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Article

Co-Authorship Network Analysis in Gastroesophageal Reflux Disease Research: Evaluating Collaboration and Structural Changes from 2000 to 2023

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Abstract: **Aim:** This study aims to analyze the evolution of co-author networks in Gastroesophageal Reflux Disease (GERD) research from 2000 to 2023, using data from the Web of Science (WoS) Core Collection. The objective is to provide a structural overview of researcher collaborations in this specialized field, highlighting key contributors and the impact of international cooperation. **Method:** I conducted a co-author network analysis on 19,463 GERD -related articles indexed in the WoS Core Collection between 2000 and 2023. Using Python (Version 3.10.5) within the PyCharm development environment (Software Version 2022.1.3), I assessed macro-level indicators including network density, clustering coefficient, number of components, and average distance. Micro-level indicators such as degree centrality, closeness centrality, and betweenness centrality were also evaluated to understand the roles of individual researchers in the network. **Result:** The GERD co-authorship network exhibited a sparse structure with low network density, indicating limited realized collaborations compared to potential connections. The clustering coefficient was consistently high across the analyzed periods, suggesting that researchers frequently formed tight-knit groups. The network was fragmented into numerous components, with significant disconnection between groups. Degree centrality highlighted key researchers such as Dent, J., and Shaheen, N.J., who had extensive collaborative reach. In contrast, closeness and betweenness centrality identified strategic intermediaries like Bredenoord, A.J. and Kahrilas, P.J., who facilitated connections across otherwise isolated segments of the network. **Conclusion:** The co-authorship network analysis revealed a persistently fragmented landscape in GERD research, with considerable room for enhancing collaboration among researchers. Identifying key contributors and understanding their roles within the network can guide future efforts to foster more integrated and comprehensive research collaborations. This study underscores the importance of strategic networking and partnership development in advancing GERD research and optimizing the field's collaborative potential.

Keywords: Gastroesophageal Reflux Disease; GERD; co-authorship network analysis; network analysis; research collaboration; research trend analysis; research trends; key researchers; research strategies; internal medicine; planning future collaborative studies

Introduction

Background and Objectives

Gastroesophageal reflux disease (GERD) is a prevalent chronic condition characterized by regurgitating stomach contents into the esophagus, leading to symptoms such as heartburn and acid reflux. GERD is a significant public health issue worldwide, with an increasing prevalence over the past decades. It has been linked to complications such as esophagitis, Barrett's esophagus, and an elevated risk of esophageal adenocarcinoma. The importance of advancing research in GERD cannot be understated, as understanding its pathophysiology, management strategies, and potential complications remains critical for improving patient outcomes [1].

Globally, GERD affects millions of people, with varying prevalence rates across different regions. The condition is prevalent in Western countries, where lifestyle factors such as diet, obesity, and sedentary behavior contribute to its high incidence. In contrast, the prevalence in Asian countries has been historically lower, but recent studies indicate a rising trend, possibly due to changes in dietary habits and increasing rates of obesity [2].

In Europe and North America, GERD is one of the most common gastrointestinal disorders. The high prevalence in these regions has led to significant healthcare costs and a substantial burden on healthcare systems. Research in these areas has focused on understanding the impact of lifestyle factors, such as diet and physical activity, on GERD symptoms and developing effective management strategies [3]. Additionally, there is a growing interest in the role of genetic predisposition and the microbiome in the development of GERD.

In Asia, the prevalence of GERD has been increasing over the past few decades. This rise is attributed to rapid urbanization, changes in dietary patterns, and an increase in obesity rates. Asian countries have also seen a growing interest in GERD research, with studies exploring the unique clinical characteristics and risk factors in this population. There is a particular focus on the role of *Helicobacter pylori* infection, which is more common in Asia and may have a protective effect against GERD [4].

Despite the growing volume of research on GERD, the field faces several challenges, including variability in diagnostic criteria, management strategies, and a need for more robust clinical guidelines. Moreover, while significant progress has been made in understanding GERD's underlying mechanisms and treatment options, collaboration among researchers remains crucial for further advancements. Co-authorship network analysis offers valuable insights into the collaborative landscape of GERD research by elucidating the relationships between researchers and identifying key contributors and influential research groups. This study aims to analyze the structure and evolution of co-authorship networks in GERD research from 2000 to 2023, providing a comprehensive overview of collaboration patterns and identifying critical nodes within the network.

