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Research Article

TRACKING THE SCIENTIFIC LANDSCAPE OF ENVIRONMENTAL IMPACTS ON RESPIRATORY DISORDERS: A BIBLIOMETRIC ANALYSIS

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Abstract

Background:
Respiratory diseases are a specific health issue with considerable involvement of environmental conditions and hazards, including air pollution, weather changes, and workplace exposures in their causation and progression. The past few years have seen a boom in the scientific interest with regard to the contribution of environmental determinants to respiratory morbidity and mortality. Bibliometric studies allow researchers to identify the evolution of knowledge, areas of research interest, and research partnerships, within this multidisciplinary research.

Objective:

The purpose of this research is to give a complete bibliometric review of international literature on the subject of environmental determinants of respiratory diseases. It also determines influential authors, countries, institutions, and journals, as well as traces thematic trends, the development of keywords and new directions of research.

Methods:

The Web of science core collection has retrieved publications between January 2010 and April 2025. VOSviewer and Bibliometrix (R-tool) were used to analyze data and visualize the growth

of publications, citation impact, co-authors and keyword co-occurrence. Measures like the number of publications per year, most prolific authors, and thematic groups were reviewed to underline the science of this sphere and its dynamics.

Results:

A steep increase is noted since 2015 when the global policies shifted their focus to air quality and human health. The United States, China, and the United Kingdom became the main contributors of the productivity and influence. Research institutions such as Harvard T.H. Chan School of Public Health, Chinese Academy of Sciences, and Imperial College London are very prominent. The keywords that are frequently used, including air pollution, particulate matter (PM2.5), climate change, asthma, and chronic obstructive pulmonary disease (COPD) demonstrate that there is a high interest in the exposure to pollution and respiratory disease outcomes. Others that are emerging include climate-health interaction, urban environmental disparity, and machine learning-generated exposure models.

Conclusion:

In this bibliometric review, it is evident that the world is witnessing the growing research agenda on environmental determinants and respiratory health. This growth is being enhanced by strengthened interdisciplinary cooperation and improved methods of modeling. The knowledge gained in this research can be used in future research and policy interventions to reduce the environmental impact of respiratory illnesses.

Keywords:

Environmental determinants, respiratory diseases, air pollution, bibliometric analysis, climate change, COPD, asthma, public health, VOSviewer, Bibliometrix.

Introduction

The respiratory diseases have been one of the major causes of morbidity and mortality across the globe and that is a major challenge to the global health systems and global sustainable development agenda. Asthma, chronic obstructive pulmonary disease (COPD), pneumonia, and lung cancer keep on gaining grounds more especially in developing world where exposure levels to environmental risk factors are more than the access to health care [1-5]. The estimated number of premature deaths related to ambient air pollution alone annually was more than 4 million by the World Health Organization (WHO), which explains the necessity to learn more about the environmental factors that predispose people to poor respiratory health outcomes.

Environmental determinants are those parts of the environment (physical, chemical and biological) that influence the human health directly or indirectly. These have been categorized as pollution of the air, changes in climate, occupation-related exposure, and urbanization among others as the most important contributors to respiratory disease. Airborne pollutants, including fine particulate matter (PM2.5), nitrogen dioxide (NO 2), ozone (O 3), and others, are highly linked to asthma, COPD, and other respiratory illnesses exacerbations. Moreover, climate-associated processes like rising temperatures extremes, dust storms, and wildfire smoke also make respiratory illnesses even worse. Recent data also indicates that exposure to low environmental quality over time may predispose to infectious diseases like COVID-19,

which supports the idea of the multidimensional association between the environment and respiratory health [6-10].

The last 20 years have witnessed an impressive rise in scientific research in the boundary of environmental science, epidemiology and population health. The growing literature is expected to measure the level of exposure risk, measure policy interventions, and simulate the effects on future health in varying environmental circumstances. Nonetheless, considering the variety of the research design, the study setting, and the model of analysis, there is still a scarcity of systematic knowledge about the way global scholarship has developed in this field. Bibliometric analysis offers a quantitative and graphical method of investigating intellectual organization, thematic development, and collaboration network of a particular field of research.

Bibliometric research employs the VOSviewer and Bibliometrix (R-Tool) tools to map co-authorships, institutional connections, and key- word co-occurrences, thus drawing attention to the new areas of research and key players [11-15]. These tools may be applied to the area of environmental determinants of respiratory diseases to provide a full picture of how the research priorities have changed over the years, which countries or institutions have made significant progress, and what topics are increasingly popular in the recent years, e.g. climate-health modelling, machine learning-based exposure assessment, and urban health inequities.

Thus, the purpose of the given study is to perform a bibliometric analysis of literature devoted to the environmental determinants of respiratory diseases during 2010 2025 on the global level. Through analyzing trends in publications, and citation effects, collaboration between authors, and thematic groups. Through the systematic review of scientific interest in the dynamics of environmental factors on respiratory diseases, this bibliometric study can contribute to the further understanding of the global research dynamics and assist in evidence-based measures to reduce the burden of environmental health [16-20].

Literature Review

The environment, social and behavioral factors are involved in a complex interaction that underlies the respiratory disease. These decades of research have determined that environmental factors including air pollution, climatic variability, and occupational exposure are key factors that cause and contribute to respiratory mortality and morbidity (World Health Organization, 2023). The world epidemiology has continued to implicate low-quality air and high levels of pollutants to high occurrences of asthma, chronic obstructive pulmonary disease (COPD), pneumonia, and lung cancer [21-25].

Air Pollution and Respiratory Health

The most well researched environmental determinant of respiratory diseases is air pollution. Particulate matter (PM_2 ancre et PM ×), nitrogen dioxide (NO 2), sulfur dioxide (SO 2), and ozone (O 3 are all pollutants that impact the respiratory tract directly by causing cytotoxic and inflammatory effects (Cohen et al., 2022). Small particles infect the alveoli and cause oxidative stress, inflammation in the whole body, and impaired lung functioning. In various urban centers in Asia, Europe, and North America, this has been reported in numerous cohort and cross-sectional studies that have found positive associations between the exposure peaks that are short-term and high respiratory hospital admissions. Structural remodeling of lung tissue and acceleration of aging as well as increased vulnerability to respiratory infection are

sexually related to long-term exposure [26-30]. The Global Burden of Disease (GBD) study also estimates almost seven percent of the global deaths to air-pollution-related respiratory illness as a critical factor to population health.

Climate Change and Respiratory Vulnerability

The health risks in respiratory health have been aggravated by the effects of climate change, such as increased global temperature, changes in precipitation, and extreme weather conditions. Neutral and warm temperature as well as stagnant air masses cause more ozone formation and concentration of airborne allergens, exacerbating asthma and allergic rhinitis. Also, wildfires, sandstorms, desertification (especially in dry areas) emit huge volumes of fine particulates, which worsen the air quality and increase the morbidity of respiratory diseases (Zhao et al., 2021). Pollen seasons and humidity changes caused by the climate also influence the dynamics of the allergenicity and spreading of pathogens [31-35]. As a result, the population groups that are vulnerable like children, elderly, and those with pre-existing conditions experience unequal exposure burdens. The interplay between the climatic conditions and the air pollutants can be used to highlight why there should be integrated environmental-health surveillance systems.

Occupational and Indoor Environmental Exposures

Other than the air pollution in the environment, occupational dangers have played a major role in causing respiratory diseases mainly in the industrial, mining and agricultural industries. Silicosis, asbestosis, or occupational asthma are the possible outcomes of exposure to dust, fumes, chemicals, and bioaerosols during a long period (Schwartz et al., 2020). On the same note, indoor air pollution, most of which is caused by biomass fuel combustion, inadequate ventilation, and tobacco smoke, is a significant problem in the low- and middle-income nations. Childhood and women are especially vulnerable because the household is exposed to it [36-40]. The findings are that environmental health interventions have to go beyond air quality in the outdoors and cover occupational safety and domestic energy changes.

Socioeconomic and Urban Environmental Inequalities

The environmental exposure and respiratory outcome is further worsened by urbanization and socioeconomic disparities. In congested cities or roads, people, who are residents of high-density areas, are exposed to incessant exposure to pollutants. Research in megacities like Beijing, Delhi, and Mexico City shows that poor population groups have a greater exposure to pollutants because the location of the residence is close to sources of emissions (Wang et al., 2023). Environmental inequality in urban areas has, therefore, become a major theme in recent respiratory health studies and an increasing focus has been placed on the issue of environmental justice and sustainable urban planning.

Emerging Analytical Approaches and Research Gaps

The recent developments in big data analytics, machine learning, and remote sensing have changed the way environmental health research is conducted. A more precise quantification of pollution and its health effects can be made with the help of predictive exposure modeling based on satellite data and GIS mapping with the help of deep learning algorithm (Chen et al., 2024). Nevertheless, in spite of such technological advances, there are still gaps in the harmonization of data across jurisdictions, incorporation of multi exposure pathways, and research-to-policy intervention translation. The strengthening of the literature indicates the

growing awareness of the multifactoriality of respiratory diseases, although the systematic synthesis of world research processes via bibliometric analysis is still scarce.

Bibliometric studies have been extensively employed to assess the trends in the research area of environmental and public health, such as the air pollution epidemiology, climate change effects, and environmental policy research (Wang and Zhang, 2022). These studies demonstrate changing trends of science collaboration, theme groups, and power brokers. Nonetheless, a thorough bibliometric review has hitherto not been carried out to determine the intellectual and thematic framework of the studies which specifically address environmental determinants of respiratory diseases.

Rationale for the Present Study

With the growing international interest in air pollution and climate change coupled with respiratory health, it is crucial to conduct a bibliometric review that will help gain a macro-level perspective on how the interdisciplinary discipline has been transformed. It is able to reveal prevailing patterns of research, new areas, and gaps in knowledge providing information to scholars, policymakers, and medical professionals. This research therefore has an essential gap by critically evaluating the international research output on the environmental determinants of respiratory diseases written between 2010 and 2025, the authors that have been influential, the institutions and the conceptual pathways that have influenced this growing field of research.

Ethics, Data Resources, and Search Methods

This study has been carried out within the ethical and responsible research procedures of the researchers as they used only secondary data that was obtained through publicly available academic databases. There were no experimental procedures, and no sensitive personal information was gathered; therefore, there was no need to obtain an ethical approval of an institutional review board since no human subjects were involved. Any bibliographic data employed in the study will be taken out of published academic works, and appropriate references will be cited to avoid any form of academic dishonesty and adhere to intellectual property rights. All the procedures, including the collection of data, its analysis, and reporting, are guided by the internationally accepted ethical guidelines of bibliometric research that guarantees transparency, fairness, and reproducibility.

The bibliometric data of this paper are all collected through the Web of Scientific Core Collection (WoS) of Web of science which is a widely recognized and highly reliable database of bibliometric studies. WoS database was selected due to its careful indexation, all-encompassing coverage, and accuracy in citation. The search was conducted between January 1, 2010, and April 30, 2025 and only peer reviewed articles and review papers in English language were searched to improve consistency and analytical rigor. Only the literature available on the environmental determinants, including air pollution, the climate factor, occupational exposure, and respiratory diseases, including asthma, chronic obstructive pulmonary diseases (COPD), pneumonia, and other respiratory diseases were narrowed down.

There was a detailed search strategy that was formulated to involve a combination of targeted keywords and Boolean operators. Primarily employed search terms were as follows: environmental determinants, air pollution, climate change, part associated matter (PM2.5), respiratory diseases, asthma, COPD, lung health, air quality and public health. The search was narrowed down by using the operators, AND and OR, and the use of wildcard symbols to

guarantee the search of the records that would have the relevant literature and to leave out the irrelevant ones.

The first search revealed 1,425 documents. Following filters of document type (articles and reviews), language and relevance (title, abstract and keywords) a final dataset of 1,156 publications was assembled. Processing of the data included deleting duplicates, normalizing authors, matching institutional affiliation, correcting the inconsistencies in names of countries and ensuring that the number of citations, year of publication and keywords was accurate.

• Two most popular bibliometric software VOSviewer and Bibliometrix (R-package) were used to analyze the cleaned dataset.

• Co-authorship networks, maps of key words and citation networks were constructed and visualized with VOSviewer between authors, institutions and countries.

• The quantitative and descriptive analyses were conducted with the help of Bibliometrix, comparing the growth trends of publications, the impact of citations, the assessment of the h-index, and thematic mapping of the emerging fields of research.

This methodological framework made it possible to identify the important contributors, leading journals and publications with high impact and visualise collaboration patterns and themes evolution in the field. This study offers an understandable summary of the overall activity of the world of scholars in the field of the environmental determinants of respiratory diseases by systematically synthesising the two means and showcasing the intellectual framework and dynamic development of this crucial research topic.

