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ORIGINAL RESEARCH

Artificial Intelligence in Chronic Obstructive Pulmonary Disease: Research Status, Trends, and Future Directions –A Bibliometric Analysis from 2009 to 2023

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Objective: A bibliometric analysis was conducted using VOSviewer and CiteSpace to examine studies published between 2009 and 2023 on the utilization of artificial intelligence (AI) in chronic obstructive pulmonary disease (COPD).

Methods: On March 24, 2024, a computer search was conducted on the Web of Science (WOS) core collection dataset published between January 1, 2009, and December 30, 2023, to identify literature related to the application of artificial intelligence in chronic obstructive pulmonary disease (COPD). VOSviewer was utilized for visual analysis of countries, institutions, authors, co-cited authors, and keywords. CiteSpace was employed to analyze the intermediary centrality of institutions, references, keyword outbreaks, and co-cited literature. Relevant descriptive analysis tables were created using Excel2021 software.

Results: This study included a total of 646 papers from WOS. The number of papers remained small and stable from 2009 to 2017 but started increasing significantly annually since 2018. The United States had the highest number of publications among countries/regions while Silverman Edwin K and Harvard Medical School were the most prolific authors and institutions respectively. Lynch DA, Kirby M. and Vestbo J. were among the top three most cited authors overall. Scientific Reports had the largest number of publications while Radiology ranked as one of the top ten influential journals. The Genetic Epidemiology of COPD (COPDGene) Study Design was frequently cited. Through keyword clustering analysis, all keywords were categorized into four groups: epidemiological study of COPD; AI-assisted imaging diagnosis; AI-assisted diagnosis; and AI-assisted treatment and prognosis prediction in the COPD research field. Currently, hot research topics include explainable artificial intelligence framework, chest CT imaging, and lung radiomics.

Conclusion: At present, AI is predominantly employed in genetic biology, early diagnosis, risk staging, efficacy evaluation, and prediction modeling of COPD. This study's results offer novel insights and directions for future research endeavors related to COPD.

Keywords: chronic obstructive pulmonary disease, artificial intelligence, visual analysis, bibliometric analysis

Introduction

Chronic obstructive pulmonary disease (COPD), which affects over 392 million individuals worldwide, ranks as the third leading cause of death globally. It also stands as the fifth most burdensome disease from a societal perspective.[1,2] Given the recent outbreak of the new coronavirus pandemic, continuous assessment of lung function damage among high-risk groups such as the elderly remains crucial.[3] This undoubtedly exacerbates the deterioration of elderly patients with COPD, making early detection, accurate diagnosis, and intervention crucial for reducing disease burden and mortality. Pulmonary function

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tests (PFTs) are the primary criteria for diagnosing and stratifying COPD risk but are underutilized in primary care settings due to limited access and expertise in performing and interpreting lung function tests.[4] It is estimated that nearly half of adults have undiagnosed COPD. In the context of precision medicine, precise diagnosis has become paramount. Artificial intelligence (AI) has rapidly advanced in disease diagnosis, treatment, and prognosis prediction with machine learning, deep learning, and neural networks showing promising application prospects in COPD.[5] Kaplan[6] and Exarchos[7] et al have demonstrated the significant value of AI from disease diagnosis to outcome prediction and management by providing medical professionals with a better understanding of its application at various stages of COPD.

Bibliometrics is a scientific method that employs statistics, mathematics, and other measurement techniques to explore big data within disciplines while visualizing research status and hotspots through maps.[8] Currently utilized by many researchers in analyzing oncology,[9] radiology,[10] and endocrinology,[11] bibliometric analysis on AI applied to COPD remains unexplored. This study utilizes VOSviewer and CiteSpace software to conduct a metrological analysis of literature regarding AI studies in COPD from 2009 to 2023 aiming to enhance researchers' comprehension of current research status as well as hotspots concerning AI applications in COPD thereby improving clinical translation rates.

Methods

Paper Retrieval and Data Extraction

The Web of Science (WOS) core collection database was computer-searched on 2024–03-24. The search query used was TS=("COPD" OR "chronic obstructive pulmonary disease*") AND ("artificial intelligence" OR "neural network*" OR "deep learning" OR "natural language processing" OR "machine learning"). The document language was limited to English, and a comprehensive search method using keywords, subject words, and free words was employed.[12] Initially, 924 literature items were selected from 2009 to 2023, resulting in obtaining 889 literature items. Finally, the types of

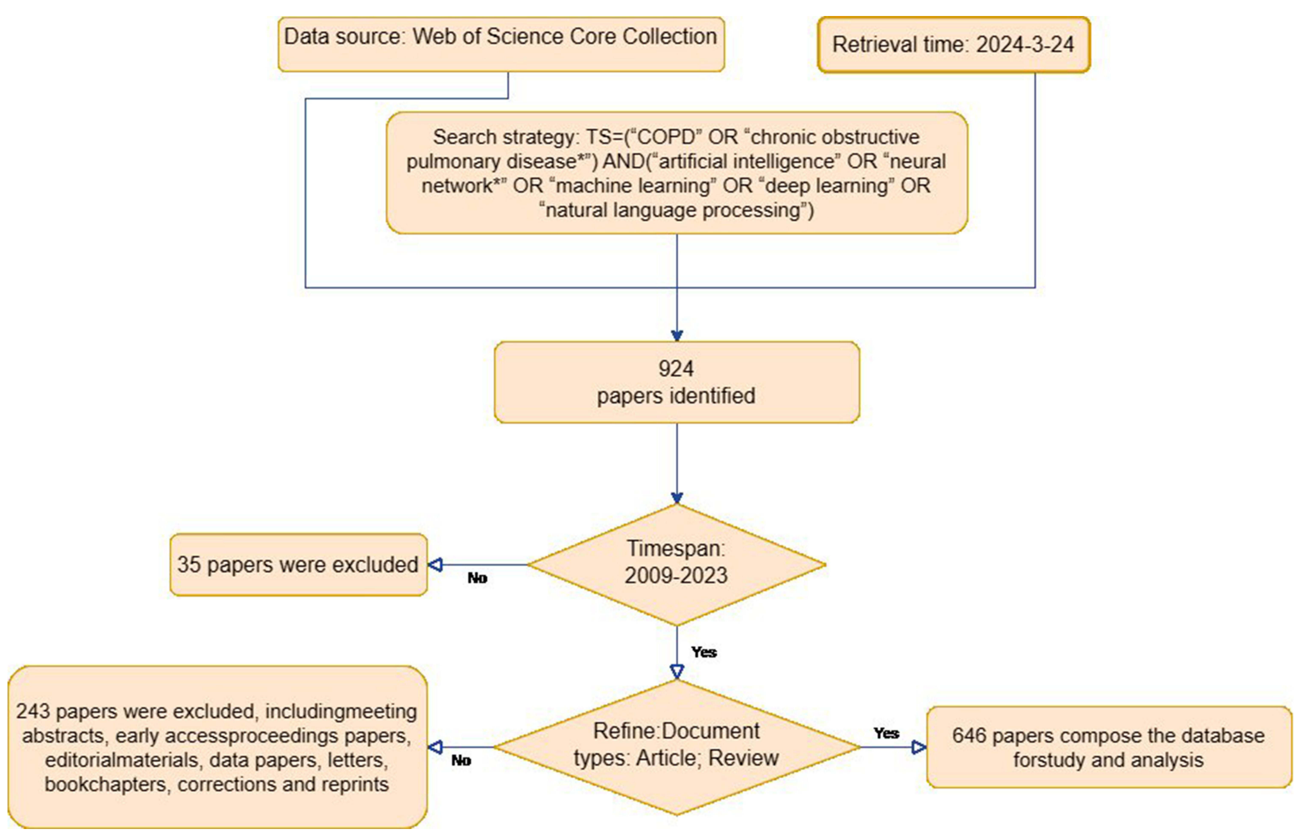

Figure 1 Includes the flow chart of the article.

literature were restricted to articles and reviews, leading to the inclusion of 646 literature items (10 of which were first published online in 2023). Figure 1 illustrates the flow chart depicting the included articles.