Scope of the Study

This study examines publications related to GERD research indexed in the Web of Science (WoS) Core Collection database between 2000 and 2023. A total of 19,463 articles were selected for analysis, providing a comprehensive overview of the collaborative landscape within this specialized field over the past two decades. The dataset ensures the inclusion of the most recent publications (as of September 2024). The analysis will focus on constructing and evaluating co-authorship networks using macro-level indicators such as network density (the ratio of actual to possible connections), clustering coefficient (the degree to which nodes tend to cluster together), number of components (distinct connected subgroups within the network), and average path length (the average distance between nodes). At the micro-level, I will assess degree centrality (the number of direct connections each node has), closeness centrality (how close a node is to all other nodes), and betweenness centrality (the extent to which a node lies on the shortest path between other nodes). These metrics will help illuminate the structure and dynamics of researcher collaborations in this field.

Significance of the Study

This study contributes significantly to the field of GERD research by providing a detailed analysis of the collaborative network structures and their evolution over time. By identifying major researchers and research institutions, the study highlights the key players who drive GERD research. Moreover, understanding the progression of international collaborative research and its impact on the field can guide future efforts to foster global partnerships. This analysis not only delineates the structural characteristics of the co-authorship networks but also sheds light on the current state and future directions of GERD research.

The findings of this study have the potential to inform strategic decisions by researchers, funding bodies, and policymakers by identifying areas where collaboration can be strengthened. Furthermore, by mapping the network changes over the years, this study provides insights into the

dynamics of research collaboration, including the emergence of new research clusters and shifts in research focus. Ultimately, this study underscores the importance of international collaboration in advancing GERD research and highlights the evolving landscape of scientific cooperation within this field.

Material and Methods

The present study investigates the co-authorship patterns in GERD research papers. I utilized the WoS Core Collection database, conducting a "Topic Search" with the keyword "gastroesophageal reflux disease" to analyze a total of 19,463 articles published between 2000 and 2023 (as of September 2024). In this analysis, I examined who collaborated with whom in co-authoring these papers. I conducted network analysis using the Python programming language (version 3.10.5) within the integrated development environment (IDE) PyCharm (software version 2022.1.3). This study employed methodology-established principles of social network analysis [5]. I carried out the analysis in two main parts:

Macro-level Metrics:

Network Density: Calculated as the ratio of the number of edges to the maximum possible edges Between all nodes.

Clustering Coefficient: Measured the extent to which nodes form clusters by considering the number of edges among neighboring nodes and calculating the average.

Components: Identified and counted the number of subgraphs (components) where nodes are mutually connected.

Average Path Length: Evaluated the average "distance" between nodes by calculating the overall average path length in the network [6].

Micro-level Metrics:

Degree Centrality: Measured the importance of each node by counting the number of edges it has in the network.

Closeness Centrality: Defined as the inverse of the sum of the shortest path lengths from a node to all other nodes, measuring how close each node is to others in the network.

Betweenness Centrality: Assessed the extent to which a node lies on the shortest paths between other nodes, indicating its importance in information transmission within the network [6,7].

The significance of these macro-level metrics in understanding the structure of scientific collaboration networks and these micro-level centrality measures in scientific collaboration networks has been well documented and used [6,7]. Through these analyses, I can identify collaborative relationships and influential researchers in GERD research. This information may be useful for understanding research trends and planning future collaborative studies.

Results

The study analyzed the co-authorship network of researchers in the field of GERD research, focusing on the periods from 2000 to 2023. The analysis was conducted using data from the WoS Core Collection and utilized both macro and micro-level network metrics to understand the evolution of collaborative networks in this field.

2000-2009: Network Analysis

During the 2000–2009 period, the GERD co-authorship network consisted of numerous nodes and links, representing authors and their collaborative relationships (Figure 1). The network density was extremely low at 0.000485 (Table 1), indicating that only 0.0485% of the potential collaborations were realized. The average clustering coefficient was 0.879 (Table 1), suggesting that authors tended to cluster together in collaborative groups (Figure 1). The network was fragmented into 1,468

components (Table 1), with the average distance between nodes being infinite, reflecting the disconnection between many parts of the network [8].