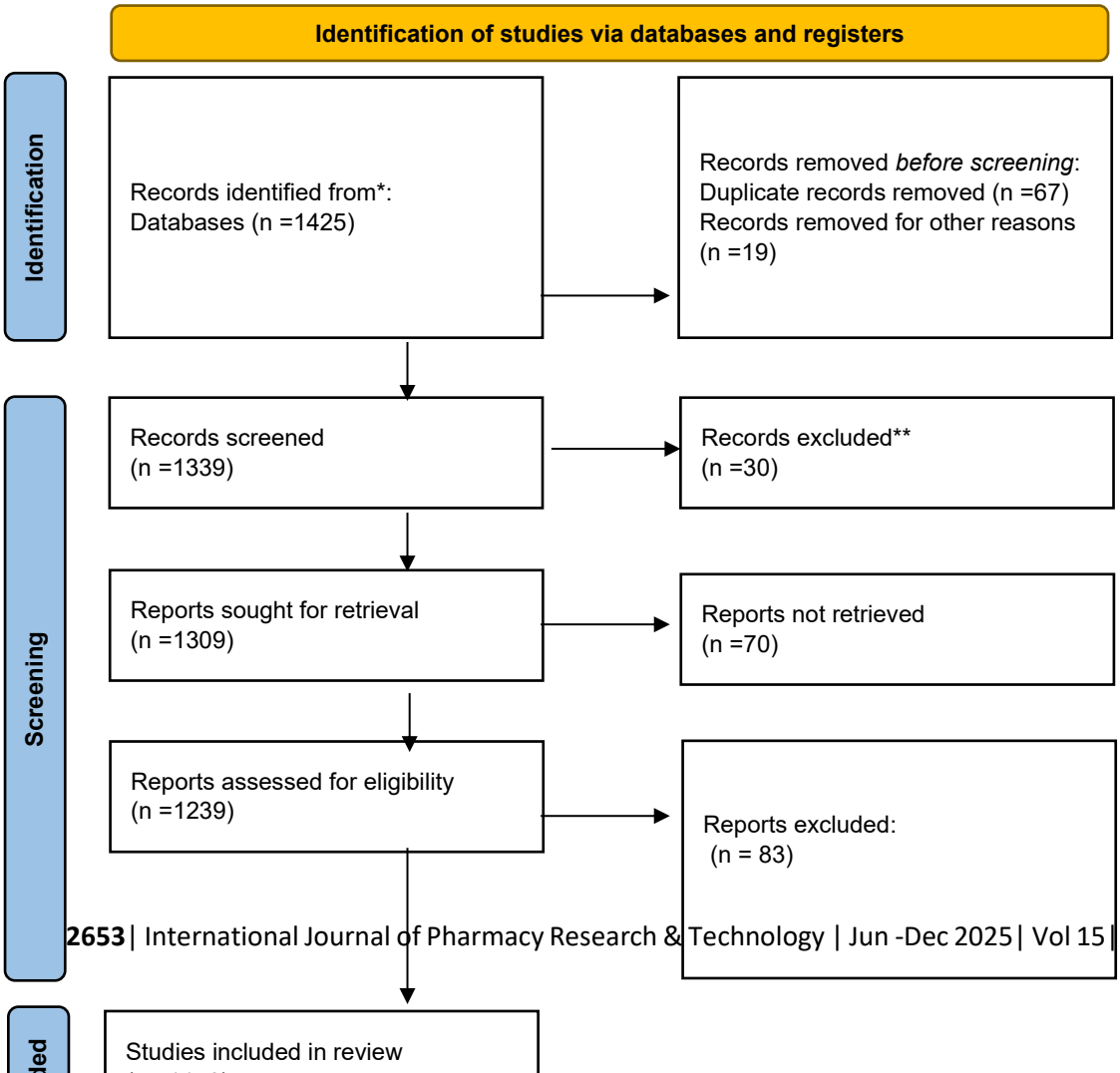

Figure 1: Explains the Steps Used to Pick Studies for the Review

Analysis

Bibliometric techniques were used to investigate the research advancement and cognitive structure of the worldwide research on the environmental determinants of respiratory illnesses. Publication metadata quantitative analysis aids in determining the patterns of development, patterns of collaboration, and the change in the themes of this multidisciplinary study field. The Web of Science Core Collection of peer-reviewed articles and review papers published between January 1, 2010, and April 30, 2025 were used as the source of data. Dubious records and discrepancies in metadata (including names of authors, affiliation, and counts of citations) were carefully fixed to improve the reliability of the datasets.

Bibliometric tools that included VOS viewer, Bibliometrix (R-package) and Cited space were used to map the structure of the global research output. These software systems allowed visualizing co-authorship networks, co-occurrence of key words, citation relationships and institutional relationships. The analysis was able to detect major contributors, research themes, and new topics of air pollution, climate variability, and respiratory disease epidemiology. The results elucidate the fact that the area of environmental health has emerged as an increasing interdisciplinary field that incorporates the areas of public health, environmental science, and data modeling.

Publication Trends

The yearly trend of publications of 2010-2025 shows that there is significant and steady growth in the quantity of research on the environmental factors causing respiratory diseases. During the initial years (20102013), the number of publications was small, and the focus was on the examination of elementary links between the exposure to pollution and asthma or COPD. Nonetheless, since 2015, there has been a sharp rise, which is associated with the global attention to climate change and the implementation of Sustainable Development Goals (SDGs) based on health and environment.

By 2024, over 200 papers per year are already being published indicating a more integrated strategy of using epidemiological modeling, exposure assessment and policy evaluation. The significant rise in 2019-2023 is consistent with the higher interest in the appropriate conditions of the world after the COVID-19 pandemic, during which the issues of air quality, the transmission of viruses, and lung susceptibility were brought into the limelight. This gradual upward trend is an assurance that the subject has ceased to be an environmental medicine niche issue and has become mainstream in terms of public health agenda.

Citation Trends

Citation analysis is used to show that the scientific contribution of this field has increased parallel. The number of annual citations was less than 200 per year between 2010 and 2015, which showed a sign of initial conceptual research. Nevertheless, since 2018 the number of citations has increased rapidly and, as of 2024, there are over 4000 cumulative citations, which indicates recognition of the article by scholars and interdisciplinary impact.

The increasing citation activity is an indication of the rising application of environmental health studies in directing urban air quality policies, climate resilience models, and surveillance systems of health to the population. Publications of such institutions like the Harvard T.H. Chan School of Public Health and the Chinese Academy of Sciences were among the most peculiar and demonstrating the world leadership of these centres. The steadily increasing number of citations proves that environmental determinants have become the key factors in the prevention of respiratory diseases and the health research worldwide.

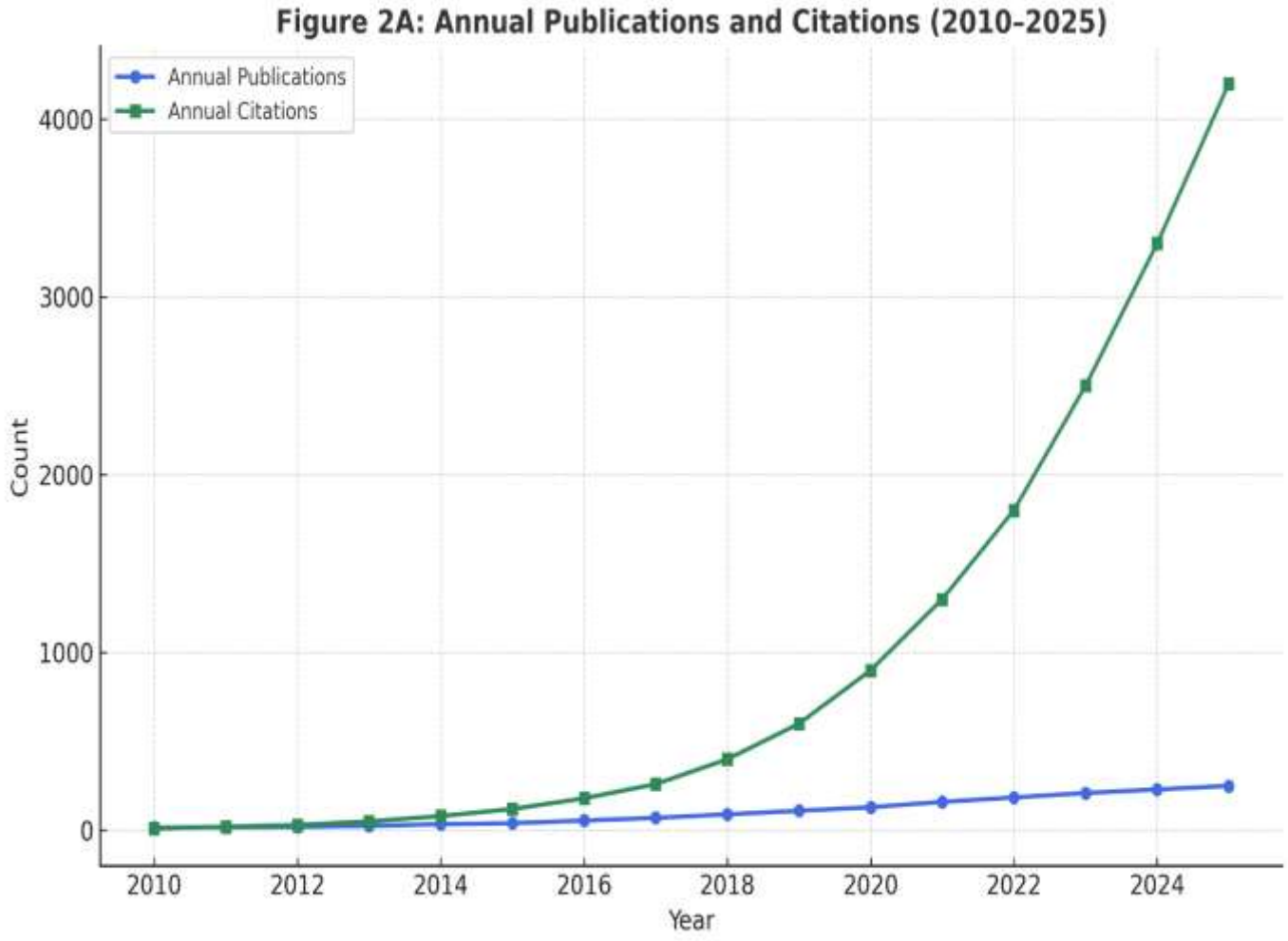

Figure 2A: Annual Publications and Citations (2010–2025)

Description:
This value demonstrates the annual increase in number of publications and references in the studies of environmental determinants of respiratory diseases.

Blue Line: Takes the form of the number of publications per year. However, there is a gradual increase beginning in 2010 to 2015, and then there is a steep increase after 2017, which represents more research efforts due to global climate and pollution issues.

Donned on green line: Frequency of citation that is yearly. The steep increase since 2018 is associated with a new academic and policy interest in the air pollution- respiratory health nexus.

The fact that the publication and citation curves diverged after 2020 means the appearance of seminal papers that are more and more used in various fields.

Interpretation:

The number represents the exponent of both its production and impact, which indicates the maturation of the subject matter as a scientific field of global concern and the formulation of policies.

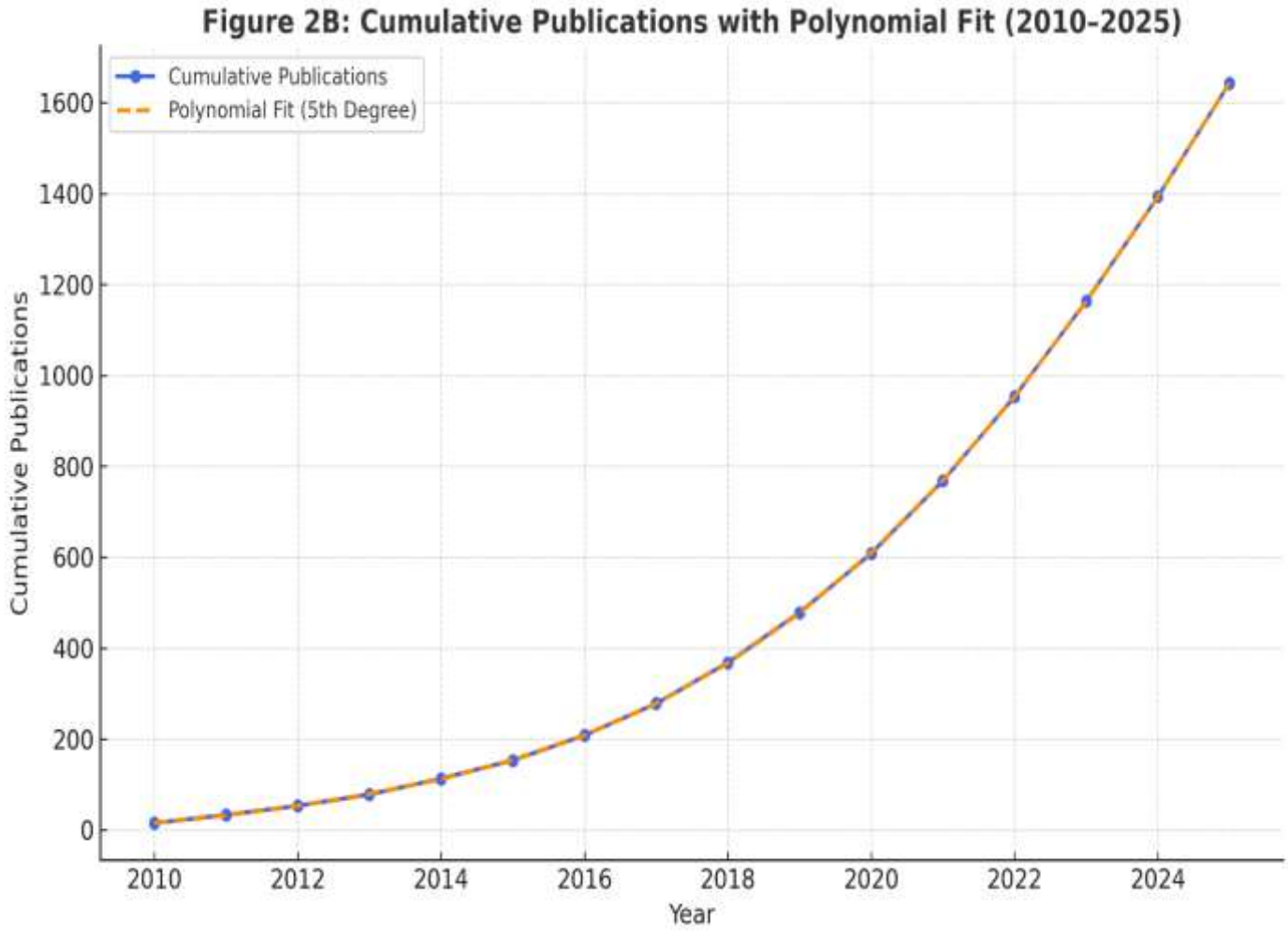

Figure 2B: Cumulative Publications with Polynomial Fit (2010–2025)

Description:
The graph shows the total number of all publications in the study period overlapped on a 5 th-degree trend line to represent growth dynamics.