Bibliometric Analysis

In this study, bibliometric and visual analyses were conducted using VOSviewer (version 1.6.20) and CiteSpace (version 6.3.1). Before data analysis, de-processing resulted in including a total of 646 papers. In VOSviewer and CiteSpace visualization analysis, nodes, colors, lines, etc., represent different meanings: nodes represent research objects such as countries, authors, institutions, etc.; node size indicates paper count or influence; circles around nodes indicates corresponding citation rings with thicker rings representing more citations; lighter color signifies more recent citation time; lines between nodes denote existing cooperative relationships with thicker lines indicating closer relationships. Additionally, relevant descriptive analysis charts have been created using Microsoft Excel (version 2021) and Drae.io.

Results

Annual Publication Trends

Among the 646 literature sources, 587 (84.8%) were categorized as Discussion articles, while 59 (15.2%) were classified as reviews. Before 2017, the number of published papers was relatively low with a slow growth rate; however, since 2018, there has been a significant increase in publications, reaching a total of 177 in 2023 – approximately twenty times that of the year 2017 (Figure 2). The polynomial fitting analysis yielded R^2 =0.9636, indicating a strong indication for continued rapid growth in this field's literature output in the future.

Country Analysis

A total of seventy countries or regions have contributed to publications within this field; among them, thirty-one countries or regions have published more than six papers each. Notably, only the United States and China have surpassed one hundred publications individually. Table 1 provides an overview of the top ten countries or regions based on publication volume from years spanning between 2009 and 2023: ranking first is the United States with 206 articles followed by China (108 articles), the United Kingdom(56articles), India(50 articles) and Germany(49articles) respectively. The cumulative citation count for these top five countries or regions are as follows: United States (3125 citations), United Kingdom (993 citations), Germany(824 citations), China(782 citations) and Spain (781 citations). To analyze international collaboration patterns, the VOS viewer software was employed (Figure 3). The leading contributors to collaborative research networks are identified as being from the United States, the United Kingdom, Germany, the Netherlands, and Switzerland. Thicker lines connecting nodes indicate closer cooperation and higher Total Link Strength (TLS).

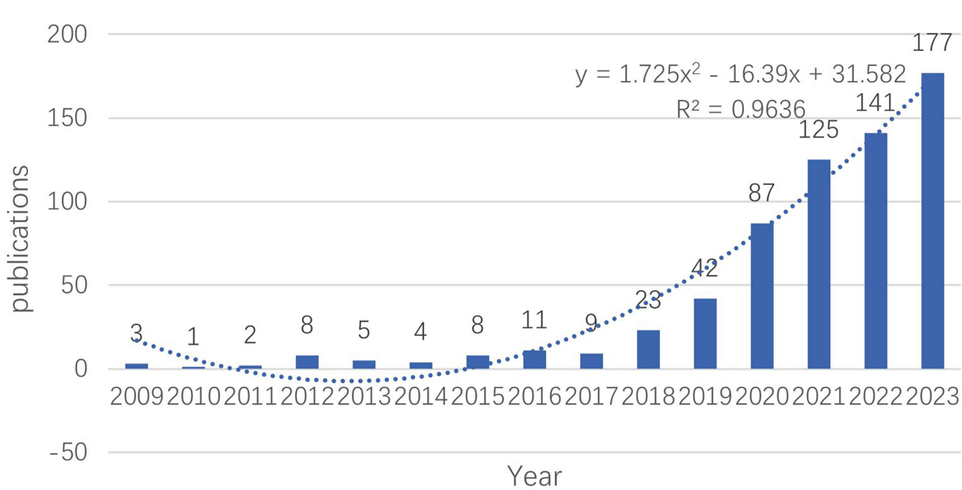

Figure 2 Trends in the application of AI to COPD literature from 2009 to 2023.

Table 1 The Top 10 Countries in Terms of Number of Publications from 2009 to 2023

sequence	Country (region)	Publications	Total citations	Average Article Citations	TLS
1	United States	206	3125	15.17	143
2	China	108	782	7.24	49
3	United Kingdom	56	993	17.73	95
4	India	50	471	9.42	17
5	Germany	49	824	16.82	90
6	Netherlands	39	614	15.74	87
7	Spain	35	781	22.31	53
8	Canada	33	402	12.18	41
9	Italy	28	287	10.25	37
10	Korea	28	267	9.54	18

Institution Analysis

A total of 1466 institutions were engaged in research on the application of AI to COPD, with 57 of them having more than five published articles. The top three institutions in terms of publications were Harvard Medical School (31), the University of Iowa (21), and Brigham and Women's Hospital (20) (refer to Table 2). Figure 4 presents an atlas illustrating institutional collaboration networks with more than five publications, where Harvard Medical School (TLS: 56), Brigham and Women's Hospital (TLS: 45), and National Jewish Medical Center (TLS: 39) emerged as the leading institutions. Intermediary centrality serves as an indicator for assessing the significance of nodes within the network.[13] Figure 5 displays intermediary centrality among institutions in this field. Institutions exhibiting high levels of intermediary centrality include the Network Biomedical Research Centres (CIBER) Consortium (0.20), the University of Sydney

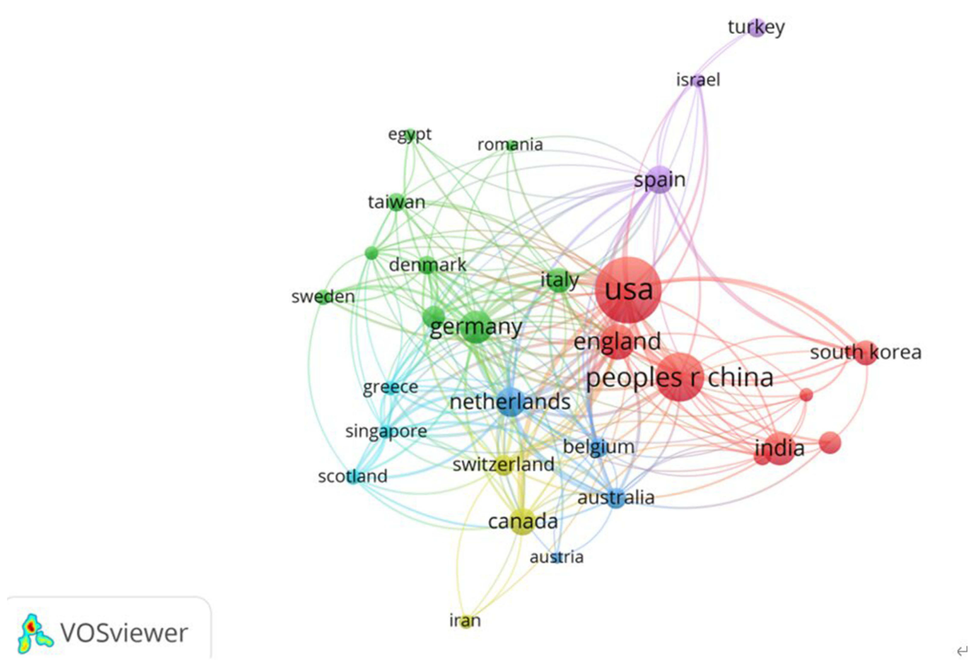

Figure 3 Mapping of collaborative networks among countries (regions).