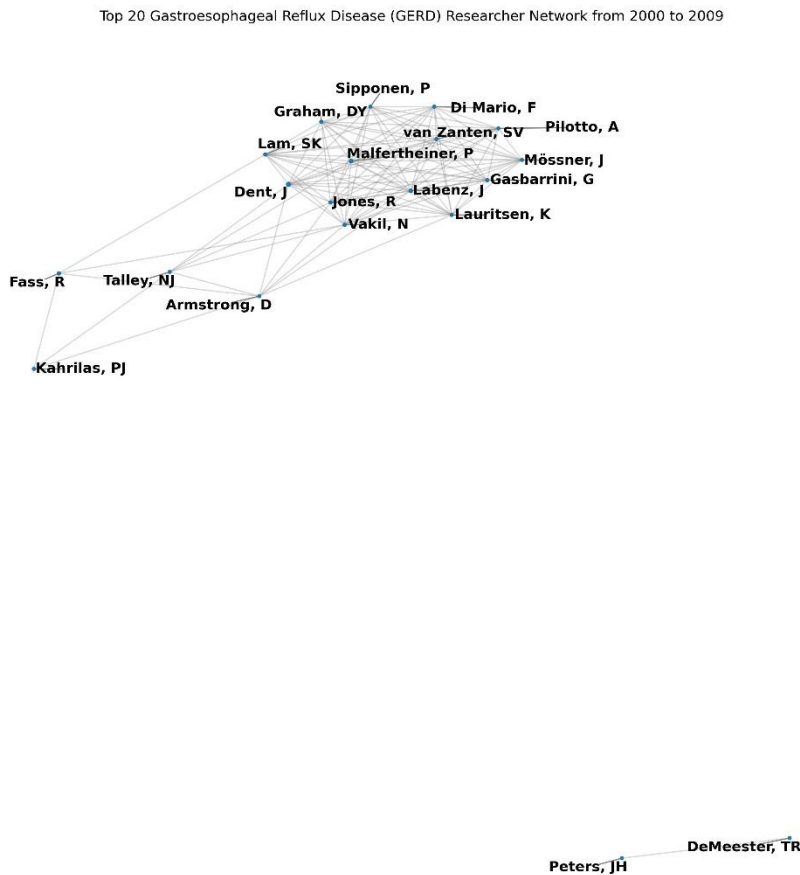


Figure 1. Top 20 Gastroesophageal reflux disease Researcher Network from 2000 to 2009.

Table 1. Network Metrics.

Metric	2000 - 2009	2010 - 2019	2020 - 2023
Network Density	0.000485	0.000514	0.000414
Average Clustering Coefficient	0.879	0.898	0.921
Number of Components	1468	2492	2172
Average Distance	infinite	infinite	infinite

In terms of micro-level metrics, the top authors by degree centrality, indicating the number of direct collaborations, included Dent, J (0.0114), Malfertheiner, P (0.0097), and Labenz, J (0.008). These authors were highly influential in terms of their collaborative reach within the network (Table 2). Closeness centrality, which measures how quickly an author can connect with others, highlighted Dent, J (0.1004), Kahrilas, PJ (0.0988), and Talley, NJ (0.0970) as central figures (Table 3). Betweenness centrality, reflecting the extent to which an author serves as a bridge in the network, identified Dent,

J (0.0203), Fass, R (0.0149), and Kahrilas, PJ (0.0147) as key intermediaries facilitating connections between otherwise disconnected authors (Table 4).

Table 2. Top 20 Nodes by Degree Centrality.