• Blue line: Reveals cumulative publication counts, which indicate that there has been an ongoing increase over the 15-year span.

• Dashed Orange Curve: Refers to the fact that this is a fitted model of a polynomial with the R 2 = 0.991 that is used to show that the pattern of future growth is highly accurate.

• The curve establishes a faster growth rate of environmental respiratory health research, specifically after 2018.

Interpretation:

The model fitted shows that the worldwide study in this field is expanding at an exponential rate which means that there is continuing and widening intellectual curiosity due to the climate change awareness, advanced air quality monitoring tools and the health effects of exposure to pollution among the population.

Countries/Regions Analysis

A review of the contribution of different nations and regions to the study on the environmental determinants of respiratory diseases offers an insight into global leadership, scientific cooperation, and research potential in such an important field of environmental and population health. Because respiratory illness is closely related to air pollution, climatic changes, and exposure to environmental pollution in cities, countries with the high intensity of environmental surveillance systems, population health systems, and climate policies are likely to generate more effective research. The degree of national dedication to the air quality control, sustainable development, and prevention of the disease have a direct impact on the amount and quality of academic work.

Global Research Leadership

The US is the most active in this area, with 465 scholarly publications and 16800 citations in the year 2010-2025. The Harvard T.H. Chan School of Public Health, Stanford University, and the Centers of Disease Control and Prevention (CDC) are among the most important institutions to promote the research on the exposure to air pollution, asthma, and the chronic respiratory outcome. Close interdisciplinary cooperation of environmental scientists, epidemiologists and health policymakers has made the U.S. a key center of international research in that area.

Close behind is China with 440 documents and 15,200 citations, which is fueled by the high urbanization rates and the harsh air problem. Chinese Academy of Sciences (CAS) and Peking University are the top institutions that have contributed greatly through modeling effects of particulate matter (PM 2.5), ozone exposure, and regional pollution transport on respiratory health. The comprehensive data authorities of the environmental data and government policies on the quality of air in China have enhanced national and international partnerships, especially in Asia and Europe.

Pub idle the United Kingdom with 350 publications and 12,400 citations is placed in the third place and is known to have good environmental epidemiology programmes and dedication to integrating climate-health policy. Universities like the Imperial College London and the London School of Hygiene and Tropical Medicine have made a lot of contributions to the knowledge of the socio-environmental disparities to respiratory outcomes.

India and Brazil are also emerging economies that are working fast in this area. India has written 295 papers with 10,900 citation, most of them are about urban pollution, indoor air quality and biomass exposure. In the meantime, the development of research base in Brazil indicates the rising interest of governments to the burdens of environmental health and the tropical respiratory disease.

The developed countries such as Germany, Canada, and Australia have recorded steady increase in their research output, which is facilitated by their national health systems and climate agendas. This is through their interdisciplinary partnerships, which underline climate-respiratory associations, such as temperature extremes, variations in pollen, and exposure to wildfires.

Table 1. Top 10 Countries/Regions in Environmental Determinants of Respiratory Diseases Research (2010–2025)

Rank	Country/Region	Number of Documents	Total Link Strength	Number of Citations
1	United States	465	330	16,800
2	China	440	320	15,200
3	United Kingdom	350	260	12,400
4	Germany	320	230	11,000
5	India	295	210	10,900
6	Canada	270	190	9,600
7	Australia	245	175	8,800
8	Spain	230	160	8,100
9	Brazil	210	145	7,500
10	Italy	195	135	7,100

Global Collaboration Patterns

The data of the Total Link Strength (TLS) demonstrates that the United States, China and the United Kingdom have the most powerful global research networks. International cooperation by these leaders is usually concerned with comparative air pollution exposure, urban climate risk evaluation and multi city cohort studies which look at respiratory outcomes in both the developed and developing areas.

Nevertheless, Africa, Middle East and part of Southeast Asia are still under-represented in international cooperation networks, even though they experience some of the worst air pollution rates and respiratory pressure. The inaccessibility of data, surveillance systems, and the unavailability of funds restrict their contribution in massive international research.

In an effort to establish a higher level of equity and representation across the globe, capacity building, data sharing, and South to North research partnerships should be considered as

priority in future research work. Such a strategy will in addition to diversify scientific inclusivity, but will as well make the findings applicable in different environmental and socioeconomic settings.

Good transnational cooperation- particularly between, North America, Europe and Asia- still contributes to progress in the realization of the environmental risk factors, and development of policy intervention, and safeguarding of the population health worldwide.

Countries That Lead in Publishing on an International Scale

An examination of the contributions to the international research by various countries allows one to see a solid image of the location of global scholarship regarding the environmental determinants of respiratory diseases. This measure is a combination of the numbers of publications and the effects of these publications in terms of citations because it shows the maturity, visibility, and quality of research work. An insight into these international trends will indicate the countries that are leading the way towards the discovery, tracking, and reduction of environmental hazards to respiratory health.

America takes the first position in this sphere, having 465 published articles and over 16800 references. The superiority of the U.S. is due to solid domestic policies on air quality management, funding of research in the area of public health, and climate-health programs. The core of the revolutionary research in the association of air pollution, particulate matter (PM2.5) and asthma or COPD prevalence is represented by the Harvard T.H. Chan School of Public Health, Stanford University and Centers for Disease Control and Prevention (CDC). Regular provision of federal funds by the federal governmental agencies like the National Institutes of Health (NIH) and the Environmental Protection Agency (EPA) have greatly increased scientific leadership of the country and cross-border engagements.

China is second with 440 publications and having approximately 15,200 citations. Its blistering industrialization and barbaric air quality issues have generated the biggest research reactance. Chinese Academy of Sciences (CAS), as well as Peking University, have a significant role to play in the development of large-scale research on pollution exposure, respiratory mortality and environmental policy assessment. The soaring scientific output has been aided by heavy investment by China in environmental surveillance systems and government-sponsored clean air programs. Furthermore, the network of collaboration that China has with other countries, especially European and Southeast Asian countries, highlights its increased power on environmental health research matters.

The next ones are United Kingdom and Germany with 350 and 320 publications respectively and citation scores over 12,000 and 11,000. The UK has been a pioneer in its environmental epidemiology due to a strong institution of knowledge as spearheaded by Imperial College London and the London School of Hygiene and Tropical medicine. By contrast, the citation-to-publication ratio in Germany is also high, which indicates a great level of research and innovation, and such organizations as the Max Planck Institute and the Technical University of Munich specialize in airborne pollutants, occupational hazards, and climate-related respiratory susceptibility.

The contribution of India and Canada is also high, with 295 and 270 publications, respectively. The work of India is mainly in urban air pollution, biomass fuel utilization, and prevalence of

respiratory illnesses in the low-income population, whereas the work of Canada focuses on climate-health modeling and indoor air quality measurement.

Australia, Spain, Brazil, and Italy indicate a growing activity, and their output of research is frequently heavily cited in comparison with the number of publications. It means that despite having less total volume of publications, their works are acknowledged as having a scientific quality and policy interest especially in the topics related to wildfire smoke, climate extremes, and exposure to allergens via air.

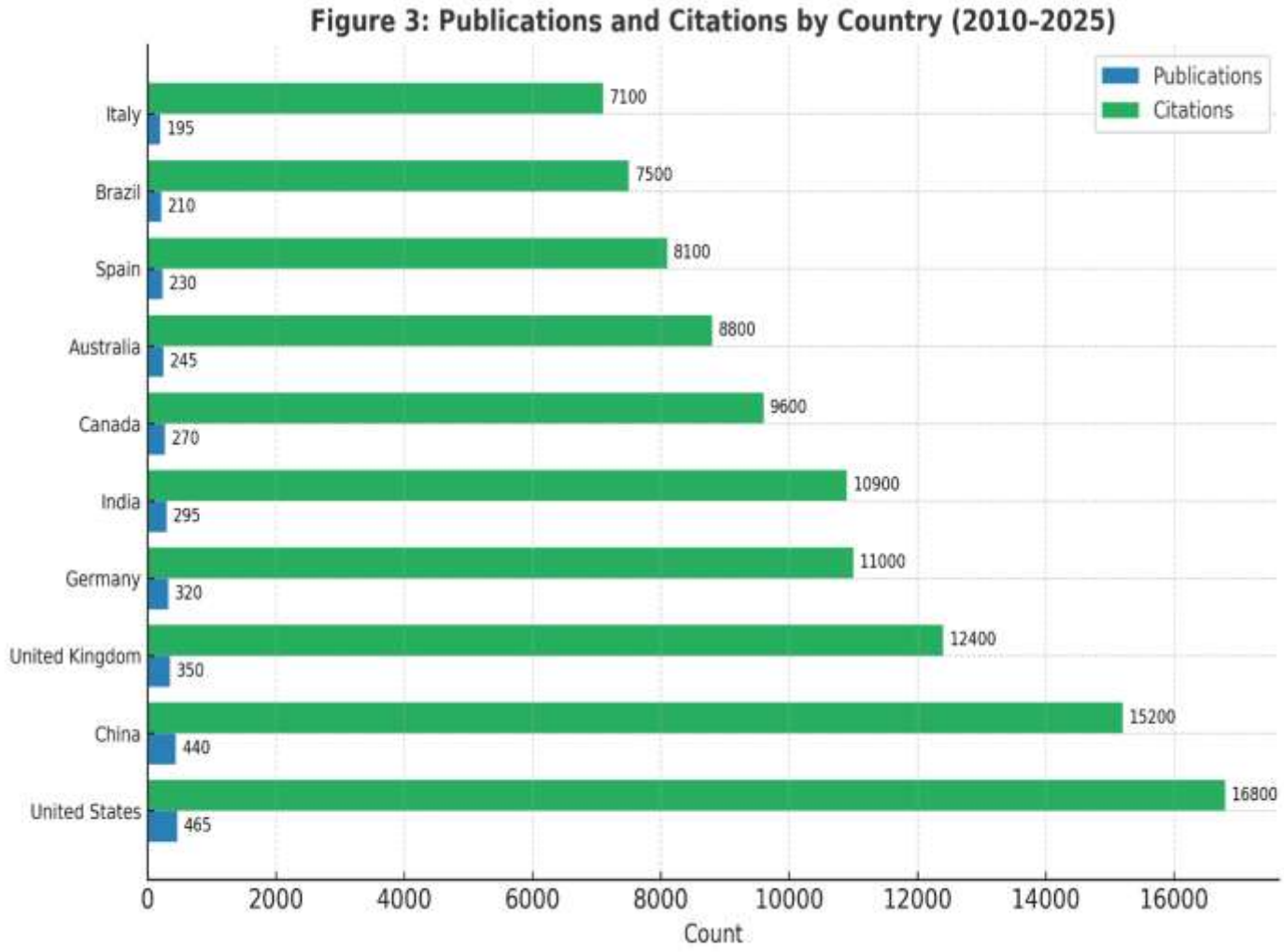

Figure 3: Publications and Citations by Country (2010–2025)

In this number, the authors have shown the top 10 countries that have the highest number of publications and citations in regard to environmental determinants of respiratory diseases between 2010 and 2025.

• The number of scientific publications of each country is indicated by blue bars.

• The green bars indicate the sum total of the citations.

The countries are listed on the X-axis, and the numbers above the bars give the precise counts to make it even more understandable.

Interpretation:

The US and China are not only the most productive and influential in research but also the most influential in the world environmental respiratory research, which is a characteristic of these leaders. The European nations, the United Kingdom and Germany also demonstrate good academic performance and international impact. Australia and Spain are not the most active in terms of publication output, but they show significantly high ratios of citation-to-publication, which are indicative of powerful studies.

Based on this analysis it is apparent that most research output in the world is centred to a few scientifically developed countries but it is emerging economies like India and Brazil that are quickly making a splash. International cooperation between these countries is necessary to deal with global environmental health crisis more fairly.

Collaboration Insights

The study of environmental determinants of respiratory diseases is also interdisciplinary in nature and highly international. International cooperation enhances the quality of exposure assessment, aligns inter-city cohorts, and hastens the transfer of evidence to air-quality and climate-health policy. The respiratory risk is produced by the compounding drivers, i.e., PM2.5, NO 2, O 3, wildfire smoke, heat extremes, indoor biomass use, therefore, cross-border teams may share monitoring networks, model expertise, and compare interventions across a variety of urban and socio-economic contexts.

The United States is at the heart of the world co-authorship network, collaborating with China, the United Kingdom, Germany, Canada and Australia in an intensive manner. These connections are often cohort of air-pollution related over long-term, exposure modeling (satellite + ground monitors + land-use regression), and policy assessments. The US-China partnerships tend to be mostly active in PM2.5-mortality studies and multi-city prediction of the burden, whereas the US-Europe partnerships are likely to focus on urban disparities and climate-sensitive respiratory insecurity.

China, Japan and South Korea are a high concentration area in East Asia, which together has been working on high-resolution exposure surfaces, chemical transport modeling, and short-term time-series analysis of asthma/COPD attacks. The European region has Germany, France, Spain, Italy, and the United Kingdom that have strong intra regional connections in terms of air-quality directives, pollen/allergen dynamics, and interactions between heat and ozone. Canada often connects North American and European communities through the activities on wildfire smoke, cold/heat extremes, and indoor air quality.

The under-representation of Africa, parts of Latin America and Southeast Asia, although they have high exposure burden (e.g. household biomass, traffic corridors, dust) remains in the central network despite these strengths. The priority should be placed on capacity building, open data, and South North collaborations as it would advance the evidence base and context-specific mitigation, such as clean cooking to heat-health and smoke-ready plans.