Table 2 The Top 10 Organizations in Terms of Publication Volume from 2009 to 2023

sequence	Institution	Country (region)	Publications	Total citations	Average Article Citations	TLS
1	Harvard Medical School	United States	31	408	13.16	56
2	The University of Iowa	United States	21	404	19.24	32
3	Brigham and Women's Hospital	United States	20	348	17.40	45
4	Northeastern University	United States	19	211	11.11	17
5	National Jewish Health	United States	16	378	23.63	39
6	University of Washington	United States	14	213	15.21	20
7	University of Michigan	United States	13	308	23.69	28
8	University of Colorado	United States	12	264	22.00	24
9	University of California San Diego	United States	11	69	6.27	13
10	University of Toronto	Canada	11	172	15.64	12

(0.17), the University of Switzerland (0.17), the University of Toronto (0.15), the University of California System (0 0.13), Cornell University(0 0.13) and Ecole Polytechnique Fédérale de Lausanne (EPFL) (0 0.13). These entities play a pivotal role in research within this domain.

Bibliometric Analysis of Journal

A total number of 646 articles were published in 322 journals, with 28 journals shaving ≥5 publications. The top 10 journals accounted for 127 papers or 19.7% of the total. Scientific Reports published the most articles with 22. The average citation rate in the Journal of Medical Internet Research was highest at 23.11/article. Radiology had the highest impact factor of 19.7 in 2023 (as illustrated in Table 3). The American Journal of Respiratory and Critical Care Medicine was the most cited journal with 1086 citations, followed by the European Respiratory Journal (831) citations and the Chest Journal (634) (as illustrated in Table 4).

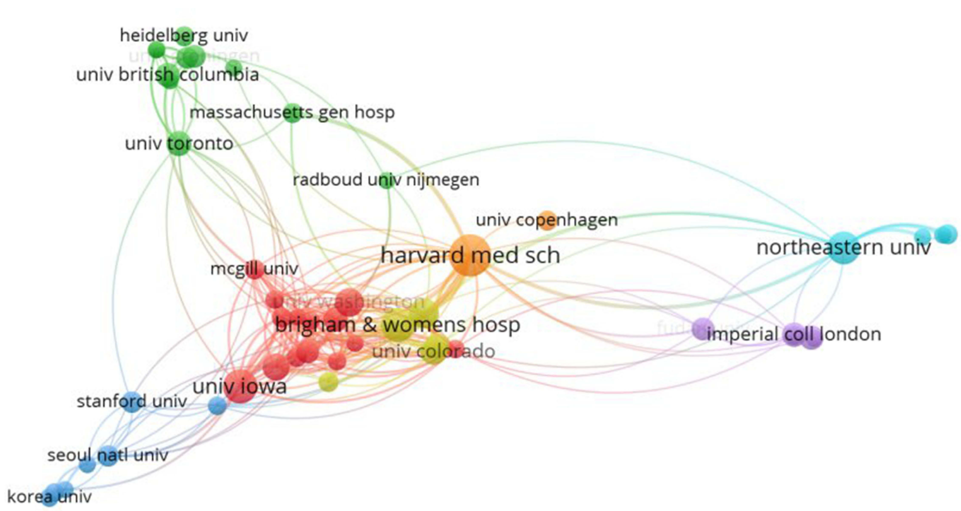

Figure 4 Inter-agency cooperation chart.

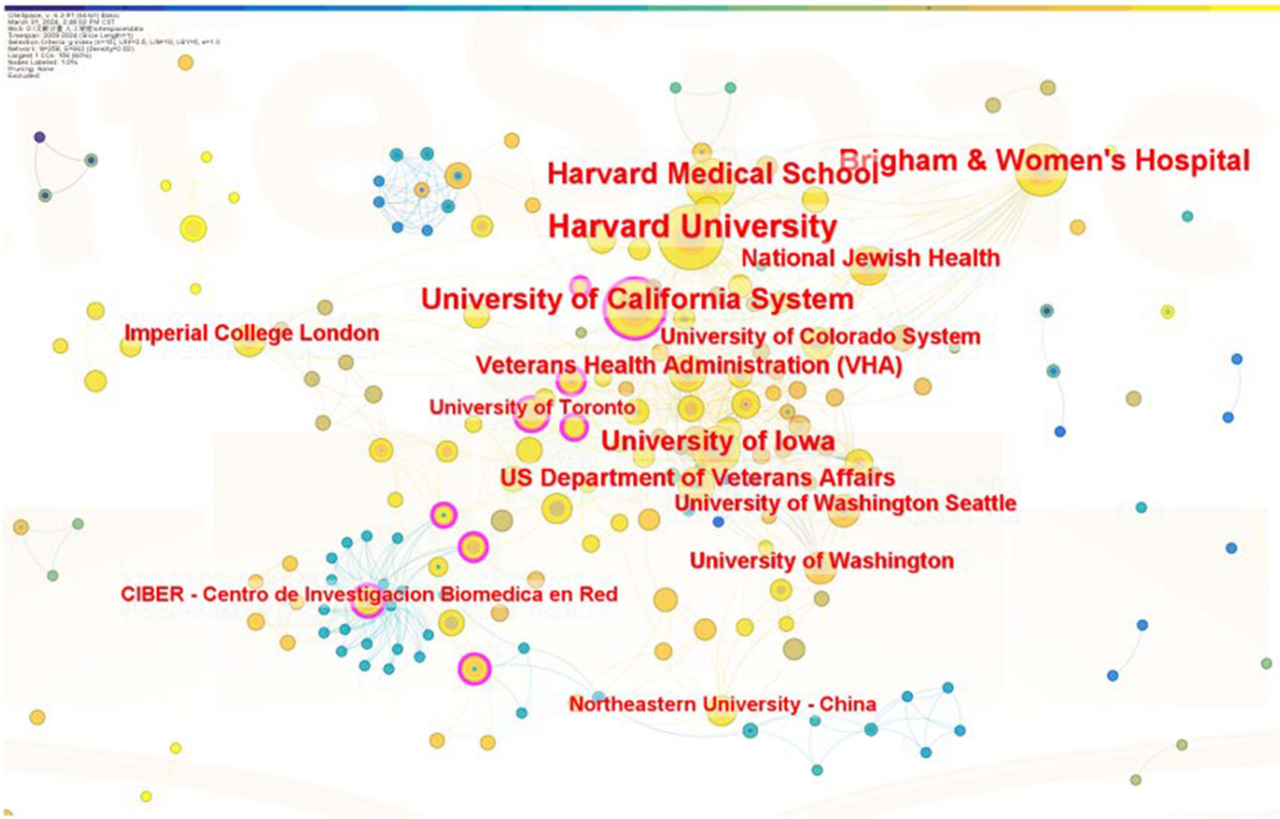

Figure 5 Mapping of intermediation centrality among institutions.