Nod e	2000 - 2009	Degree Centrality	2010 - 2019	Degree Centrality	2020 - 2023	Degree Centrality
1	Dent, J	0.0114	Shaheen, Nicholas J.	0.0185	Savarino, Edoardo	0.0119
2	Malfertheiner, P	0.0097	De Giorgio, Roberto	0.0135	Gyawali, C. Prakash	0.0081
3	Labenz, J	0.008	Di Sabatino, Antonio	0.0131	Sifrim, Daniel	0.0081
4	Fass, R	0.0076	Lenti, Marco Vincenzo	0.0131	Yadlapati, Rena	0.0063
5	Lam, SK	0.0073	Mengoli, Caterina	0.013	de Bortoli, Nicola	0.0056
6	Jones, R	0.0073	Miceli, Emanuela	0.013	Tack, Jan	0.0054
7	Graham, DY	0.0069	Maggio, Marcello Giuseppe	0.013	Fass, Ronnie	0.0053
8	Di Mario, F	0.0069	Ticinesi, Andrea	0.013	Xiao, Yinglian	0.0053
9	Gasbarrini, G	0.0069	Ceda, Gian Paolo	0.013	Lechien, Jerome R.	0.0052
10	Vakil, N	0.0067	Gabrielli, Armando	0.013	Vieth, Michael	0.0051
11	van Zanten, SV	0.0066	Corley, Douglas A.	0.0129	Visaggi, Pierfrancesco	0.0051
12	Lauritsen, K	0.0064	Harari, Sergio	0.0129	Shaheen, Nicholas J.	0.005
13	Kahrilas, PJ	0.0063	Lonati, Chiara	0.0129	Pandolfino, John E.	0.005
14	DeMeester, TR	0.0062	Manfredini, Roberto	0.0128	Vaezi, Michael F.	0.005
15	Pilotto, A	0.0061	Tiseo, Ruana	0.0128	Gockel, Ines	0.0048
16	Peters, JH	0.006	Stanghellini, Vincenzo	0.0128	Kermansaravi, Mohammad	0.0047
17	Armstrong, D	0.006	Pasina, Luca	0.0128	Clarke, John O.	0.0046
18	Sipponen, P	0.0059	Marengoni, Alessandra	0.0128	Inoue, Haruhiro	0.0044
19	Talley, NJ	0.0059	Nobili, Alessandro	0.0128	Tolone, Salvatore	0.0044
20	Mössner, J	0.0059	Zaccari, Michele	0.0128	Gottrand, Frederic	0.0044

Table 3. Top 20 Nodes by Closeness Centrality.

Node	2000 - 2009	Closeness Centrality	2010 - 2019	Closeness Centrality	2020 - 2023	Closeness Centrality
1	Dent, J	0.1004	Gyawali, C. Prakash	0.1341	Savarino, Edoardo	0.1271
2	Kahrilas, PJ	0.0988	Bredenoord, Albert J.	0.1334	Gyawali, C. Prakash	0.1262
3	Talley, NJ	0.097	Vaezi, Michael F.	0.1332	Yadlapati, Rena	0.1226
4	Fass, R	0.096	Shaheen, Nicholas J.	0.1331	Roman, Sabine	0.1208
5	Vakil, N	0.0953	Kahrilas, Peter J.	0.1329	Sifrim, Daniel	0.1208
6	Armstrong, D	0.095	Savarino, Edoardo	0.1318	Xiao, Yinglian	0.1205
7	Fennerty, MB	0.0942	Souza, Rhonda F.	0.1318	Vaezi, Michael F.	0.1203
8	Lam, SK	0.0939	Katzka, David A.	0.1316	Zerbib, Frank	0.1199
9	Jones, R	0.0938	Vela, Marcelo F.	0.1315	de Bortoli, Nicola	0.1196
10	Malfertheiner, P	0.0933	Spechler, Stuart J.	0.1315	Chen, Chien-Lin	0.1187
11	Hunt, R	0.0928	Talley, Nicholas J.	0.1314	Lee, Yeong Yeh	0.1182
12	Tack, J	0.0927	Pandolfino, John E.	0.1307	Bhatia, Shobna	0.1181
13	Moayyedi, P	0.0926	Tack, Jan	0.1303	Fass, Ronnie	0.1181
14	Castell, DO	0.0923	Richter, Joel E.	0.1302	Tack, Jan	0.1176
15	Sonnenberg, A	0.0922	Kinoshita, Yoshikazu	0.1299	Pandolfino, John E.	0.1175
16	Johnson, DA	0.092	Falk, Gary W.	0.1296	Sharma, Prateek	0.1175
17	Labenz, J	0.0914	Sifrim, Daniel	0.1294	Visaggi, Pierfrancesco	0.1172
18	Lauritsen, K	0.091	Penagini, Roberto	0.1291	Bredenoord, Albert J.	0.1169
19	Deltenre, M	0.0908	Zerbib, Frank	0.1287	Savarino, Edoardo V.	0.1168
20	Bytzer, P	0.0907	Attwood, Stephen E.	0.1284	Penagini, Roberto	0.1166

Table 4. Top 20 Nodes by Betweenness Centrality.