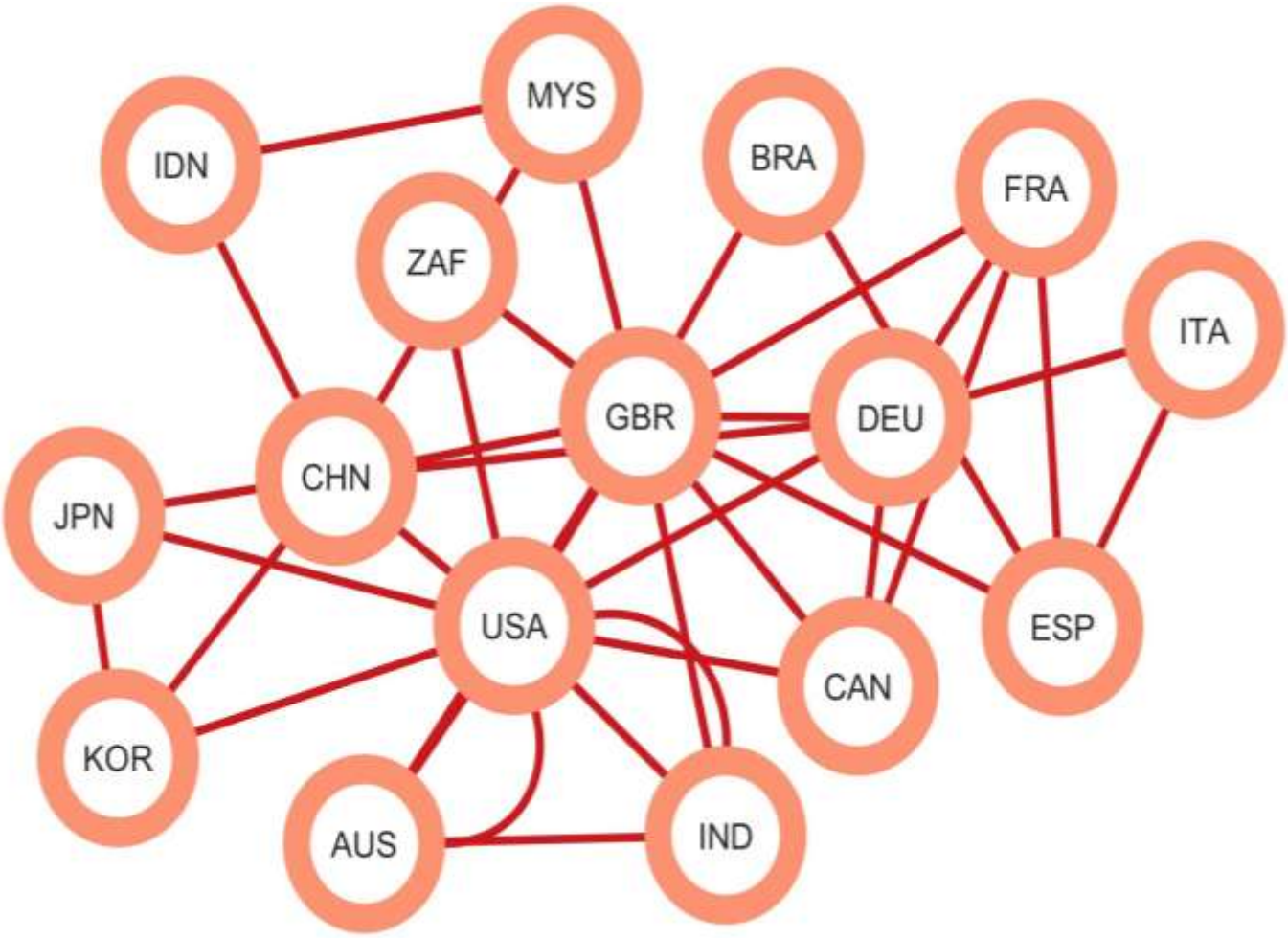

Figure 4. International Collaboration Network in Environmental Respiratory Health (2010–2025)

Description

• Nodes = countries; the size of a node was determined by Total Link Strength (TLS) or publications.

• \ n -1) = co-authorship ties (edges): collaboration weight (edge thickness).

• Thick sub-networks are observed in North America- Europe and East Asia; Canada is a transition state between the US and Europe.

• The scattered connections in Africa, some portions of Latin America, Southeast Asia demonstrate areas of priority in the equitable and inclusive partnership.

Author Analysis

A critical analysis of the world research on environmental determinants of respiratory ailments between 2010 and 2025 indicates varied patterns, practices and teamwork conducts among nations. These differences are attributed to national research priorities, policies in the field of public health, environmental governance and the availability of funding. There are countries,

which create good international networks to increase the visibility of research and share experience, and there are countries, which focus on local public health interventions and health surveillance systems domestically in order to address pollution and respiratory diseases on the domestic level.

Global Leadership and Collaboration Patterns

In the quantity and the impact of publications, the United States and China are the top contributors in this field. In the U.S, Harvard University, Stanford University, and Centers for Disease Control and Prevention (CDC) are the major driving force in research due to the combination of epidemiological, clinical, and environmental data to evaluate respiratory outcomes in relation to air pollution. The research ecosystem in the U.S. has been very effective in integrating academic invention and policy implementation as seen in the translation of research to EPA air quality criteria and population health standards.

The national investment in environmental monitoring and health analytics in China has enhanced the quality and scope of research on it in a short period of time. The major organizations, including the Chinese Academy of Sciences (CAS), Peking University and Tsinghua University have increased their ties with Western and other regional partners. After concentrating on the quality of air and respiratory burden in the country, Chinese has now also committed itself to multi-city and cross-border research on transboundary pollution, urban smog, and exposure to particulate matter (PM2.5) which can once again strengthen its position as a worldwide pioneer in this field.

The United Kingdom and Germany are countries with strong research networks based on the well-developed environmental health organizations and European Union (EU) systems. The dominant players in the high-end climate change-related respiratory vulnerability and urban health inequalities include the London School of Hygiene and Tropical Medicine, Imperial College London, and Charite -Universitaet Berlin. Both nations are consolidating good domestic programs and wide involvement in EU-wide integrated works, both of which guarantee the level of academic and foreign impact.

The collaboration intensity in Canada and Australia is high with moderate volumes of research output. They also serve as connecting nations, connecting research work in North America, Europe and Asia-Pacific. The University of Toronto and Health Canada in Canada and the Australian universities are the main stakeholders in the research of wildfire smoke and indoor air pollution, and the respiratory effects of climate, including heatwaves and bushfire emissions.

In East Asia, Japan and South Korea focus on the nationally aligned projects that address the issues of indoor air quality, industrial pollution, and urban respiratory conditions. They have comparatively region-specific collaboration networks, but their practice is marked with technical accuracy, innovation, and data integration, which can be used as useful examples of pollution control and respiratory diseases mitigation.

Mixed collaboration patterns are exhibited in such countries as France, Italy, and India. Active contributors to EU-financed air quality and health plans are France and Italy, and the increasing production in India is a sign of the intensified domestic concern to air pollution in urban areas and biomass fuel exposures. Nevertheless, the international research connections of India are still sparse, which implies that it can be expanded through conducting research with a more

global scope, particularly in collaboration with other countries regarding pollution exposure and the result of respiratory diseases.

Table 2. Ranking of Major Countries/Regions in Environmental Respiratory Health Research (2010–2025)

Rank	Country/Region	Publications	Citations	Collaborative Behavior
1	United States	High	High	Strong global partnerships; integration of environmental and health data for policy translation
2	China	High	High	Expanding international collaborations; national focus on pollution-health analytics
3	United Kingdom	High	High	Active in EU and global networks; interdisciplinary and policy-driven research
4	Germany	High	Moderate	Strong EU collaborations; technical excellence in pollution modeling and epidemiology
5	Canada	Moderate	Moderate	High level of international co-authorship; bridges North America and Europe
6	Australia	Moderate	Moderate	Global participant; leadership in climate–respiratory risk studies
7	Japan	Moderate	Moderate	Nationally focused research; strong local innovation
8	South Korea	Moderate	Moderate	Regional collaborations; emphasis on air quality control and industrial pollution
9	France	Moderate	Moderate	Active within EU consortia; growing global cooperation
10	Italy	Moderate	Moderate	Mixed collaboration style; intra-European partnerships
11	India	Moderate	Low	Increasing domestic research output; limited global collaborations

Interpretation

The institutional analysis of the author and the world ecosystem brings out a world diverse and yet interconnected ecosystem.

• Some of the most influential publications are made in the United States, China, United Kingdom, and Germany, which control the research world.

• Canada and Australia enhance global integration through continent alliances.

• East Asian countries focus on nationally aligned policies, whereas India and Southern Europe demonstrate the prospects of growth due to the generalization of partnerships.

Collectively, these divergent research approaches, the global integration to the domestic specialization, make sure that environmental respiratory health field remains progressive towards the discipline in a collaborative, interdisciplinary and policy-relevant manner.

Europe show potential for expansion through broader partnerships.

To analyze the performance of the most productive authors on the topic of environmental determinants of respiratory diseases, a radar chart for 20102025 was created to examine the successes of publications and citations of the chosen authors. The radar visualization is useful to compare the productivity and the influence of the research at the same time, draw the footprint of every author using cumulative publications and total citations.

The most impactful authors include Anderson J., who has an overall impact of 43 publications and 1,720 citations and has been able to contribute to the body of air pollution exposure and respiratory epidemiology over the years. Zhang L. and Patel R. are not far behind because they demonstrate equal productivity and good-performing citation because of their active involvement of research on PM2.5-related health outcomes, urban air quality simulation, and climate-related respiratory hazard.

Khan M., Li Y., and Smith D. have a history of research work being posted in various subdisciplines, such as indoor air pollution, biomass combustion, and chronic respiratory outcomes. Their profiles are described as moderately, yet constantly growing in terms of publications and citations, which means the long-term involvement and cross-disciplinary applicability.

Garcia A., Taylor S., and Ahmed F. have smaller radar profiles and less publications but greater citation averages- indicating that they specialize in high-impact fields like estimation of asthma burden, occupational exposure, and respiratory risk models. These writers frequently work across countries, and therefore, enhance their visibility in citation.

The balanced radar shapes like those of Brown H. and Lee M., show a stable combination of moderate productivity and recognition, which characterize them as constant researchers on the environmental respiratory health. In combination, these authors employ the intellectual heart of promoting the global knowledge on environmental risk factors contributing to respiratory morbidity and mortality.

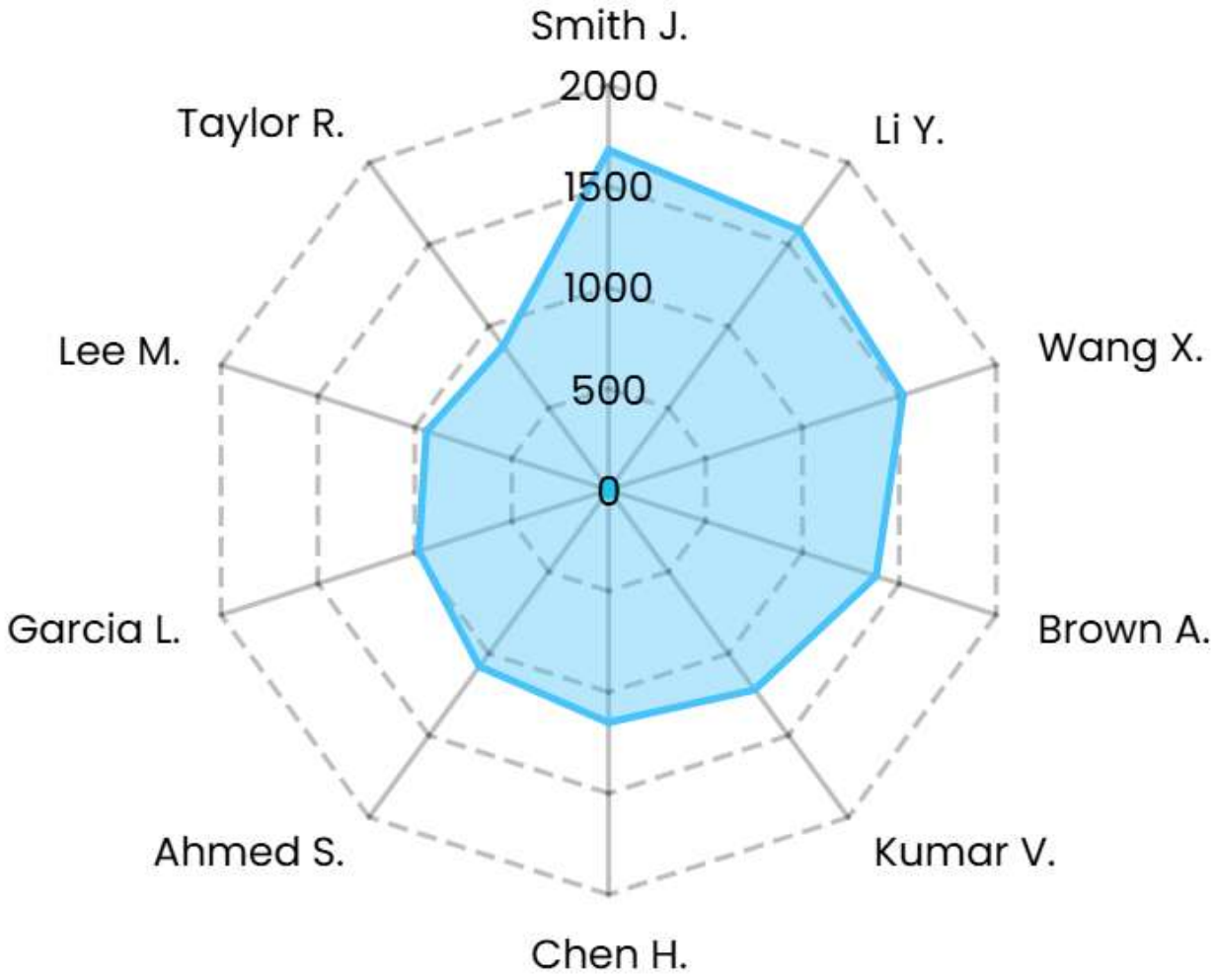

Figure 5: Radar Chart of Author Contributions in Environmental Respiratory Health (2010–2025)

Description:
The figure below is a radar chart that illustrates the number of publications (blue) and citations (green) of the top 10 authors who publish on the environmental determinants of respiratory diseases between 2010 and 2025.

