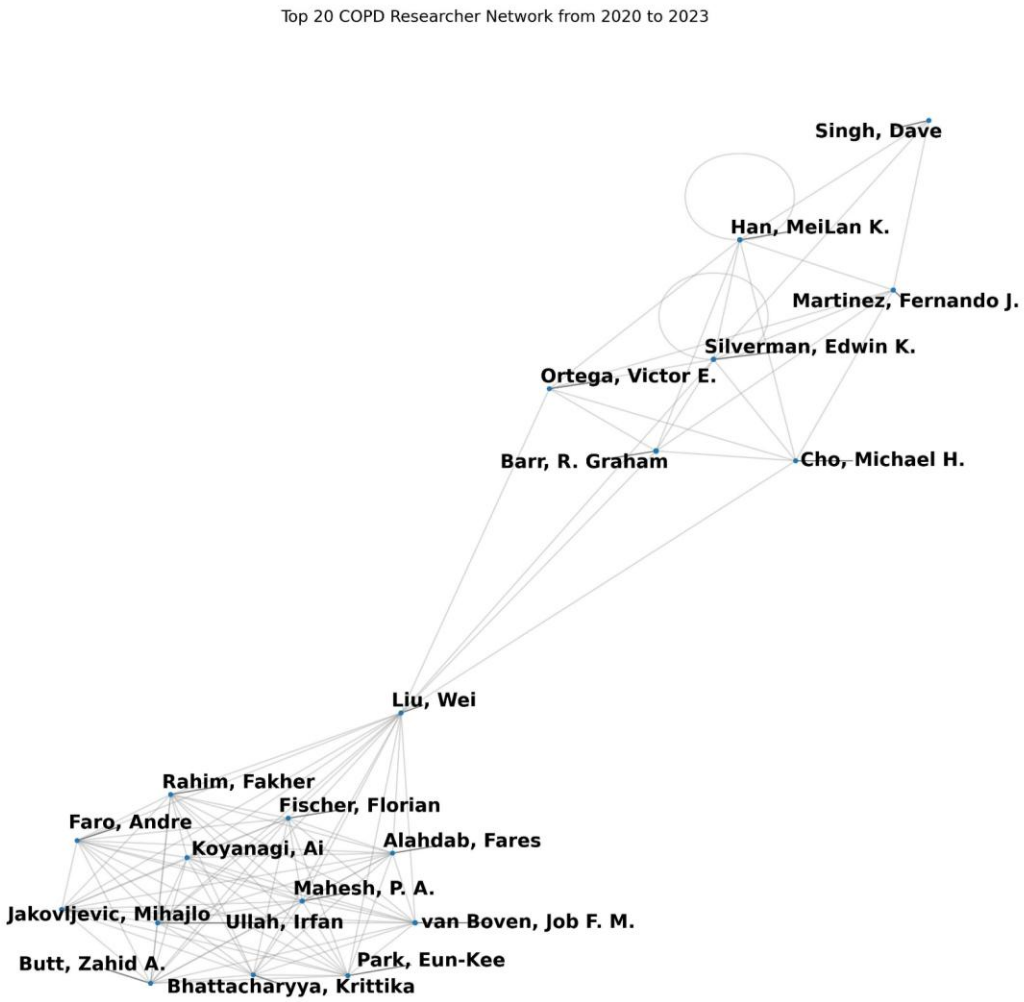

Figure 3. The top 20 chronic obstructive pulmonary disease researcher networks from 2020 to 2023

2020-2023: Key Researchers (Table 2-4)

***Degree centrality*: ** R.G. Barr (0.0106) emerged as the most connected researcher, followed by E.K. Silverman (0.0095) and M.K. Han (0.0094)

***Closeness centrality*: ** M. Miravitlles (0.2050) and D. Singh (0.2046) occupied central positions in the network, emphasizing their accessibility for collaboration.