Node	2000 - 2009	Betweenness Centrality	2010 - 2019	Betweenness Centrality	2020 - 2023	Betweenness Centrality
1	Dent, J	0.0203	Verheij, J.	0.026	Savarino, Edoardo	0.0198
2	Fass, R	0.0149	Bredenoord, Albert J.	0.0240	Gyawali, C. Prakash	0.0177
3	Kahrilas, PJ	0.0147	Kahrilas, Peter J.	0.0188	Lin, Lin	0.0129
4	Talley, NJ	0.0102	Bredenoord, A. J.	0.0184	Yadlapati, Rena	0.0128
5	Castell, DO	0.0097	Shaheen, Nicholas J.	0.0175	Xiao, Yinglian	0.0128
6	Kinoshita, Y	0.0089	Kinoshita, Yoshikazu	0.0168	Sifrim, Daniel	0.0096
7	Wong, BCY	0.0085	Patti, Marco G.	0.014	Kohn, Geoffrey P.	0.009
8	Armstrong, D	0.0067	De Giorgio, Roberto	0.0128	Shaheen, Nicholas J.	0.0089
9	Holloway, RH	0.0065	Vaezi, Michael F.	0.0125	Vieth, Michael	0.0077
10	Johnson, DA	0.0059	Locke, G. Richard, III	0.0116	Zhang, Shutian	0.0076
11	Tack, J	0.0059	Smout, Andre J. P. M.	0.0116	Sharma, Prateek	0.0076
12	Lam, SK	0.0058	Gyawali, C. Prakash	0.011	Vaezi, Michael F.	0.0074
13	Hunter, JG	0.0055	Talley, Nicholas J.	0.0109	Fass, Ronnie	0.0066
14	Benninga, MA	0.0054	Savarino, Edoardo	0.0107	Tolone, Salvatore	0.0066
15	Devière, J	0.0054	Talley, N. J.	0.0102	Li, Li	0.0057
16	Filipi, CJ	0.0050	Kim, Nayoung	0.0089	Hoppo, Toshitaka	0.0056
17	Triadafilopoulos, G	0.0045	Boeckstaens, Guy	0.0082	Chan, Walter W.	0.0054
18	Spechler, SJ	0.0044	Fass, Ronnie	0.0082	Raghu, Ganesh	0.0051
19	Malfertheiner, P	0.0042	Miwa, Hiroto	0.0078	Tack, Jan	0.0051
20	Shaker, R	0.0042	Smout, A. J. P. M.	0.0077	Kasama, Kazunori	0.0050

2010-2019: Network Analysis

In the subsequent decade (2010–2019), the GERD co-authorship network expanded, yet it remained sparse with a network density of 0.000514 (Table 1), slightly higher than the previous period but still indicating limited collaboration among potential connections (Figure 2). The average clustering coefficient increased to 0.898 (Table 1), demonstrating a stronger tendency for authors to form tight-knit clusters (Figure 2). The number of components rose to 2,492 (Table 1), reflecting the network's continued fragmentation, and the average distance remained infinite, indicating persistent structural gaps [8].