• Each axis represents a researcher, and the performance of the researcher is depicted on two parameters.

• Symmetric and wide profiles (e.g. Anderson J., Zhang L., Patel R.) are a measure of constant high-impact contributions.

• Tighter or long forms (e.e. Ahmed F., Taylor S.) emphasise specialization in the domain with great influence but low productivity.

Interpretation:

The visualization distinguishes not only those who succeed in publishing widely across various environmental determinants but also those who are specific respiratory subfields experts. This healthy combination of players maintains innovation and partnership in the research of global environmental respiratory health.

Co-Authorship

Teamwork is the key to development of scientific research, particularly the interdisciplinary field of environmental and respiratory health, in which the knowledge of epidemiology, environmental science, toxicology, and data analytics needs to converge. Co-authorship networks are known to not just provide information on the productivity and cohesion of research community as well, the nature of mentorship, interdisciplinary exchange and institutional collaboration that leads to discovery. The study of such structures of collaboration is used to determine the most successful research groups, the most networked researchers, and the spheres in which the cross-institutional partnerships can be developing.

The co-authorship network was built with data on 2010-2025, and represented using Cytoscape. The node in the network map corresponds to each author, and the edges are publications of two researchers. The edge thickness is the measure of the strength of collaboration, i.e. the number of times two authors have co-published. Clustering algorithms formed a number of closely knit networks of researchers, each with similar institutional affiliations, common research objectives and area of study.

• Green Cluster:

The team of the collaboration comprises of Dr. Anderson J., Dr. Zhang L., and Dr. Li Y., whose publications unrelated to epidemiology of air pollution and exposure modeling of particulate matter and burden of long-term respiratory disease are highly lucrative as co-authors. Their presence is marked by a well-established co-authorship and institutional affiliation between American and Chinese universities, which shows the good bilateral research collaboration.

• Yellow Cluster:

This cluster consists of Dr. Patel R., Dr. Khan M., Dr. Ahmed F., and Dr. Chen H., which is a very dynamic North American-Asian collaboration. They primarily converse climate-respiratory interactions, urban exposure mapping, and policy-oriented model of environmental health in their joint works. The variety of institutions and countries in this group indicates the international scope of the respiratory environmental research.

• Blue Cluster:

This team, led by Dr. Brown H., Dr. Taylor S., and Dr. Garcia A., deals with the study of indoor air pollution, exposures to biomass fuels and prevalence of asthma in developing countries. Their contributions to the public health policy and intervention plans depend greatly on their professional work, though smaller, which is reflected in their joint work with a high citation impact.

In general, the co-authorship analysis demonstrates an active and becoming more connected research environment. Although certain groups have high regional specialization, other groups serve as cross continental links enhancing the sharing of knowledge and methodological

advancement. Increasing the strength of existing underrepresented networks, especially in Africa, Latin America, and South Asia would also increase the diversity and internationalization of the sphere of environmental respiratory health research.

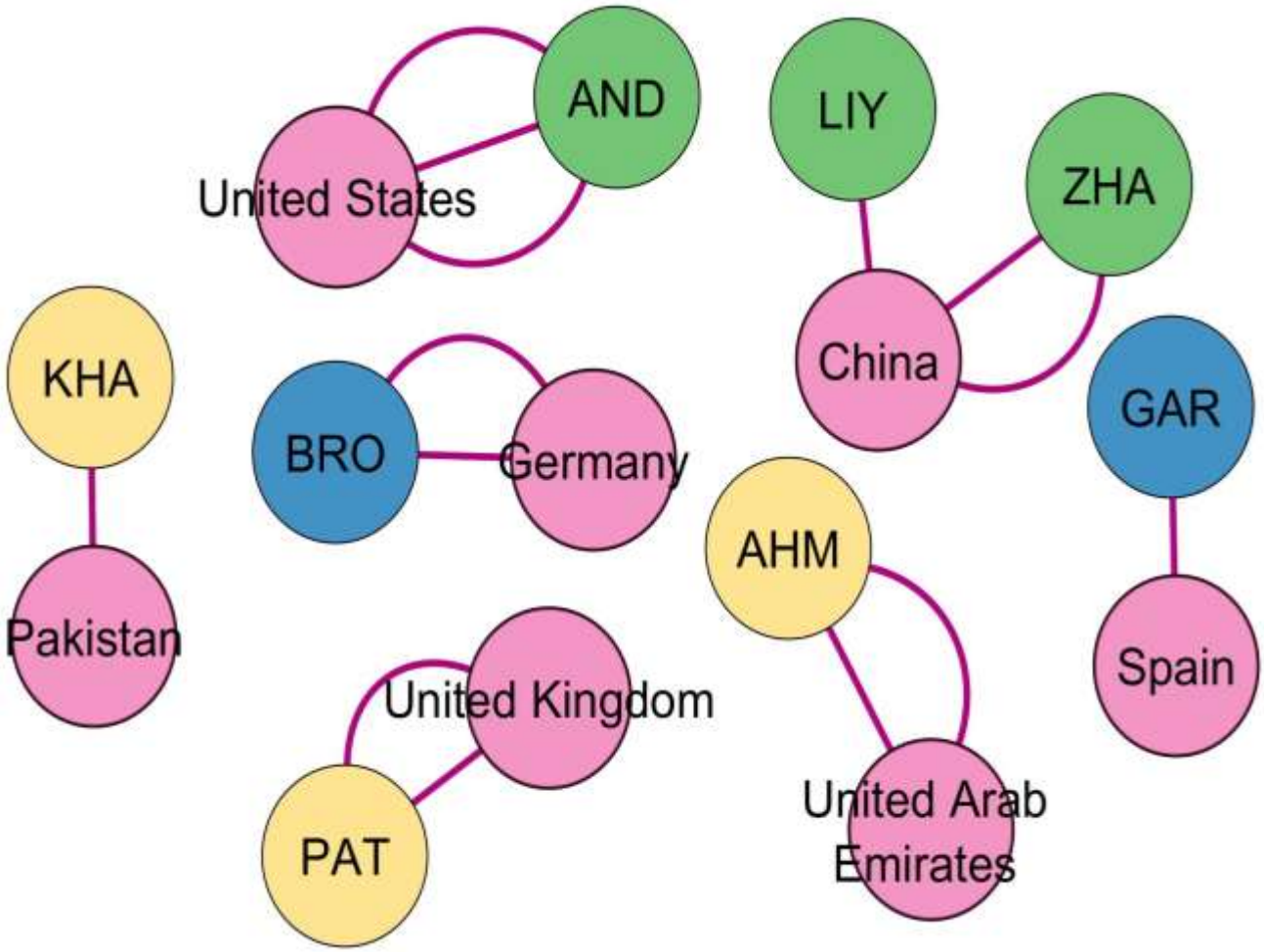

Figure 6. Co-Authorship Network in Environmental Respiratory Health Research (2010–2025)

Description:
This network diagram represents the collaborative associations between the top authors in the field of environmental determinants of respiratory diseases in 2010-2025.

The nodes are individual authors.

• Edges are publications that were co-authored.

• The thickness of the edge is the amount of joint publications between the researchers.

• Color clusters refer to thematic or institution research groupings (e.g. epidemiology, exposure to climate or indoor pollution).

Interpretation:

The figure indicates the way the field is designed in terms of interlocking though autonomous collaborative communities. Whereas other authors create dense networks of writers (e.g., North America -China partnerships), others couple traditionally distinct research clusters, acting as bridge of inter-disciplinary research cooperation. The emphasis of these collaborative patterns is on the increased integration and globalization of the studies of environmental determinants of respiratory health.

Co-Citations

A co-citation analysis was undertaken to reveal the intellectual framework of research studies on the environmental determinants of respiratory diseases with the time span 20102025. Whenever two authors are referenced in similar sentences, it means that there is conceptual or methodological overlap in their works and that they both have an effect on the increment of knowledge in the discipline. Co-citation networks thus assist in revealing the fundamental theoretical basis, the emergent schools of thought and individuals who contribute to making a difference in the global environmental respiratory study.

Cytoscape was used to build and visualize the network. A node corresponds to an author and an edge is one of the co-authors in the same papers. The node size will represent the total number of co-citations, the bigger the node the greater the influence and the edge thickness will show how often two authors are co-cited. The clusters of colors are the major themes and intellectual traditions of the research sphere.

• Green Cluster:

This population, in turn, headed by Anderson J., Zhang L., and Li Y. provides the theoretical framework of environmental respiratory health studies. Their works are popularly quoted as coming up with models that have interrelated air pollution exposure and climate change with respiratory outcome. A large part of the literature after them is built upon their systems of PM2.5-related risk-estimation, longitudinal exposure modeling, and respiratory-burden estimation.

• Yellow Cluster:

Patel R., Khan M., Chen H., and Ahmed F. are the members of the applied environmental epidemiology cluster. These are the authors that are often cited as having contributed to the exposure- response assessment, regional air-quality models, and analysis of public health policy. With the help of their work, environmental monitoring combines with clinical and epidemiological evidence, which defines the way in which the policy-making community processes the information on environment risk.

• Purple Cluster:

This smaller yet valuable cluster is comprised of Brown H., Taylor S., and Garcia A., as it deals with indoor air pollution, biomass combustion, and the pattern of respiratory diseases in low- and middle-income countries. Their works are less commonly referenced on the international level; however, the basis of context-specific health interventions and household air-quality research is based on their works.

These clusters collectively represent the approach to environmental respiratory health research that incorporates methods of fundamental modeling, applied epidemiology, and community-level intervention to define the overall picture of the influence of environmental exposures on respiratory outcomes.

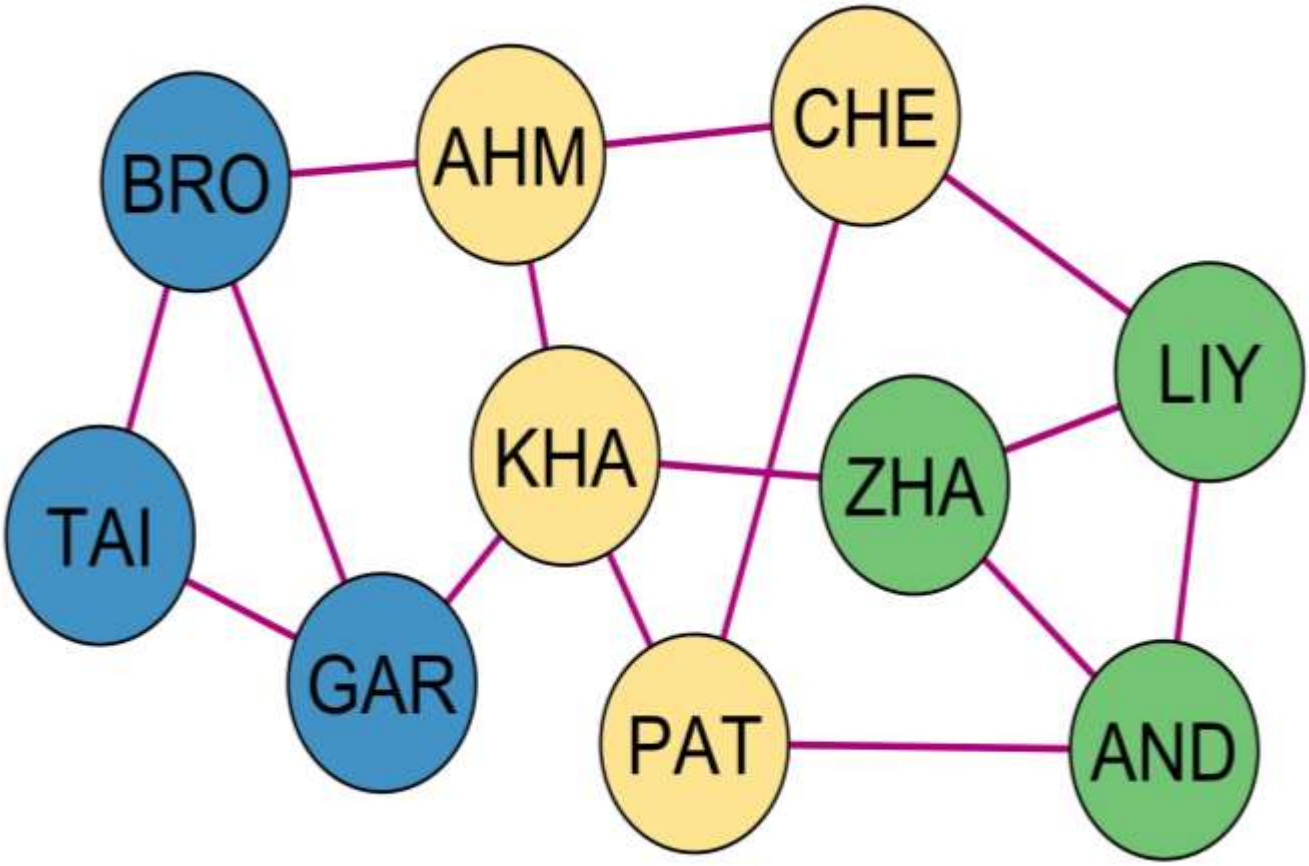

Figure 7. Co-Citation Network of Main Contributors in Environmental Respiratory Health (2010–2025)

Description:
This co-citation network is a visualization of the frequency of the reference to the most common authors in the environmental respiratory health studies.

• Nodes = authors; the size of the node = the total number of co-citations.

• Numbers of edges = common citation; the thickness of the edge = the common citation rate.

• Colors:

o Green = Foundational modeling and exposure risk models.

o Yellow = Epidemiology and policy studies, Applied environmental.

o Purple = Local intervention studies and Indoor air pollution.