***Betweenness centrality*: ** M. Miravitlles (0.0207) led in betweenness centrality, indicating a pivotal role in bridging collaborations between distinct research clusters.

The network density and clustering coefficients in COPD research showed consistent growth, strengthening collaborative relationships in the research community. Key researchers drove this progress during distinct periods: P.J. Barnes (2000-2009), Frank C. Sciurba (2010-2019), and R.G. Barr (2020-2023) emerged as central figures who shaped these research networks. Despite these advances, significant fragmentation persists in the network, as evidenced by numerous isolated components and infinite average distances across all periods. This structure reveals the progress in research collaboration and the remaining opportunities to enhance network integration and connectivity for more effective knowledge dissemination and innovation.

DISCUSSION

This study revealed critical patterns in collaboration dynamics and network evolution in COPD research from 2000 to 2023. The co-authorship network analysis demonstrated significant progress in research collaborations while highlighting persistent challenges in network fragmentation.

Collaboration Dynamics Over Time

The network analysis indicated progressive improvement in collaboration intensity, demonstrated by increasing network density and clustering coefficients across study periods. These metrics pointed to a steady strengthening of cooperative efforts among researchers. The clustering coefficient peaked during 2020-2023, indicating stronger localized collaborations and the formation of cohesive research groups. However, the high number of components and infinite average distances across all periods revealed persistent fragmentation, emphasizing the need for greater integration to maximize knowledge dissemination and innovation within the COPD research community.

The Role of Key Researchers

The analysis identified several pivotal contributors who shaped the COPD research landscape. P.J. Barnes emerged as a central figure from 2000 to 2009, achieving the highest degree and second-highest betweenness centrality while ranking fifth in closeness. His influence stems from his capacity to connect disparate research groups and facilitate knowledge exchange. In comparison, Klaus F. Rabe ranked second in degree, first in closeness, and first in betweenness centrality, highlighting his significant role in bridging research networks. The 2010-2019 period saw researchers such as Frank C. Sciurba, Robert A. Wise, Emiel F.M. Wouters, Gerard J. Criner, and Alvar Agusti assume leading roles. Frank C. Sciurba and Robert A. Wise were prominent in degree centrality, demonstrating their critical roles in fostering collaboration. Emiel F.M. Wouters, Gerard J. Criner, and Alvar Agusti stood out for their central positions within the network. Emiel F.M. Wouters led the betweenness centrality, highlighting his influence as a connector across disparate research groups. During 2020-2023, new central figures emerged, including R.G. Barr, M. Miravitlles, and D. Singh, signaling a dynamic shift in leadership and influence within the research network.

Implications for Future Research Collaboration

The findings highlighted the critical importance of international and interdisciplinary collaborations in addressing network fragmentation in COPD research. Multiple isolated components suggested missed opportunities for cross-pollination of ideas and innovation. Strengthening global partnerships, particularly between high-output countries like the US, UK, China, and regions with unique challenges, such as Asia and Latin America, could bridge these gaps and enhance research impact.

The role of key researchers as central nodes emphasizes the significance of mentorship and strategic collaboration. Supporting emerging researchers and facilitating connections between established and nascent research groups could enhance network cohesion. Additionally, leveraging information and communication technologies (ICT), artificial intelligence (AI), and large-scale data-sharing platforms can significantly improve collaboration opportunities.

Future Directions

The analysis suggested several avenues for future research and policy initiatives. Key future directions include:

International Research Consortia and Funding Mechanisms

Establishing and expanding research consortia that provide collaborative grants and funding opportunities can facilitate cross-border research initiatives. To optimize international collaboration, it is crucial to analyze successful case studies of multinational research projects, evaluate the impact of funding allocation strategies, and identify institutional support mechanisms that enhance long-term cooperation. Creating dedicated funding programs prioritizing COPD-related research in underrepresented regions can also contribute to a more globally inclusive research network.