Author and Co-Cited Author Analysis

A total of 3924 authors and 17,960 co-citations were involved in research in this area. The number of publications and citation times of the top 10 authors are presented in Table 5. Among them, Edwin K Silverman published the highest

Table 3 10 Journals with the Highest Number of Publications from 2009 to 2023

Sequence	Journal	Country (region)	Publications	Total citations	Average Article Citations	TLS	IF
1	Scientific Reports	United Kingdom	22	271	12.32	77	4.6
2	PLOS One	United States	18	332	18.44	28	3.7
3	Sensors	Switzerland	12	266	22.17	27	3.9
4	IEEE Access	United States	12	131	10.92	41	3.9
5	International Journal of Chronic Obstructive Pulmonary Disease	United Kingdom	12	112	9.33	50	2.8
6	Diagnostics	Sweden	12	76	6.33	50	3.6
7	IEEE Journal of Biomedical and Health Informatics	United States	11	254	23.09	46	7.7
8	Computer Methods and Programs in Biomedicine	Netherlands	11	178	16.18	101	6.1
9	Journal of Medical Internet Research	Canada	9	208	23.11	34	7.3
10	Radiology	United States	8	184	23.00	38	19.7

Table 4 The Top 10 Journals with Total Citations from 2009 to 2023

Sequence	Journal	Country (region)	Co-citations	TLS	IF	JCR partition
1	American Journal of Respiratory and Critical Care Medicine	United States	1086	29,815	24.7	Q1
2	European Respiratory Journal	United Kingdom	831	20,898	24.3	Q1
3	Chest	United States	634	16,708	9.6	Q1
4	Radiology	United States	444	16,067	19.7	Q1
5	Thorax	United Kingdom	428	13,015	10	Q1
6	PLOS One	United States	416	8383	3.7	Q3
7	New England Journal of Medicine	United States	393	10,495	158.5	Q1
8	International Journal Of Chronic Obstructive Pulmonary Disease	United Kingdom	390	9385	2.8	Q3
9	Expert Review Of Respiratory Medicine	United States	302	8277	3.9	Q3
10	Lancet	United Kingdom	296	6580	168.9	Q1

Table 5 The Top 10 Authors in Terms of Publication Volume and Total Citation Times from 2009 to 2023

Sequence	Author	Publications	Co-cited author	Number of co-citations
1	Silverman, Edwin K	13	Lynch, Da	70
2	Hoffman, Eric A	12	Kirby, M	69
3	Cho, Michael H	10	Yestbo, J	62
4	Estepar, Raul San Jose	10	Regan, Ea	61
5	Castaldi, Peter J	8	Amaral, Jlm	50
6	Reinhardt, Joseph M	7	Bhatt, Sp	50
7	Washko, George R	7	Celli, Br	49
8	Comellas, Alejandro P	6	Rabe, Kf	46
9	Li Wei	6	Breiman, l	44
10	Lynch, David A	6	Hurst, Jr	42

number of articles (13 pieces), followed by Eric A. Hoffman (12 pieces) and Michael H. Cho (10 pieces). The most frequently cited authors are Da Lynch (70 citations), M Kirby (69 citations), and J Vestbo (62 citations). Figure 6 illustrates that the research is primarily divided into small groups comprising independent authors with no evidence of multi-center collaborative research. Figure 7 displays the cooperative relationships among co-cited authors.

Reference Analysis

There were a total of 23,977 references, out of which only seventeen were cited more than twenty times. Detailed information can be found in Table 6 where the top ten references are listed based on their co-citations. Among these references, 《Genetic Epidemiology of COPD (COPD Gene) Study Design》was cited the most frequently (49 times),

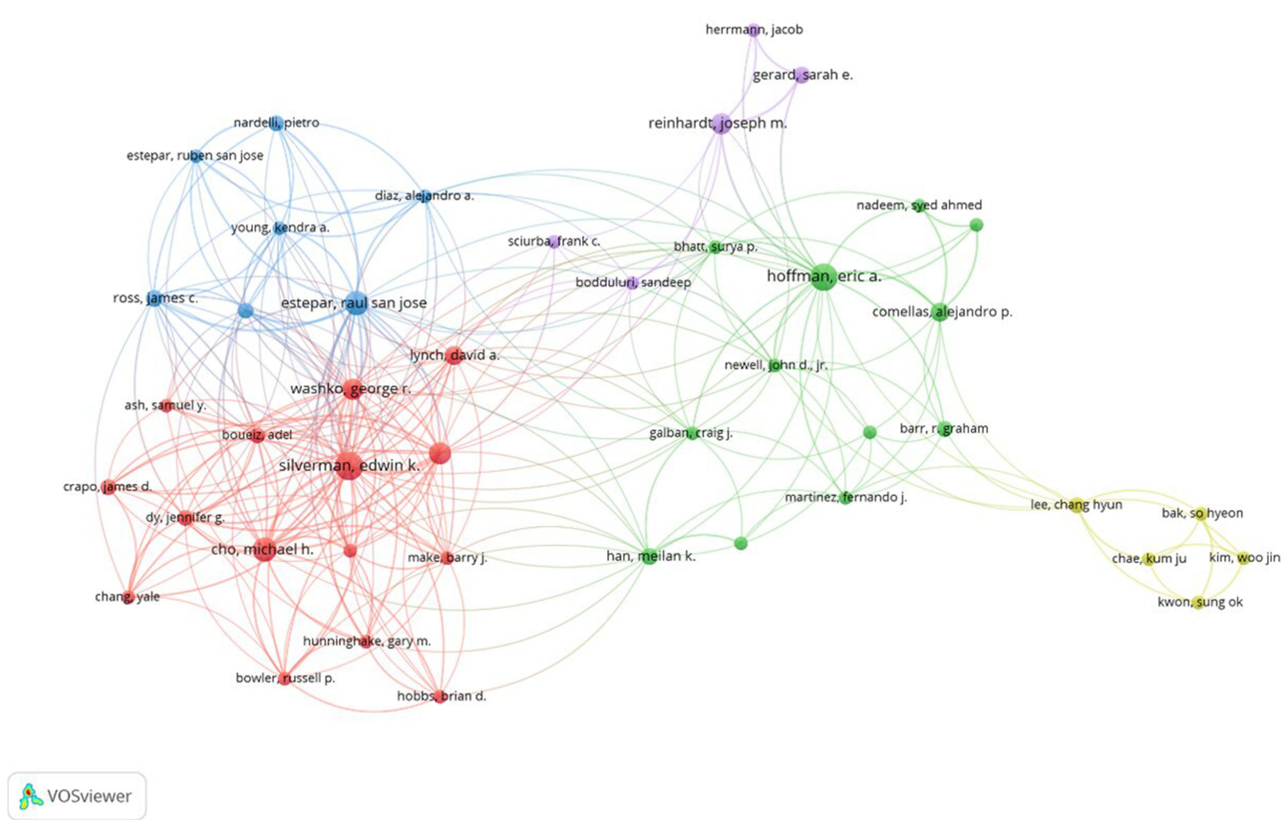

Figure 6 Cooperation diagram between authors.