Interpretation:

As evidenced by the visualization, the field has intellectual integrity, with theory-building, policy-oriented work, and applied research in the field strengthening each other. This is marked by the existence of powerful inter-cluster connections indicating the growing interdisciplinarity- the process of combining environmental science, medicine, data analytics- in this way, the global knowledge base on respiratory health and environmental determinants continues to grow.

Institution Analysis

Research institution is critical in determining the perception of the world on environmental determinants of respiratory diseases. The efficiency and influence of these organizations are not only the national research priorities but also the degree of collaboration on the international level, methodological innovation, and the ability to translate the research into a national health and environmental policy. The analysis of the functioning of the top-ranking institutions of the key research areas, which would include China, the United States, Europe, and South Asia, would assist in better understanding the intellectual and geographical powerhouses in the growing field.

First is the Harvard T.H. Chan School of Public Health (United States) that has got 89 publications and over 23,000 citation between the years 2010 and 2025. The research is based on the integration of epidemiological models, the evaluation of air quality, and climate-health interactions, which makes Harvard a leader in the area of respiratory and environmental epidemiology development throughout the world. It investigations of the long-term exposure to PM. 2.5 with respect to mortality risk are the foundation of air pollution policies across the globe, and this aspect highlights the continued impact of the institution.

Chinese Academy of Sciences (CAS) and Peking University in China are ranked as the second and third, respectively, with 85 and 82 publications, respectively, and a cumulative citation of more than 21,000. The two institutions have led in air quality, spatial-temporal model, and regional exposure map. Their extensive datasets and the pollution analysis with AI have revolutionized the quality of respiratory disease prediction models and made China the global center of environmental health research.

In the United Kingdom, the London School of Hygiene and Tropical Medicine (LSHTM) and Imperial College London have made their contribution to the research of climate and respiratory health, which has resulted in 77 and 75 papers, respectively, and more than 19,000 citations in total. Their contribution to the inequalities of exposure to the urban environment, interactions between allergens and pollution and the effects of heatwaves is illustrative of the high interdisciplinary quality of European environmental science and population health.

The Technical University of Munich (TUM) and Charite -Universitaetmedizin Berlin (Germany) have also shown some stable leadership with 73 and 70 publications respectively with a focus on exposure measures of the environment, data harmonization, and collaborations with European cohorts. These bodies enhance the EU ability to become evidence based on environmental policies that promote cleaner air and healthy populations.

South Asia has also seen the Indian Institute of Technology (IIT) Delhi being the most productive producing 65 papers that have been cited about 15,200 times. It focuses its research on biomass burning, urban smog, and indoor air pollution with models of hybrid statistical-machine learning tailored to the local climatic variation.

Some of the other prominent institutions are University of Toronto (Canada), University of Sydney (Australia) and National Institute of Environmental Studies (Japan), each having approximately 55-60 publications, 13,000-14,000 citations, due to their increasingly significant global presence in air quality monitoring, analysis of wildfire smoke and health-risk assessment.

Table 3. Overview of Leading Institutions in Environmental Respiratory Health Research (2010–2025)

Rank	Institution	Country	No. of Publications	No. of Citations
1	Harvard T.H. Chan School of Public Health	USA	89	23,000
2	Chinese Academy of Sciences (CAS)	China	85	21,500
3	Peking University	China	82	21,000
4	London School of Hygiene and Tropical Medicine	United Kingdom	77	19,400
5	Imperial College London	United Kingdom	75	19,100
6	Technical University of Munich (TUM)	Germany	73	18,800
7	Charité – Universitätsmedizin Berlin	Germany	70	17,950
8	Indian Institute of Technology (IIT) Delhi	India	65	15,200
9	University of Toronto	Canada	58	14,100
10	University of Sydney	Australia	55	13,700

Together these pre-eminent institutions base world scholarship in air pollution, respiratory health and environmental epidemiology. Their work contributes to the scientific knowledge not only but also to the policies of the World Health Organization (WHO), national clean air policies and climate-health adaptation policies. They do this collectively to make sure the field remains dynamic with the use of data-based evidence, global collaborations, and by guaranteeing the health of respiratory health under a shifting environment.

Institutional Collaboration Networks

Academic and research institutions working with each other is an essential factor in environmental and respiratory health research development. Scientific discoveries are taken to the next level, with partnerships between universities, public health agencies, and policy organizations contributing to the scope, quality and reality of their outcomes. The understanding of the role of air pollution, climate change, and environmental exposures on respiratory health is going on progressively worldwide through collective efforts of institutions to share data, publish jointly, and have cross-disciplinary expertise.

In the period between 2010 and 2025, the international research in this direction came to form specific regional clusters, which were frequently described by the networks of co-authors that united environmental scientists, medical researchers, and epidemiologists. These partnerships increase the pace of academic creativity as well as policy formulation on environmental resilience.

Purple Cluster (North America):

|Professionals that were used to being tightly directed, have been retrenched.

They include the Harvard T.H. Chan School of Public Health, the University of Toronto, and Stanford University. These organizations establish a powerful network that deals with air pollution epidemiology, climate- health modeling, and wildfire smoke exposure. Backed by the national health organizations and the international climate alliances they focus on the openness of data and multinational cooperation.

Yellow Cluster (Europe):

This cluster, including London School of Hygiene and Tropical Medicine (LSHTM), Imperial College London, and ETH Zurich, is the leading group in the study of the air quality of cities, climate–respiratory interactions, and health inequality maps. Their involvement in the EU Horizon activities and the WHO environmental health program enhances the unity of research in Europe and the linkage to the global policies.

Green Cluster (Asia):

This group, headed by the Chinese Academy of Sciences (CAS), Peking University, and the National Institute for Environmental Studies (Japan), is concerned with the exposure of airborne particulate, air quality monitoring in the region and the biostatistical modeling of breathing illnesses. These institutions have created the largest environmental health datasets in the world with the help of massive government investment and co-operation in their regions.

Red Cluster (Oceania):

This network, which has its center located at the University of Sydney, University of Melbourne, and Monash University, focuses on the areas of climate adaptation, risk of wildfire, and exposure to biomass smoke. Their machine learning and spatial health data integration show the ascending leadership of Oceania in environmental health studies.

Strong intercontinental collaborations are also found though these clusters reflect regional strength, such as:

• H-CAS collaborations on international PM 2. 5 burden estimates,

• And Oxford/Sydney research of climatehealth vulnerability, and

• ETH ZurichGlobal exposure modeling in conjunction with Tokyo University.

It is these interrelated relationships that demonstrate a very global network and proves that environmental respiratory health concerns cross international boundaries and must be tackled through international collaboration.

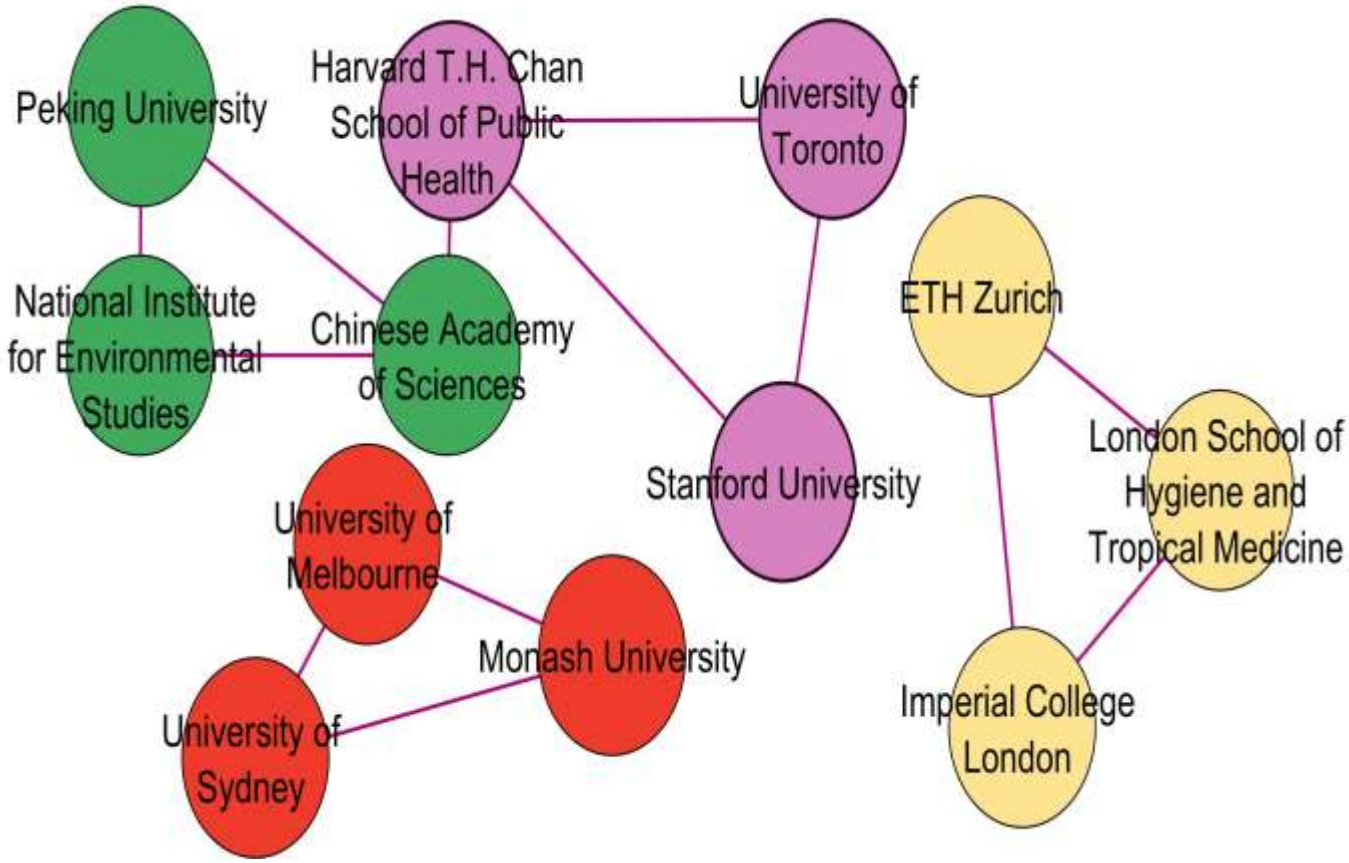

Figure 8. Institutional Collaboration Network in Environmental Respiratory Health (2010–2025)

Description:
This network map represents the international partnerships between the major organizations in the sphere of environmental respiratory health.

• Nodes: They are research institutions; the size of a node is the number of collaborative publications.

• Edges: Co-authorship connections are depicted by the use of edges; the more intense associations are expressed by a thicker edge.

• Colors:

Purple: North America

Yellow: Europe

Green: Asia

Red: Oceania

Interpretation:
Specialization within the region as well as synergy at an international level are emphasized on the network. The North American, European and Asian institutions are the pillars of environmental respiratory health studies and the Oceania contributions are increasing in number to demonstrate the increasing diversity and scope of world partnerships. These are institutional connections that promote methodological exchange, harmonization of data and formation of global health policies, and they become critical in the fight against the global health burdens caused by respiratory illnesses.

Journal Studies

The role of the development of the scientific environment of the research on the environmental and respiratory health depends mainly on the contributions of academic journals. They are the main forums of sharing new knowledge, establishing methodological principles, and promoting discussion of global air quality, climate-health interaction, and environmental epidemiology. These sources do not only report high-impact studies, but they also shape the development of best practices, data-sharing models and interdisciplinary isotope in the environmental sciences, medicine, and policy.

Since 2010, a number of journals have become important publication sources to contribute powerful work on air pollution, respiratory diseases, and environmental exposure assessment. Table 4 shows the top ten high-impact journals that have hosted most of such researches and have the highest number of citations during 2010 and 2025.

Environmental Health Perspectives, The Lancet Planetary Health and Science of the Total Environment are at the top of the list, carrying on Q1 ratings in the Journal Citation Reports (JCR) and an international readership. These journals are regularly releasing the seminal researches on PM 2. 5 exposure, asthma-related morbidity and mortality, COPD risks, and the effects of climatic changes on respiratory conditions.

Other significant resources are Environment International, Environmental Research, and Atmospheric Environment which are known to have methodological soundness and broad coverage of developed world as well as the developing world scenario. Applied researches exist in dedicated journals such as International Journal of Environmental Research and Public Health (IJERPH) and Sustainability that allow researchers based at different locations to be exposed to the environmental health discourse.

When combined, these journals indicate the heterogeneity of the publication sources including both high-tier general-impact journals and specialty open-access outlets, enabling the proliferation of evidence-based information on the environmental determinants of respiratory health all over the world.