Research Data and Resource Sharing

Developing an international data-sharing platform will provide researchers access to a comprehensive database, facilitating collaborative studies despite differences in research methods and approaches. This platform should include clinical trial data, epidemiological datasets, and AI-driven predictive models to enhance COPD research. Standardized data-sharing agreements and secure access protocols will be essential to ensure ethical and efficient collaboration.

Enhanced Academic Network

Encouraging participation in international conferences, workshops, and symposia organized by national and regional respiratory or internal medicine societies can help connect researchers from different regions. Additionally, establishing dedicated COPD research forums and virtual networking events can foster interdisciplinary discussions and long-term partnerships.

Leveraging Technological Advancements

The widespread use of ICT, AI, and big data analytics has enhanced global research connectivity. Expanding the use of these tools in COPD research collaboration will enable more efficient data-sharing and cooperative research efforts. Furthermore, integrating virtual reality (VR) technologies can revolutionize collaboration. For instance, VR-based virtual lab tours can facilitate the exchange of experimental techniques. At the same time, remote participation in real-time imaging and endoscopic procedures can enhance the training of early-career researchers.

Engagement of Key Contributors as Collaboration Ambassadors

The influential researchers in this study can serve as ambassadors for international collaboration. Their advisory and leadership roles in collaborative projects can bridge research gaps and connect isolated research groups. Respiratory and internal medicine societies in different countries and regions can actively engage these researchers as keynote speakers and panelists to initiate discussions on global research priorities and foster new international collaborations. Implementing these strategies can strengthen global research collaboration in COPD studies, fostering more inclusive and impactful scientific advancements.

SUMMARY

This study presented a comprehensive analysis of collaborative networks in COPD research from 2000 to 2023, revealing insights into the evolution and structure of scientific cooperation within this field. Network analysis of WoS Core Collection data identified key patterns, strengths, and persistent challenges in COPD research collaborations over the past two decades.

Network density and clustering coefficients strengthened, demonstrating increasingly robust research connections. Yet the high number of components and infinite average distances reveal persistent isolation among numerous research groups. Influential researchers have shaped the network structure at different periods, with P.J. Barnes (2000-2009), Frank C. Sciurba (2010-2019), and R.G. Barr (2020-2023) emerging as central figures who facilitated meaningful collaboration.

Despite these positive trends, network fragmentation remains a significant challenge. Strengthening international and interdisciplinary collaborations is essential for driving innovation and knowledge dissemination in this field. Future development of the COPD research landscape may benefit from expanded research consortia, enhanced data-sharing platforms, and integration of emerging technologies such as VR, AI, and big data analytics. Furthermore, engaging key researchers as collaboration ambassadors could help bridge gaps between isolated research communities.

Future efforts should focus on building a more comprehensive and globally connected research structure to optimize the impact of COPD research and accelerate scientific progress in this field. Given the worldwide severity of COPD as a public health challenge, the establishment of a research environment that fosters cross-border and interdisciplinary collaboration becomes imperative for effectively addressing this disease. This study aimed to contribute to this goal by highlighting pathways toward a more integrated research community.

LIMITATIONS OF THE STUDY

While this study provided a comprehensive analysis of COPD research networks, several limitations warrant consideration. Reliance on the WoS data may exclude relevant publications indexed in other databases, potentially introducing bias. It is important to note that the WoS Core Collection selectively includes over 18,000 of the most influential academic journals worldwide. Still, it does not cover all academic journals or society publications. Additionally, co-authorship as a collaboration proxy may not fully capture informal or multidisciplinary collaborations. Future studies incorporating alternative metrics, such as citation networks or thematic analyses, could provide a more nuanced understanding of research dynamics.

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Conflict of Interest
The authors declared there is no conflict of interest.

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Author's Contributions

Performed all aspects of manuscript preparation, including research planning, data acquisition, data analysis (using Python software), interpretation of the results, manuscript drafting, and final review: NO.

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