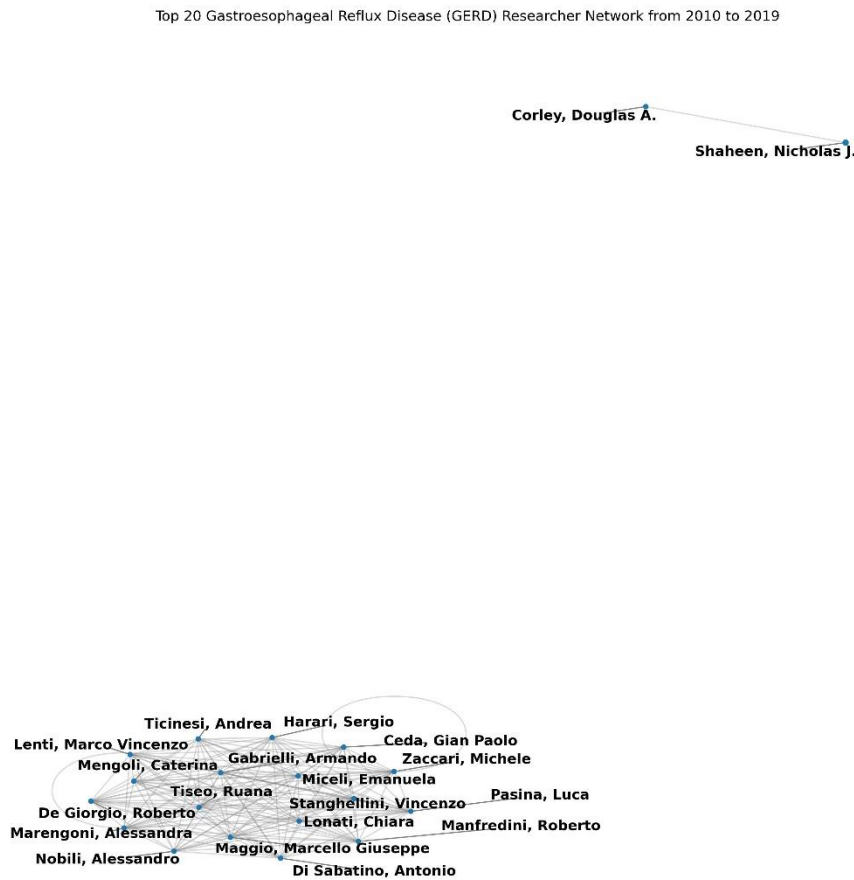


Figure 2. Top 20 Gastroesophageal reflux disease Researcher Network from 2010 to 2019.

The degree centrality analysis for this period revealed that Shaheen, Nicholas J. (0.0185), De Giorgio, Roberto (0.0135), and Di Sabatino, Antonio (0.0131) were among the most collaborative authors, engaging with numerous peers (Table 2). Closeness centrality scores highlighted Gyawali, C. Prakash (0.1341), Bredenoord, Albert J. (0.1334), and Vaezi, Michael F. (0.1332) as being strategically positioned to reach others efficiently (Table 3). Betweenness centrality underscored the importance of authors such as Verheij, J (0.026), Bredenoord, Albert J. (0.0240), and Kahrilas, Peter J. (0.0188), who played significant roles in connecting disparate parts of the network (Table 4).

2020-2023: Network Analysis

The GERD co-authorship network analysis from 2000 to 2023 revealed a complex structure of collaborative relationships. The network density was extremely low at 0.000414 (Table 1), indicating that only 0.0414% of potential collaborations were realized. This suggests a sparse network with considerable untapped collaborative potential (Figure 3). The average clustering coefficient was high at 0.921 (Table 1), demonstrating that authors tended to form tight-knit collaborative groups (Figure 3). The network was highly fragmented, consisting of 2,172 components (Table 1), with the average

distance between nodes being infinite, reflecting significant disconnection between many parts of the network [8].