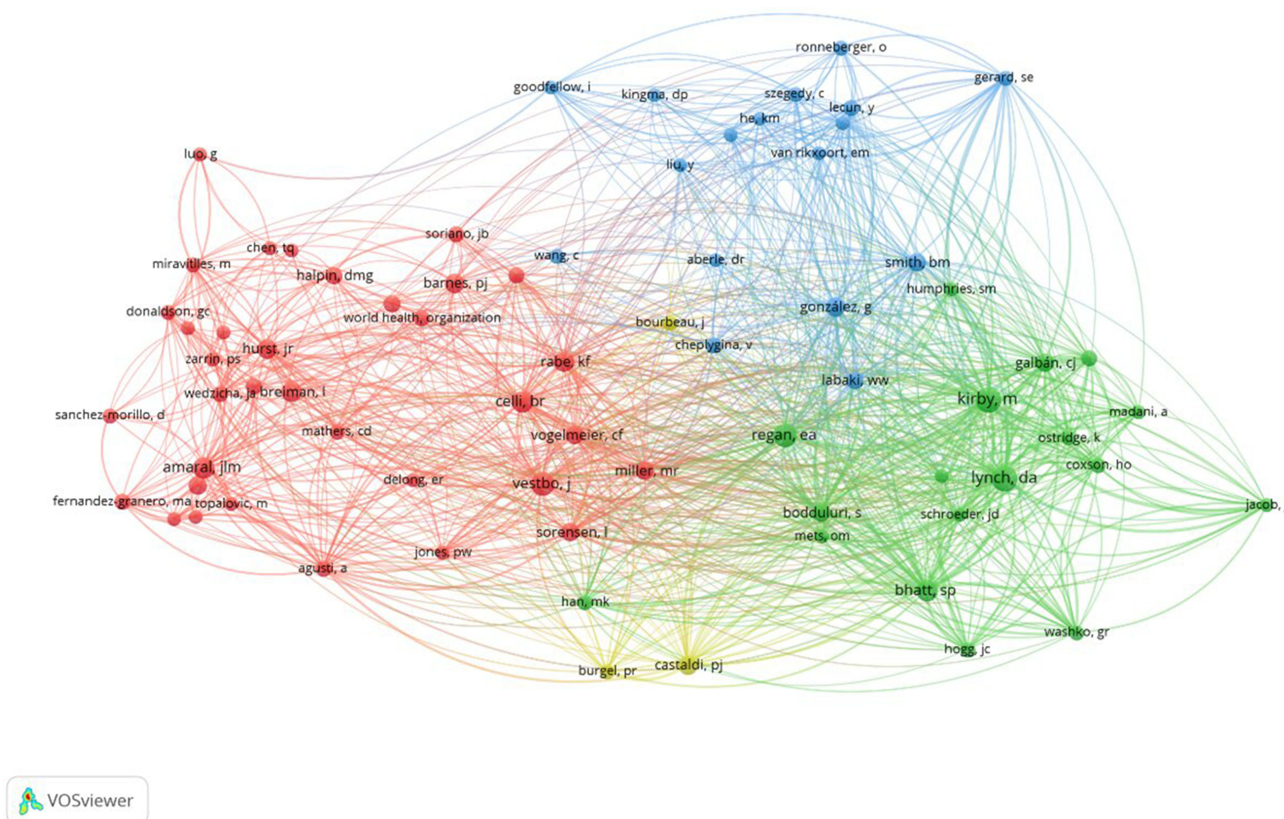

Figure 7 Cooperation diagram among co-cited authors.

Table 6 References with the Top 10 Cited Times

Sequence	Reference	Journal	Author	Co-citations	TLS
1	Genetic Epidemiology of COPD (COPDGene) Study Design	COPD	Elizabeth A Regan	49	80
2	CT-Deffnable subtypes of chronic Obstructive Pulmonary Disease: A Statement of the Fleischner Society	Radiology	Lynch DA	38	70
3	Disease Staging and Prognosis in Smokers Using Deep Learning in Chest Computed Tomography	Am J Respir Crit Care Med	Germán González	36	64
4	Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease GOLD Executive Summary	Am J Respir Crit Care Med	Vestbo J	33	51
5	Computed tomography-based biomarkers provide unique signatures for the diagnosis of COPD phenotypes and disease progression	Nature Medicine	Craig J Galbán	32	52
6	Series "ats/ers task force: standardization of lung function testing"	Eur Respir j	Miller Mr	28	38
7	Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease	Am J Respir Crit Care Med	Vestbo J	28	28
8	Random Forests	Machine Learning	Breiman l	24	18
9	Projections of Global Mortality and Burden of Disease from 2002 to 2030	PLOS Med	Mathers CD	24	34
10	Comparing the Areas under Two or More Correlated Receiver Operating Characteristic Curves: A Nonparametric Approach	Biometrics	DeLong ER	23	24

followed by 《CT-Defined subtypes of chronic Obstructive Pulmonary Disease: A Statement of the Fleischner Society》 (38 times) and《Disease Staging and Prognosis in Smokers Using Deep Learning in Chest Computed Tomography》 (36 times). Since most literature falls within the timeframe from 2018 to 2023, we conducted a cluster analysis solely on literature cited during these last six years resulting in ten clusters being identified. These clusters encompass various aspects related to COPD diagnosis and staging such as Deep Convolution Neural Network, Interpretable Artificial Intelligence Framework, Chest CT Scans, Lung Imaging Omics Analysis, and Digital Lung Auscultation. Figure 8 provides an overview of these clusters while Figure 9 depicts a timeline graph highlighting current research hotspots focusing mainly on interpretable artificial intelligence frameworks along with chest CT scans and lung imaging omics analyses. It should be noted that deep neural convolutional network models have been a prominent research hotspot since the early stages. Lastly, Figure 10 shows cases of seventeen standout references within this field demonstrating a rapid increase in citations since year-2018 indicating that AI in the field of COPD diagnosis and treatment is still a research hotspot in the next few years.

Keywords Analysis

The total number of keywords was 2783, with 34 keywords appearing more than 20 times. After excluding keywords such as COPD and artificial intelligence, Table 7 presents the top ten frequently occurring keywords, where Classification, Diagnosis, and Asthma rank highest. VOSviewer was utilized to generate a keyword co-occurrence network map (Figure 11). The keywords were categorized into four clusters represented by different colors (Table 8), with red indicating genetic biology research on COPD. Keywords in this category included COVID-19, burden, management, mortality, prevalence, among others. Blue represents AI-assisted imaging diagnosis of COPD, involving

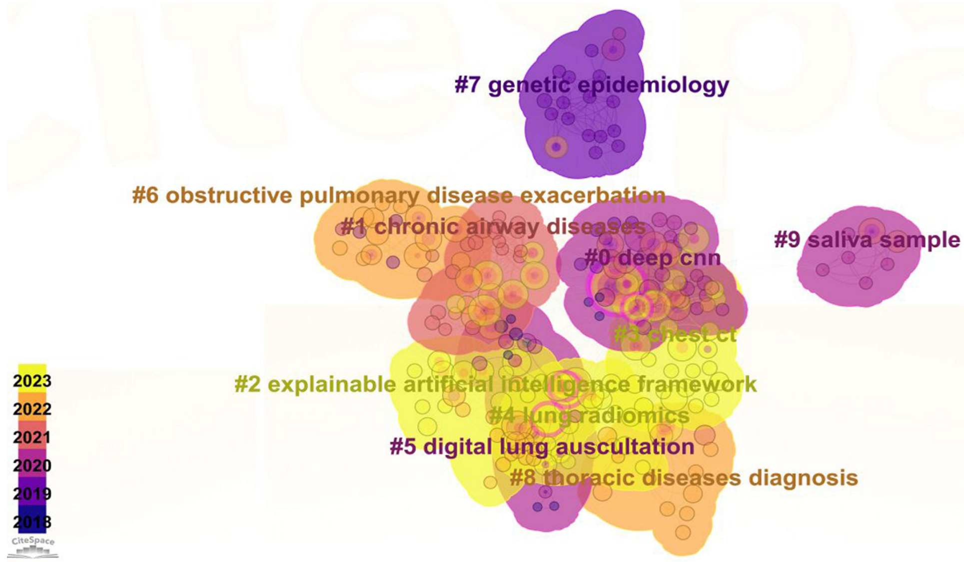

Figure 8 Clustering analysis of co-cited literature in the last 6 years.