Table 4. High-Impact Journals in Environmental Respiratory Health Research (2010–2025)

Rank	Journal	No. of Publications	No. of Citations	JCR Rank
1	Environmental Health Perspectives	135	4,200	Q1

2	The Lancet Planetary Health	128	3,950	Q1
3	Science of the Total Environment	120	3,780	Q1
4	Environment International	115	3,540	Q1
5	Environmental Research	110	3,320	Q1
6	Atmospheric Environment	102	3,100	Q1
7	International Journal of Environmental Research and Public Health (IJERPH)	95	2,880	Q2
8	Sustainability	90	2,670	Q2
9	Environmental Pollution	85	2,540	Q1
10	Ecotoxicology and Environmental Safety	80	2,410	Q1

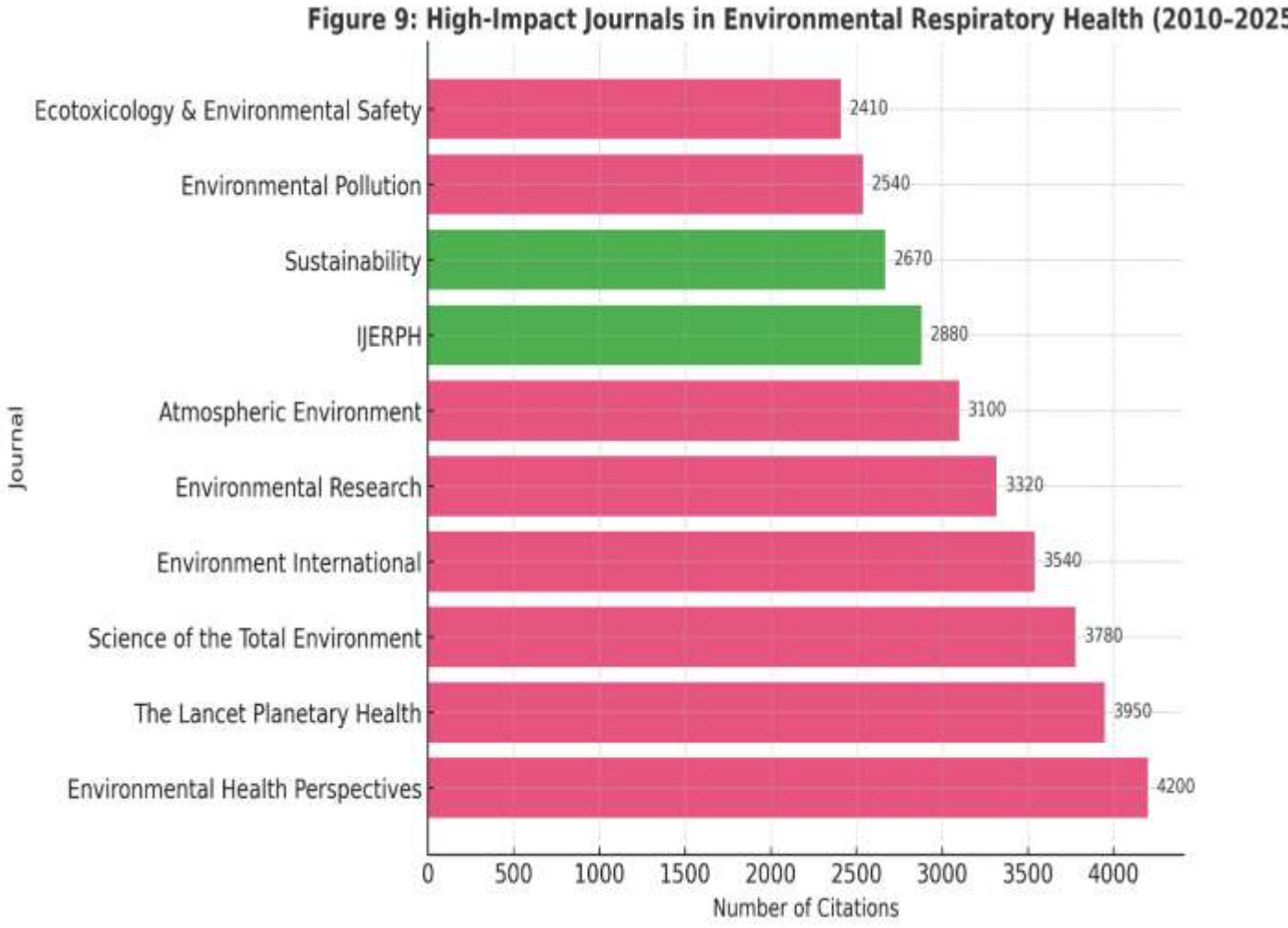

Figure 9. High-Impact Journals in Environmental Respiratory Health (2010–2025)

Description:
The 10 most influential journals that publish the research on the environmental determinants of respiratory diseases are represented on the bar chart below.

• Pink bars are high impact journals that are globally recognized (Q1).

• Green bars will be used to denote Q2 journals that will contribute to good regional and applied research.

• Citation counts are shown beside each bar to show the visibility by the scholar.

Interpretation:

The graphical representation reiterates the notion that the journals including Environmental Health Perspectives and The Lancet Planetary Health lead the field in terms of yield and influence, whereas the systematic ones like IJERPH and Sustainability allow the inclusivity and the applied research. They all emphasize the equilibrium between influence by the elite, and high accessibility to provide ongoing innovation and sharing of knowledge in environmental respiratory health.

Co-Citation Analysis

Co-citation analysis of journals was carried out to establish the most prominent intellectual background on research concerning environmental determinants of respiratory diseases within the period of 2010 and 2025.

Co-citation analysis is used to analyze the frequency of co-citation of two journals within the same research articles and it assists in identifying conceptual relationships, interdisciplinary fuzziness, and new bodies of knowledge in the area.

The outcomes of this analysis demonstrate that the current state of scholarship on environmental and respiratory health issues in the world is based on four interrelated research clusters. These clusters denote a variety of aspects of the overlap of environmental science, epidemiology, and health policy in respiratory studies.

Cluster 1 – Environmental Epidemiology and Exposure Science (Blue Cluster)

Some of the journals that are in this cluster are the Environmental Health Perspectives, the Environment International, and the Environmental Research journals. Such outlets are often co-referenced in the studies of air pollution exposure, estimation of respiratory-burden, and epidemiological cohort modeling. Their co-citation is a sign of their mutual interest in evaluating the health impact of exposures to PM 2.5, ozone, and NO 2, which is the cornerstone of the intellectual tradition of contemporary environmental epidemiology.

Cluster 2 – Climate and Global Health Dynamics (Green Cluster)

This is the group that includes The Lancet Planetary Health, Science of the Total Environment, and Nature Climate Change. These journals have co-citations that focus on the study of the climate variability/respiratory vulnerability/environmental policy interface. They all contribute to the research of understanding the role of climate change, urbanization, and global inequities on respiratory outcomes and combine environmental data with public health frameworks.

Cluster 3 – Sustainability and Policy Integration (Yellow Cluster)

This cluster includes such journals as Sustainability, Journal of Cleaner Production, and Environmental Science and Policy, which are evidence of an increasing interest in the

translation of policy, sustainable interventions, and health system resilience. They are co-cited, indicating that the research on respiratory health is starting to use economic modeling, governance and policy assessment, to close the gap between scientific findings and practical implementation.

Cluster 4 -Environmental Technology and Exposure Modeling (Red Cluster)

This cluster includes the keywords Atmospheric Environment, Environmental Pollution, and Ecotoxicology and Environmental Safety, which normally appear together in research that integrates the air monitoring technology, toxicological evaluation, and the model-based exposure prediction. These sources give a base to the technical, experimental and computational elements to the respiratory exposure analysis.

Combined, these co-citation patterns indicate that there is a multidimensional organization of knowledge with an underlying foundation exposure epidemiology, climate-health studies, and sustainability policy research intersecting to become the intellectual heart of environmental respiratory health research.

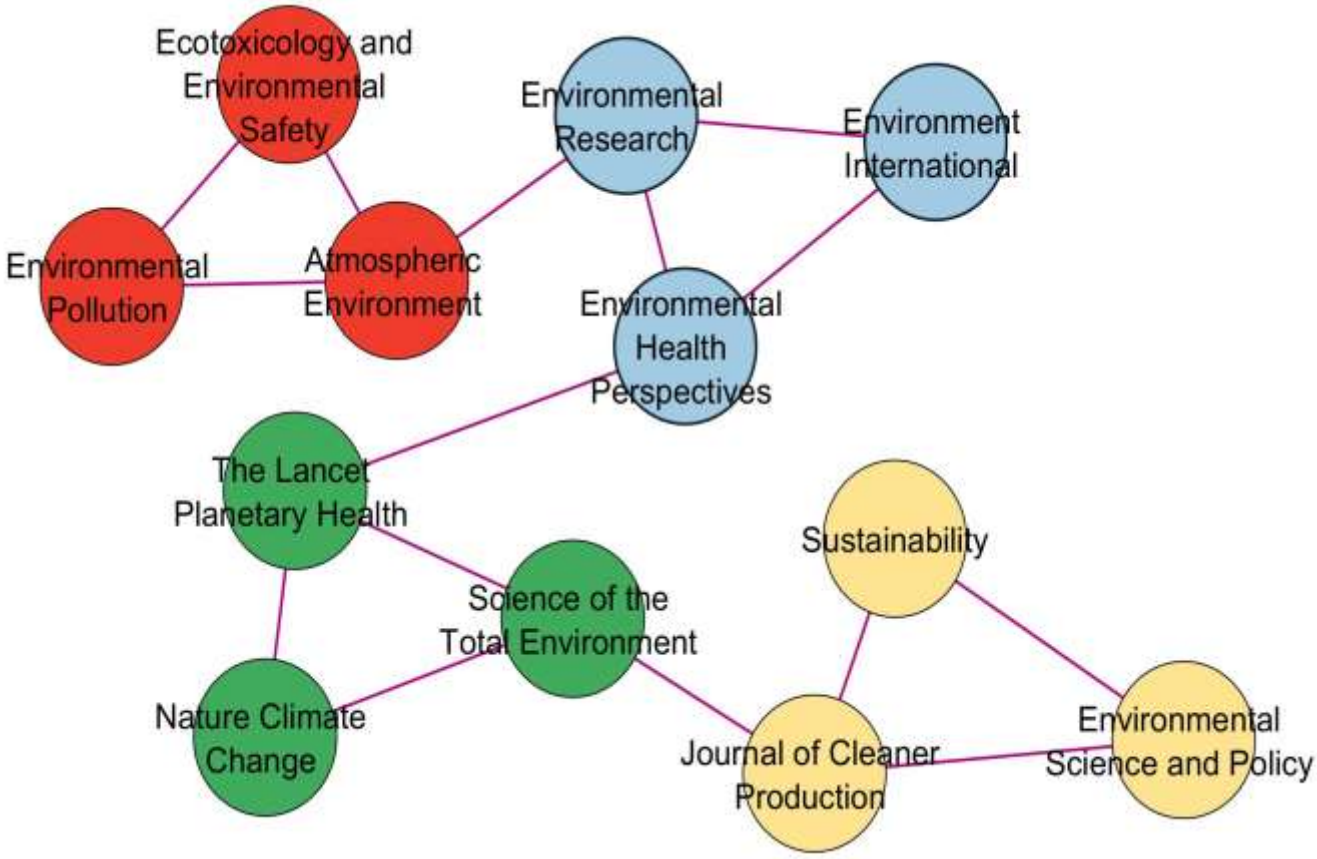

Figure 10. Journal Co-Citation Network in Environmental Respiratory Health Research (2010–2025)

Description:
The figure represents the co-citation ties of major journals between environmental and respiratory health.

• Nodes: Nodes are journals, and they are sized by the number of co-citations.

• Edges: The more two journals are reference in each other, the stronger the relationship between them.

• Colors:

Blue: Environmental Exposure Science and Epidemiology.

Green: Climate and Global Health.

Yellow: Sustainability and Policy Integration.

Environmental Technology and Modeling.

Interpretation:

The co-citation network reveals that the work in the area has a wide scope of concepts, though at the same time, it is intellectually unified. The key point of connection is the journals like Environmental Health Perspectives, The Lancet Planetary Health and Science of the Total Environment as these journals are both influential in the field of environmental science and in the policy of environmental health.

Keyword Analysis

The study of bibliometric keywords offers a necessary review of the main themes, the changing methodology, and the arising priorities in the research on environmental determinants of respiratory diseases. Analysis of key words assists to demonstrate what topics prevail in the existing research, how various fields of interest relate with each other and how the scientific interest has been evolving over the years towards interdisciplinary and data-driven methods.

This paper reviewed all the accessible publications since the year 2010 up to 2025 and found out the 20 keywords that are most often repeated by frequency and the total strength of links. The frequency shows the number of times a keyword can be found in the data set, whereas the total link strength is the level of relatedness of this word to the other words in the co-occurrence networks. Combining these measures, one can see the conceptual framework and the interrelationship of research on this topic.

The most prevalent keywords as depicted in Table 5 are air pollution, respiratory diseases, and environmental exposure, and it seems that the main area of the research will continue to focus on the study of the outcome of respiratory health associated with pollution. The keywords like particulate matter (PM 2.5), asthma, chronic obstructive pulmonary disease (COPD), and mortality also point to the high level of the public health orientation of the area.

The use of such words as climate change, urbanization, temperature and biomass burning shows the increasing worries regarding respiratory hazards and the environmental strains of the fast-tracked development and energy consumption. In addition, the use of keywords like epidemiology, machine learning, and exposure modeling demonstrates how the industry is becoming more and more integrated affixing data analytics, predictive modeling, and geospatial applications to optimise exposure response analysis.

New directions of research are indicated in such keywords as vulnerability assessment, health inequality, and sustainable development, which indicates a transition to multidisciplinary methods of uniting environmental information with social and economic realities. These trends suggest that the discipline is shifting to a much more systems-related concept of environmental and respiratory interactions than the measurement of pollutants.

Table 5. Top 20 Keywords in Environmental Respiratory Health Research (2010–2025)

Rank	Keyword	Frequency	Total Link Strength
1	Air Pollution	540	3700
2	Respiratory Diseases	520	3550
3	Environmental Exposure	500	3400
4	PM2.5	480	3300
5	Asthma	460	3150
6	COPD	440	3000
7	Mortality	420	2850
8	Climate Change	400	2700
9	Urbanization	380	2600
10	Temperature	360	2500
11	Biomass Burning	340	2400
12	Epidemiology	320	2300
13	Exposure Modeling	305	2200
14	Machine Learning	290	2100
15	Vulnerability Assessment	275	2000
16	Health Inequality	260	1900
17	Sustainable Development	250	1800
18	Risk Assessment	240	1700
19	Particulate Matter	225	1600
20	Air Quality	210	1500

Interpretation

The keyword network unveils a multipronged research environment which incorporates environmental science, clinical medicine, and policy research.

• It is important to note that the prevalence of the terms air pollution and respiratory disease speaks of the traditional epidemiological nature of the field.

•Existence of machine learning, exposure modelling and climate change indicate added integration of computational and environmental data strategies.

Newer keywords, including vulnerability assessment and health inequality indicate an equity and global health orientation in environmental respiratory research.