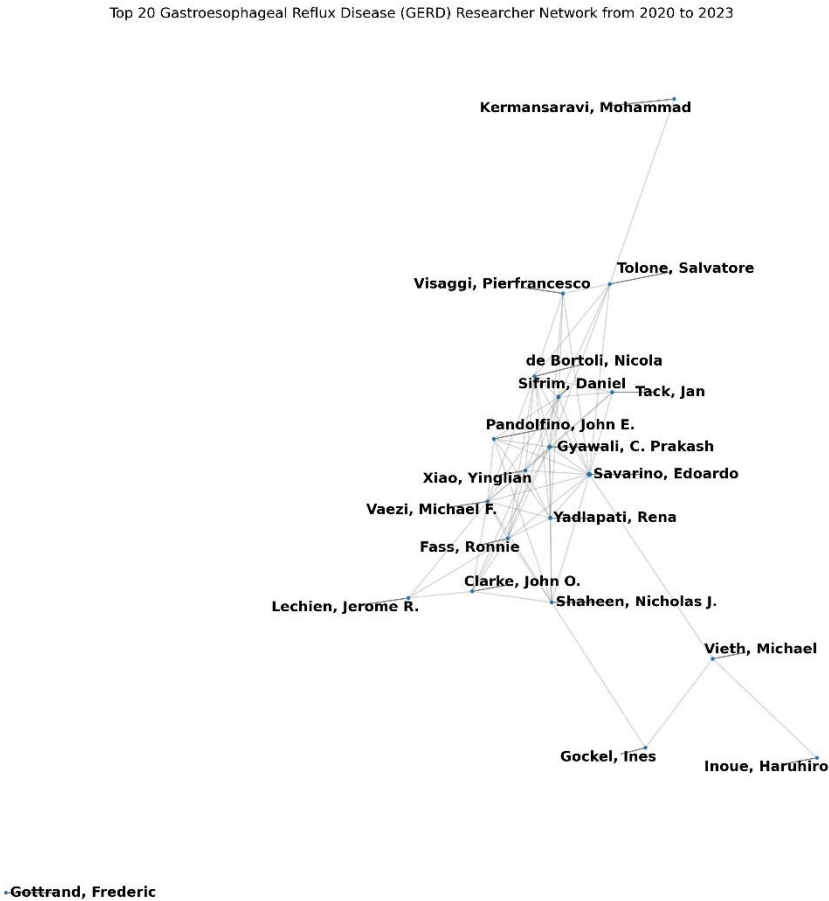


Figure 3. Top 20 Gastroesophageal reflux disease Researcher Network from 2020 to 2023.

At the micro level, the top authors by degree centrality, indicating the number of direct collaborations, included Savarino, Edoardo (0.0119), Gyawali, C. Prakash (0.0081), and Sifrim, Daniel (0.0081). These authors were highly influential in terms of their collaborative reach within the network (Table 2). Closeness centrality, which measures how quickly an author can connect with others, highlighted Savarino, Edoardo (0.1271), Gyawali, C. Prakash (0.1262), and Yadlapati, Rena (0.1226) as central figures (Table 3). Betweenness centrality, reflecting the extent to which an author serves as a bridge in the network, identified Savarino, Edoardo (0.0198), Gyawali, C. Prakash (0.0177), and Lin, Lin (0.0129) as key intermediaries facilitating connections between otherwise disconnected authors (Table 4).

Discussion

This study examined the structure of co-authorship networks in GERD research from 2000 to 2023, using data from the WoS Core Collection. The analysis revealed significant insights into the

collaborative landscape of GERD research, highlighting both the strengths and weaknesses of the existing network structures over time.

From 2000 to 2009, the GERD research co-authorship network displayed low connectivity, characterized by a sparse network with a density of only 0.000485. This suggests collaborative efforts were relatively limited, with most potential co-authorships remaining unrealized. Despite this, the clustering coefficient was relatively high at 0.879, indicating that when collaborations did occur, they were often within closely-knit groups of researchers. This high clustering tendency may suggest that collaborations were largely driven by small, focused research teams rather than extensive interdisciplinary or international collaborations. In the subsequent decade (2010-2019), the network density was 0.000514, indicating a relatively sparse network with limited collaborative efforts in GERD research. The average clustering coefficient was notably high at 0.898, suggesting that while collaborations existed, they were primarily within tightly knit research groups rather than across the broader network. The large number of components (2,492) and the infinite average path length indicate significant fragmentation within the network, with many researchers working in isolated subgroups without connections to the broader research community. During the most recent period (2020-2023), the co-authorship network showed a slight decline in density to 0.000414, reflecting a continued sparsity in collaborative connections. However, the average clustering coefficient increased to 0.921, indicating a trend towards even more closely connected clusters within the network, albeit without a substantial increase in overall interconnectedness. The number of components decreased to 2,172, reflecting a modest improvement in network integration, but the average distance remained infinite, highlighting persistent gaps between research groups.

Analyzing micro-level metrics revealed that researchers with a high degree centrality played pivotal roles in facilitating collaborations across different periods in GERD research. For instance, during 2000-2009, Dent, J (0.0114) and Malfertheiner, P (0.0097) were among the highest in degree centrality, emphasizing their influence in connecting researchers within the network. Similarly, from 2010-2019, Shaheen, Nicholas J. (0.0185) and De Giorgio, Roberto (0.0135) were key figures, and from 2020-2023, Savarino, Edoardo (0.0119) and Gyawali, C. Prakash (0.0081) emerged as central nodes. Their consistent presence underscores the central role these individuals played in fostering research connections across the years.