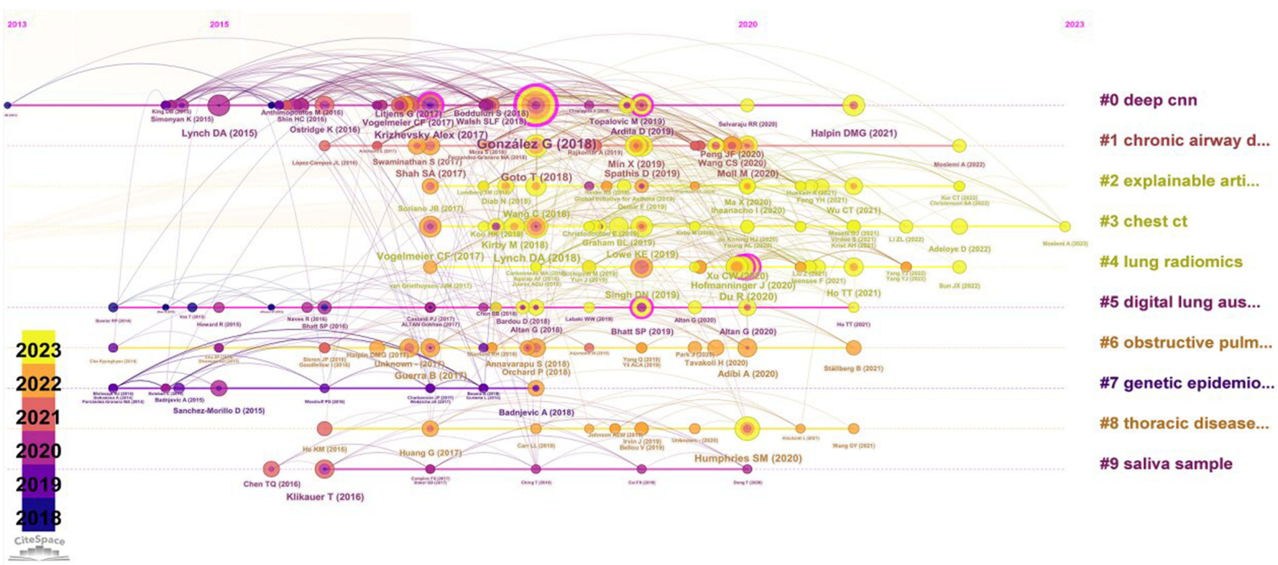

Figure 9 Co-cited literature clustering timeline.

keywords COPD, computed tomography, CT, segmentation, etc. Green signifies AI-assisted diagnosis of COPD with keywords chronic obstructive pulmonary disease, diagnosis, deep learning, feature extraction, and spirometry involved. Yellow denotes AI-assisted treatment and prognosis prediction of COPD including chronic obstructive pulmonary disease, exacerbations, model, prediction, machine learning as relevant terms. Figure 12 displays the keyword overlay diagram where yellow nodes represent emerging keywords suggesting current research hotspots. Notably, Validation, impact, association, COVID-19, smokers, computed tomography, and models have been frequently observed in recent years indicating potential future research hotspots in this field. Figure 13 illustrates the prominence of the top 25 keywords which have experienced rapid growth since 2017; many continue to appear frequently in recent years signifying that artificial intelligence remains a prominent research hotspot for COPD diagnosis and treatment in the coming years.

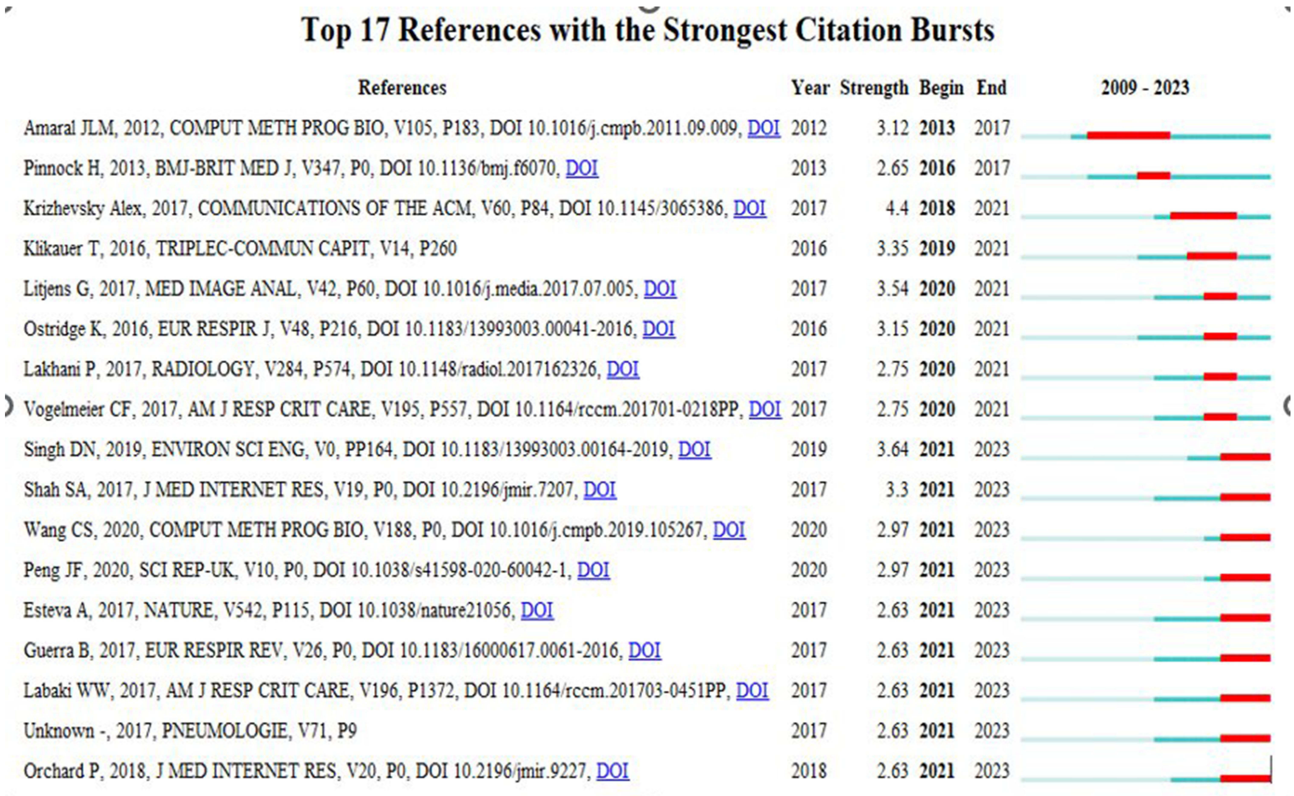

Figure 10 The top 17 references for explosive power in 2009–2023.

Discussion

In this study, a total of 646 publications from 2009 to 2023 were visually evaluated using VOSviewer1.6.20 and CiteSpace6.3.1 software, and the research status, research hotspot, and AI development trend in the field of COPD were reviewed. According to the statistical findings of the number of published articles, the literature on this subject has seen exponential development since 2018, and the polynomial fitting result is R2 =0.9636, implying that the literature's

Table 7 Top 10 Keywords with Frequency from 2009 to 2023

Sequence	Keywords	Occurrence Frequency	TLS
1	COPD	239	695
2	machine learning	184	516
3	chronic obstructive pulmonary disease	105	336
4	obstructive pulmonary disease	101	330
5	classification	79	275
6	diagnosis	78	248
7	asthma	71	216
8	artificial intelligence	63	199
9	emphysema	63	247
10	deep learning	57	185

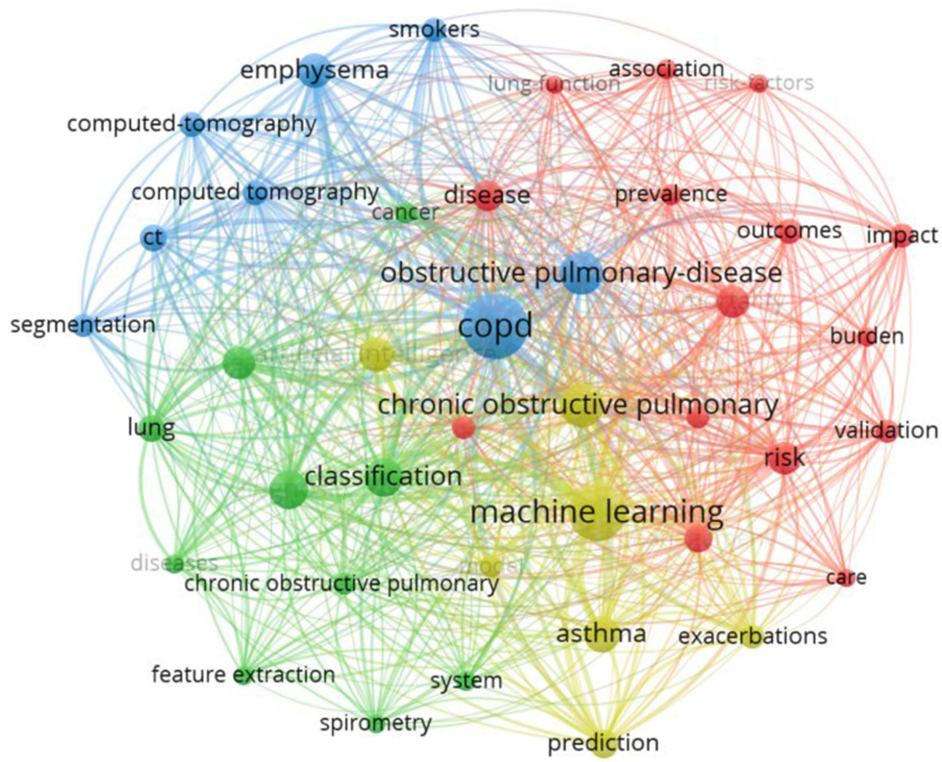

Figure 11 Co-occurrence mapping of keywords.

growth rate will continue in the future. The United Kingdom, Germany, the Netherlands, and Spain are all in the top ten for both the number of publications and the average number of citations, demonstrating that scientists from these four countries play a prominent role in the field of study. Although there are not many publications in Turkey, they are the most referenced, reflecting the excellent quality of Turkish articles in this discipline. China ranks second in the number of publications in the field, trailing only the United States; however, China's literature is cited far less on average than many other countries, including Turkey, Norway, Israel, and Spain, which could be attributed to China's late start in AI research, resulting in lower academic impact of its research findings. As a result, Chinese scholars should focus on increasing the quality and impact of their research.

According to the TLS (Transnational Cooperation Index), the United States, the United Kingdom, Germany, and the Netherlands frequently collaborate with other countries (regions), and Chinese scholars should strengthen ties with developed countries in Europe and the United States to promote development in this field. Nine of the top ten institutions with the most publications are from the United States, with Harvard Medical School ranking first in total citations and TLS, indicating its significant contributions to the field and extensive collaboration with other institutions. Harvard Medical School's study focuses on COPD genetics and the application of artificial intelligence to predict COPD.

According to a VOSviewer analysis of the authors, Edwin Kepner Silverman, MD, from Harvard Medical School emerged as the top author. He holds the position of Chief at the Channing Division of Network Medicine and serves as

Table 8 Keywords Clustering of Artificial Intelligence in the COPD Field

Cluster	Color	Keyword
1	Green	chronic obstructive pulmonary disease, diagnosis, deep learning, feature extraction, spirometry, system
2	Blue	COPD, computed tomography, CT, segmentation
3	Red	COVID-19, burden, management, mortality, prevalence, risk
4	yellow	COPD, exacerbations, model, prediction, machine learning

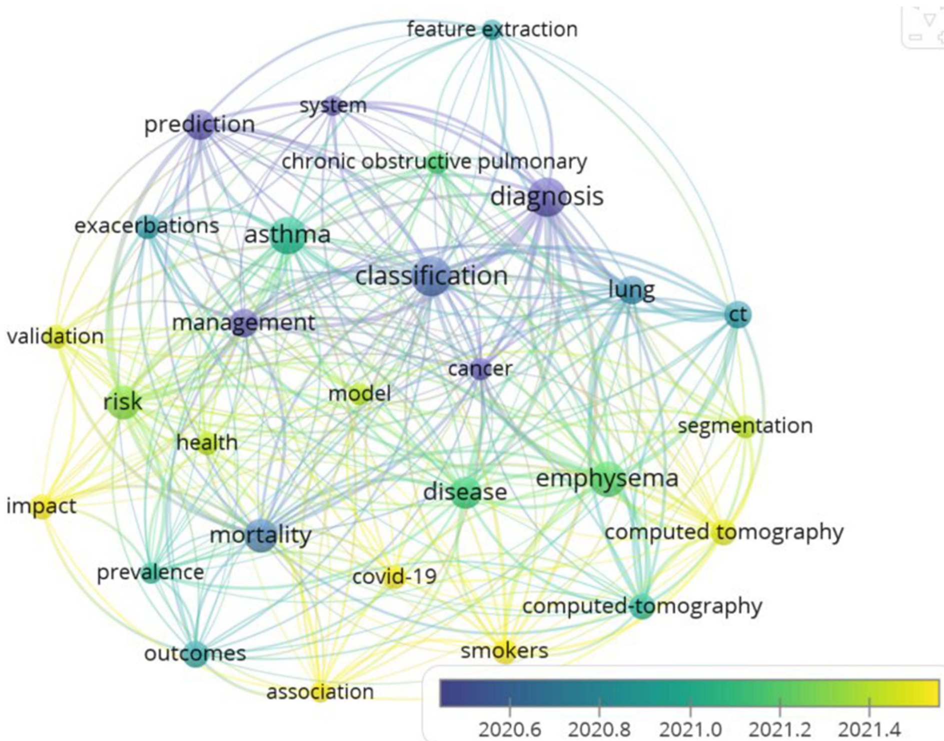

Figure 12 Mapping of keywords overlay.

a physician at Brigham and Women's Hospital (BWH). His research primarily focuses on COPD gene investigation. Eric A. Hoffman, PhD, from the University of Minnesota secured second place with his primary research area being advanced imaging Methods in respiratory physiology. Michael H. Cho, MD, specializing in genetic epidemiology and COPD at Brigham and Women's Hospital ranked third on the list. The authors highlight that Edwin Kepner Silverman acts as a central hub in this network map due to his prolific output and high-quality articles. In summary, studying COPD gene levels is expected to be an upcoming hotspot for future research.