In terms of closeness centrality, Dent, J (0.1004) and Kahrilas, PJ (0.0988) were prominent during 2000-2009, suggesting their well-positioned roles within the network, which allowed them to effectively disseminate information and ideas. In 2010-2019, Gyawali, C. Prakash (0.1341) and Bredenoord, Albert J. (0.1334) stood out, while in 2020-2023, Savarino, Edoardo (0.1271) and Gyawali, C. Prakash (0.1262) maintained strong positions, indicating their ability to connect rapidly with other researchers. Betweenness centrality analysis identified several researchers as critical bridges within the network. For 2000-2009, Dent, J (0.0203) and Fass, R (0.0149) were key intermediaries, facilitating the flow of knowledge across otherwise disconnected groups. From 2010-2019, Verheij, J. (0.026) and Bredenoord, Albert J. (0.0240) played similar roles, and in 2020-2023, Savarino, Edoardo (0.0198) and Gyawali, C. Prakash (0.0177) acted as essential connectors, enhancing the overall connectivity of the GERD research community. The analysis indicates that while GERD research networks have become increasingly connected over time, evidenced by high clustering coefficients across all periods (0.879, 0.898, 0.921), there is still room for growth, particularly in fostering more global and interdisciplinary collaborations. The relatively low network densities (0.000485, 0.000514, 0.000414) and high number of components suggest that while the networks are interconnected, the overall percentage of realized collaborations remains limited, highlighting the potential for expanding research partnerships. The findings underscore the importance of key researchers who act as central nodes within the network. These individuals often drive the direction of research and significantly influence the development of collaborative projects. Efforts to encourage broader participation and integrate emerging researchers into the network could further enhance the robustness and reach of GERD research.

In conclusion, this study provides a comprehensive overview of the evolution of co-authorship networks in GERD research from 2000 to 2023. The findings highlight both progress and ongoing challenges in the field, emphasizing the need for continued efforts to foster collaboration and

integration within the GERD research community. By identifying key contributors and understanding the structural dynamics of research networks, this analysis offers valuable insights that can guide future collaborative initiatives and research strategies in GERD.

Conclusion

The co-authorship network analysis of GERD research from 2000 to 2023 reveals a sparse and fragmented collaborative landscape, with significant room for improvement in researcher cooperation and connectivity. Despite the global prevalence of GERD and its substantial impact on public health, the co-authorship network exhibited a consistently low density across all periods studied, indicating that only a small fraction of potential collaborations between researchers have been realized. Specifically, the network density remained below 0.001 in each period, demonstrating a vast number of unexploited collaborative opportunities.

The analysis highlighted a persistent trend of high clustering within smaller groups, as evidenced by average clustering coefficients exceeding 0.87 across all decades. This suggests that while authors tend to form tight-knit collaborative clusters, these clusters are largely isolated from one another, contributing to the overall disconnection of the network. The number of components consistently increased over time, reaching 2,172 in the 2020-2023 period, and the average path length between nodes remained infinite, indicating significant structural gaps and limited pathways for information flow across the broader network.

At the micro level, key researchers with high degree, closeness, and betweenness centrality scores were identified in each period, underscoring their pivotal roles in facilitating collaboration and information dissemination within their respective clusters. For example, in the most recent period (2020-2023), Savarino, Edoardo (Italy), Gyawali, C. Prakash (USA), and Sifrim, Daniel (UK) emerged as influential figures with extensive collaborative reach, as reflected by their high centrality metrics. However, the reliance on a limited number of central nodes for connectivity underscores the network's vulnerability to disruptions, as these key individuals serve as critical bridges in otherwise disconnected segments of the network.

The findings from this study underscore the need for enhanced collaborative efforts and broader integration among GERD researchers worldwide. Increasing inter-cluster collaborations could significantly improve the cohesion of the network, facilitating more efficient knowledge sharing and accelerating scientific advancements in GERD research. As the prevalence of GERD continues to rise globally, particularly in Asia, fostering robust international collaborations and expanding the network's connectivity will be crucial for addressing the complex challenges associated with this condition. Ultimately, this study highlights the evolving landscape of GERD research collaboration and provides a roadmap for strategic efforts to strengthen the global research network in this field.

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Conflicts of Interest: none.

Abbreviations

GERD, Gastroesophageal Reflux Disease; WoS, Web of Science; IDE, Integrated Development Environment

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