The top 10 cited literature reflects the current trend in applying artificial intelligence to diagnose and treat chronic obstructive pulmonary disease (COPD), with most studies focusing on COPD diagnosis and model prediction. Among these publications is "Genetic Epidemiology of COPD (COPDGene) Study Design", which is a multicenter observational study aimed at identifying genetic factors associated with COPD; it has received significant co-citations.[14] Another notable paper titled "CT-Deffnable subtypes of chronic Obstructive Pulmonary Disease: CT-Deffnable Subtypes of chronic obstructive pulmonary Disease: A Statement by Fleischner Society" utilizes quantitative CT scans to identify emphysema-induced pulmonary destruction degree changes in airway walls and expiratory retention while defining specific CT phenotypes for personalized treatment approaches for patients with COPD.[15] The temporal graph depicting co-cited literature clusters can illustrate changing trends within research frontiers. The deep neural convolutional network model has emerged as a prominent research area,[16] followed by a shift in focus toward chest CT[17] and lung radionics.[18]

Based on the statistical analysis of published documents, we conducted keyword clustering in two distinct periods. The first period spanned from 2009 to 2017, during which there was a gradual increase in publications. The primary research emphasis revolved around the classification and diagnosis of COPD, aiming to provide clinical decision support. Diagnosis primarily relied on identifying emphysema; however, the methods employed were limited to small sample sizes. AI research about other respiratory diseases also predominantly focused on disease diagnosis.[19,20] The second period spans from 2018 to 2023, witnessing a rapid annual increase in publications with computer-aided diagnosis emerging as the main research direction. Feature extraction has become the most frequently utilized deep-learning method for COPD recognition,[21] risk classification,[22] and CT diagnosis.[23] Additionally, random forest models,[24] logistic

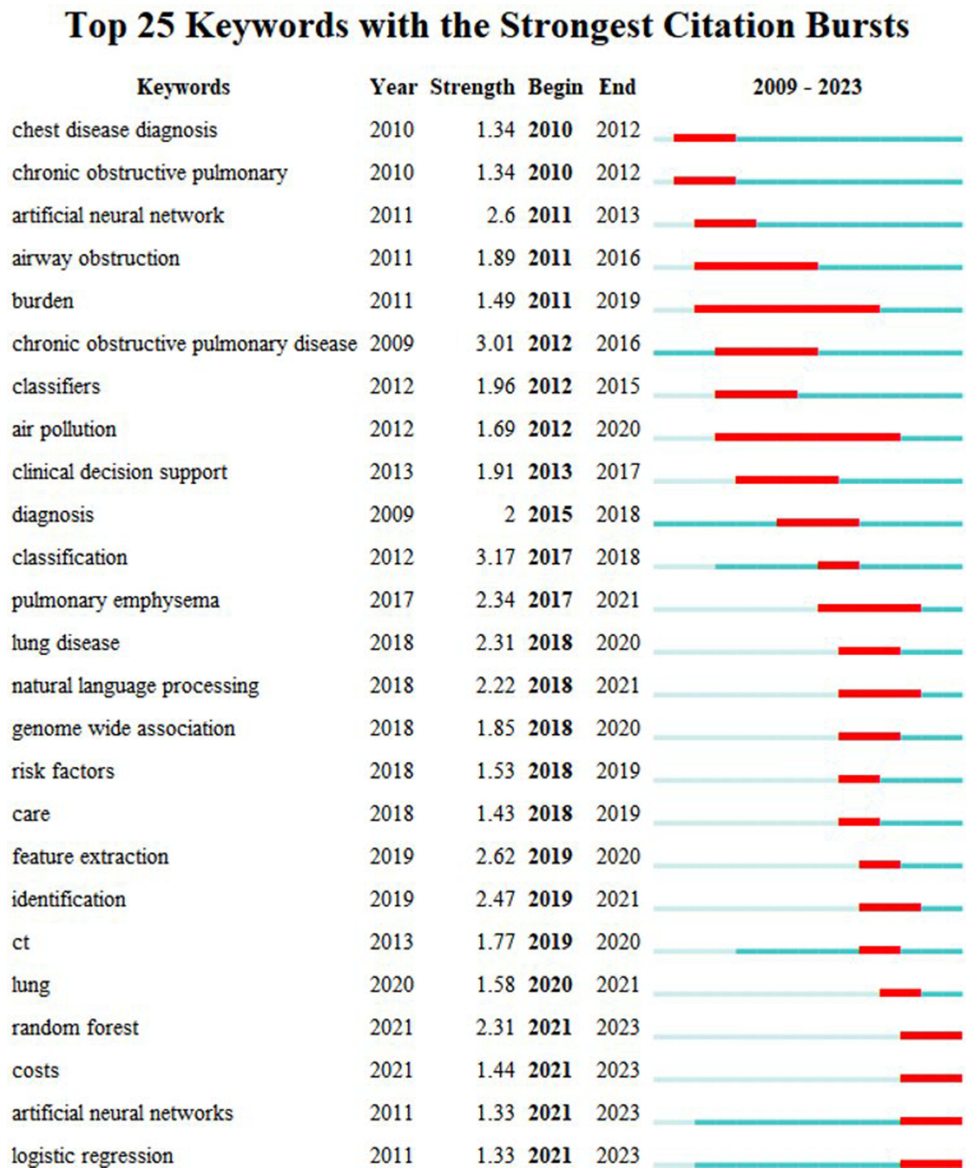

Figure 13 The top 25 keywords of explosive power in 2009–2023.

regression models,[25] and artificial neural networks[26] have been extensively employed for building COPD prediction models - aligning well with the keyword overlay atlas.

Currently, artificial intelligence (AI) has gained widespread utilization. In Turkey, deep learning techniques have been employed to analyze 12-channel pulmonary sound auscultation for enhanced recognition and classification of chronic obstructive pulmonary disease (COPD).[27] Within the field of COPD genetic epidemiology research, machine learning algorithms can identify novel subtypes of COPD by leveraging patterns derived from clinical and molecular markers.[28] AI serves as an effective tool in predicting the clinical development of investigational drugs.[29] Simultaneously, in the absence of clinical data, AI can offer a model for accurate differentiation between asthma and COPD.[30] Cosentino et al have established a comprehensive framework that enhances genomic discovery for disease prediction and drug design through the integration of machine-learning techniques with medical record-based labeling.[31] Yin et al utilized deep learning to establish a fractional order dynamic model capable of extracting meaningful physiological signal features in patients across all stages of COPD, thereby facilitating stage prediction.[32] Compared to pulmonary function testing (PFT), computer-aided diagnosis systems based on deep learning are not constrained by local medical resource limitations and contribute towards improved screening efficiency for early intervention in diagnosing COPD-related diseases.[6] Deep learning models based on CT imaging omics aid radiologists in evaluating early identification,[33] risk classification,[34] severity classification,[35] and related outcome prediction[36] associated with COPD, thus providing clinicians with valuable decision support tools while realizing precision medicine implementation. Moreover, the multi-modal model incorporating CT imaging omics, demographic data, and relevant clinical indicators exhibits superior accuracy in predicting COPD compared to a single model.[37]

Conclusion

This study unveils the rapid advancement of artificial intelligence (AI) in the domain of chronic obstructive pulmonary disease (COPD) diagnosis and treatment. Currently, cutting-edge research focuses on AI technologies such as deep learning, imaging omics, random forest, and convolutional neural networks that aid in COPD classification, diagnosis, risk stratification, and predictive modeling. Future investigations may concentrate on developing comprehensive AI systems for COPD diagnosis by integrating imaging, genomics, and proteomics. Furthermore, the integration of AI technology has the potential to address resource limitations in medical institutions and developing regions while fostering breakthroughs in COPD research. However, the accuracy of current AI models is primarily contingent upon the quality and representativeness of the training set. Different populations, such as various races, geographical locations, genders, or age groups, may necessitate distinct COPD diagnostic models. When employing AI in healthcare decision-making, it is imperative to bolster data privacy and security measures while also delineating liability for medical disputes. Limitations of this paper include potential underestimation due to database updates resulting in a time lag for frontier findings beyond 2023; moreover, this analysis solely encompasses English literature from the WOS core collection database which may introduce bias into our Results. Additionally, some articles related to COPD AI might not have included the keyword "AI", leading to potentially incomplete coverage. Nevertheless, these findings can still serve as a valuable reference for future research endeavors within this field. As relevant technologies continue to evolve and improve over time, these limitations will gradually diminish.

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Disclosure

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