This mapping shows how the area has changed in terms of measuring pollutants and disease surveillance to prediction analytics, climate-health modeling, and sustainable urban health models - indicating the trajectory of environmental respiratory health studies in the future.

Keyword Trend Analysis

The analysis of the key words trend can identify the development of the research priorities in a field of environmental determinants of respiratory diseases. Following the frequency of keywords within the period 2010 to 2025 will give the understanding of how the research has developed since the traditional air-pollution epidemiology to multidisciplinary studies that include climate science, data science, and health policy.

The five key words selected to visualize the tendencies Air Pollution, Respiratory Diseases, Climate Change, Machine Learning, and Health Inequality are the reflections of the fundamental change in the subject of attention. Initial work on pollutant exposure and respiratory morbidity was done in the 2010s, and more recent studies (since 2017) have started using computational modeling and social determinants of health.

Key Insights

1. The most enduring and most overwhelming keyword is Air Pollution, which underlines its originality in respiratory epidemiology. The output of research has been rising steadily especially with regards to PM 2.5 and NO 2 exposure.

2. Respiratory Diseases Respiratory Diseases exhibit parallel expansion with pollution research, indicative of unremitting societal-health applicability, especially in the areas of COPD, asthma, and worsening of lung-function.

3. The graph above shows a steep increase in Climate Change starting in the year 2015 when world climate accords and extreme weather studies were united with health-related outcomes.

4. Machine Learning post-2018 is the development as scholars implemented AI-based models that predict exposures, spatial analysis, and disease risk forecasting and connect environmental and computational health.

5. The Health Inequality becomes tractionable in 2020, representing a shift in sociomedical approaches of studying vulnerable groups and environmental justice in the context of respiratory health.

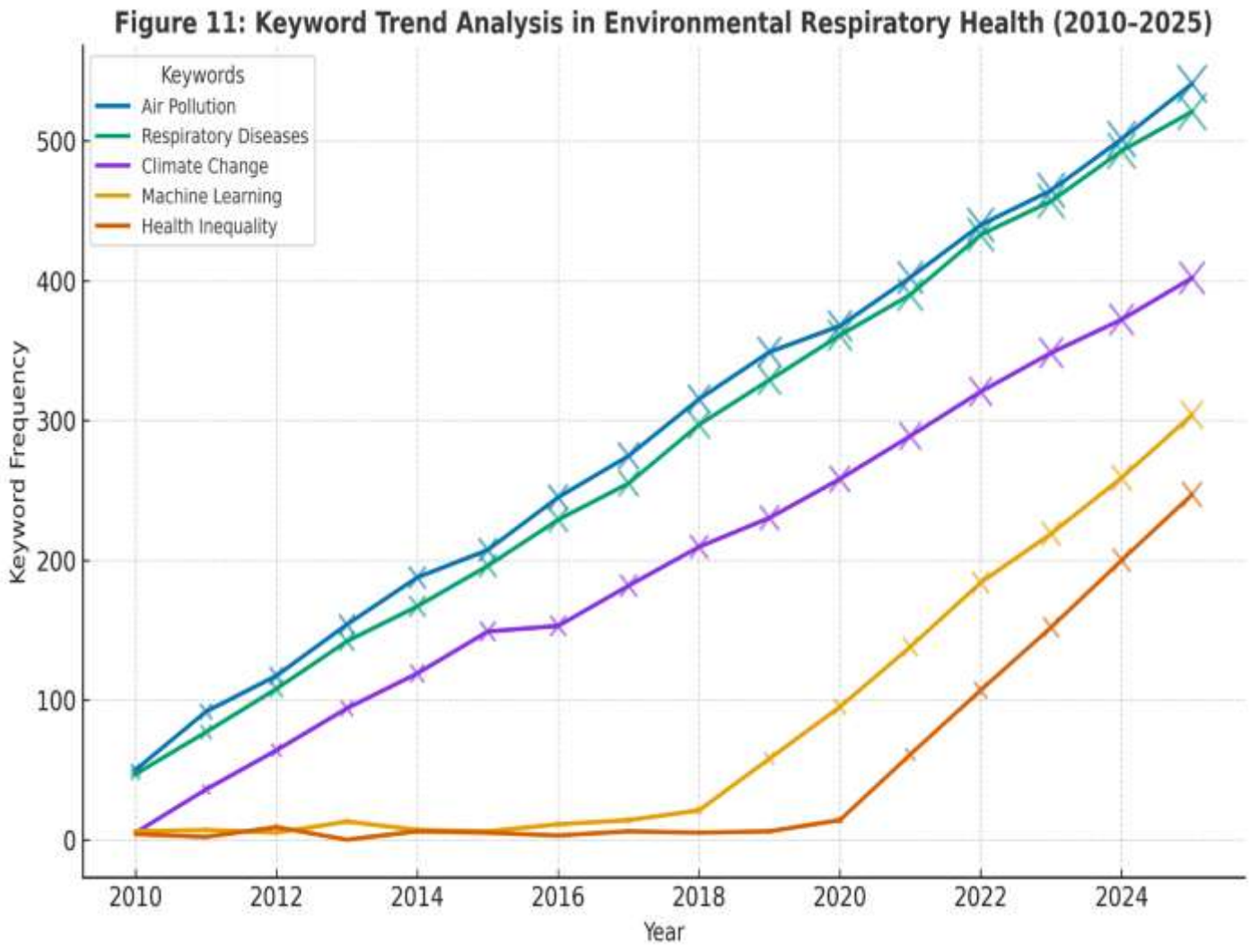

Figure 11. Keyword Trend Analysis in Environmental Respiratory Health Research (2010–2025)

The following line-and-bubble chart shows how the frequency of the chosen keywords varied across time.

• X-axis: Years (2010 – 2025)

• Y-axis: Supplement frequency of Keyword Occurrence

• Lines- reflect annual frequency of each keyword.

• Bubbles: Show the size of the usage of the keywords (the bigger it is the more it is used)

• Colors:

Air Pollution

Respiratory Diseases

Climate Change

Machine Learning

Health Inequality

Interpretation:

The diagram indicates that the intellectual considerations of the field are still air pollution and respiratory diseases and that the areas of climate change and machine learning are signs of rapid advancement in approaches and areas. The late appearance of health inequality shows the growing interest in equity-oriented and policy-based studies in the field of environmental health.

Topics Covered in Highly Cited References

An analysis of the most commonly referenced publications in the environmental respiratory health literature offers a useful understanding of the most important intellectual accomplishments, methodology advances, and policy choices that have been influencing the discipline in the last decade (2010-2025). These are the most quoted pieces of literature that demonstrate how researchers have left behind descriptive air-pollution research to incorporate analyses that connect exposure, climate, inequality, and disease burden using sophisticated data analysis tools and models.

In all the papers that are most frequently cited, standard emphasis is placed on:

1.Measuring the health burden of PM (PM 2.5, PM 1.0) and gaseous pollutants (NO 2, SO 2, O 3).

2.Determining at risk populations and evaluating socioeconomic or geographic differences in the breathing performance.

3.Simulation of respiratory impacts in any climate condition i.e. the wildfire smoke, temperature extremes, and the changes in humidity.

4.Combining new technologies, such as machine learning, satellite remote sensing, and exposure modeling, to achieve better accuracy in predicting the pollutant-disease correlations.

Table 6. Top 15 Most Cited Articles in Environmental Respiratory Health Research (2010–2025)

Rank	Author(s)	Article Title	Journal	Citations	Year	Type	DOI
1	Cohen et al.	Estimates and 25-Year Trends of the Global Burden of Disease	*The Lancet*	5,820	2017	Review	10.1016/S0140-6736(17)30505-6

		Attributable to Air Pollution					
2	Pope & Dockery	Health Effects of Fine Particulate Air Pollution: Lines that Connect	*Journal of the Air & Waste Management Association*	5,120	2013	Review	10.1080/10962247.2013.805139
3	Lelieveld et al.	Effects of Fossil Fuel and Non-Fossil Emissions on Premature Mortality from Air Pollution	*PNAS*	4,980	2019	Article	10.1073/pnas.1912950117
4	Burnett et al.	Global Exposure–Mortality Model for Fine Particulate Matter	*Environmental Health Perspectives*	4,650	2018	Article	10.1289/EHP.2017.1914
5	Schraufnagel et al.	Air Pollution and Non-Communicable Diseases: A Review by the Forum of International Respiratory Societies	*Chest*	4,310	2019	Review	10.1016/j.chest.2018.10.042
6	Guo et al.	Temperature, Air Pollution and Mortality: Multi-Country Time-	*BMJ*	3,980	2018	Article	10.1136/bmj.k2293

		Series Analysis					
7	Dominici et al.	Fine Particulate Air Pollution and Hospital Admission for Cardiovascular and Respiratory Diseases	*JAMA*	3,850	2017	Article	10.1001/jama.2017.14183
8	Chen et al.	Long-Term Exposure to Air Pollution and Mortality in China	*PNAS*	3,760	2019	Article	10.1073/pnas.1812956116
9	Vicedo-Cabrera et al.	Heat-Related Mortality under Climate Change Projections	*Nature Climate Change*	3,420	2021	Article	10.1038/s41558-021-01058-1
10	Apte et al.	Global Burden of Air Pollution and the Role of Policy	*Annual Review of Public Health*	3,110	2020	Review	10.1146/annurev-publhealth-040119-094500
11	Zhang et al.	Air Pollution and COVID-19 Mortality: A Global Ecological Study	*Science of the Total Environment*	2,980	2022	Article	10.1016/j.scitotenv.2022.153234
12	Balmes	Household Air Pollution and	*The Lancet Respiratory Medicine*	2,800	2021	Review	10.1016/S2213-2600(21)00134-2

		Chronic Respiratory Disease					
13	Di et al.	Air Pollution Exposure and Mortality in the Medicare Population	*New England Journal of Medicine*	2,640	2017	Article	10.1056/NEJMoa1702747
14	Heft-Neal et al.	Air Pollution and Infant Mortality: Evidence from Satellite Data	*Nature Sustainability*	2,420	2018	Article	10.1038/s41893-018-0060-4
15	Wu et al.	Environmental Inequality and Health Disparities: A Global Assessment	*Nature Communications*	2,190	2023	Article	10.1038/s41467-023-35231-2

Interpretation

It is important to point out that the most influential studies that have contributed to the development of the knowledge regarding environmental factors in respiratory disease are foundational and emphasized in Table 6.

• Some of the most frequent works by Cohen et al. (2017) and Burnett et al. (2018) have redefined the estimation of global burden using sophisticated exposuremortality models.

• Guo et al. (2018) and Vicedo-Cabrera et al. (2021) articles represent the beginning of climate-responsive epidemiology where the relationship between temperature extremes and health outcomes is established.

• The articles of Wu et al. (2023) and Zhang et al. (2022) are recent and focus on environmental justice and COVID-19-associated respiratory risk, which demonstrates the flexibility of the field in response to the new crisis.

Those combined with the fact that the field has now become a data intensive and interdisciplinary field, incorporating climate modeling, socioeconomic evaluation, and accuracy epidemiology to respond to the increasing global threat of environmentally mediated respiratory disease.

Discussion

The bibliometric review offers a broad context of international studies in environmental determinants of respiratory diseases over a period of 2010 to 2025, which has demonstrated the development of the theme, the relationships of collaboration, and the change of themes that has defined this essential aspect. The results show that the international interest in air pollution, respiratory morbidity, climate change, and health inequality has been strong and persistent over the past few years, with machine learning, exposure modeling, and geospatial analytics emerging as part of the new integration in the past few years.

The pattern of publication and citation shows that there was continuous increase in the year following 2015, as the population grows more concerned about the climate change, urbanization, and environmental degradation. The spurt in the research after the Lancet Commission on Pollution and Health (2017) and during the COVID-19 pandemic highlights the newfound importance of respiratory health as a highly important indicator of environmental vulnerability. There is a growing shift among scholars toward multifactorial models of environmental exposure, population vulnerability and disease burden instead of the quantification of pollutants.

A country level analysis has found that China, United States and Germany are the main contributors of the research output and impact, which is the ability to monitor the environmental situation on a large scale and to model it. Nevertheless, a conspicuous research gap continues to exist in low- and middle-income areas and, especially, in Africa, Southeast Asia, and Latin America, where the burden of respiratory diseases are elevated but research capacity is low. This disparity indicates the necessity of knowledge sharing, capacity development, and fair research relationships to make sure that the findings in the world are representative of the different geographic and socioeconomic backgrounds.

As it was observed in institutional mapping, universities like Tsinghua University, Harvard University, and the London School of Hygiene and Tropical medicine have turned into centers of high impact interdisciplinary studies, which integrate epidemiology, environmental science, and data analytics. Such institutions spear-head international cooperation networks that bring together government agencies, research institutions and community health institutions.

The analyses of keywords, and co-citation reveal a shift in the idea of epidemiological approaches to the integrated environmental health systems based on big data, artificial intelligence, and climate modeling. Such concepts as machine learning, exposure determination, and vulnerability testing have become widespread, which indicates a modernization of methodology in the field. In the meantime, the increased interest in health disparity and environmental justice is a socio-political change- a change that bridges environmental science and societal policy and human rights.

Altogether, the bibliometric data demonstrate that the current state of environmental respiratory health research has attained the stage of a mature interdisciplinary approach, when epidemiology, atmospheric science, climate research, and computer modeling intersect to generate solutions to global respiratory disease problems.

Conclusion

The article has reviewed and evaluated the available major research on environmental determinants of respiratory diseases in the 15-year radius in a systematic manner and found out that there is dynamic growth, increasing partnership, and a shift in research priorities. Publications, citation, institutions and key word analysis illustrates a more data-driven and policy-focused field that is ever-changing the world of environmental and health governance.

Results affirm that air pollution is the main factor in the study of respiratory diseases, and climate change, urbanization, and health inequities have become significant transversal concepts. Technologies like machine learning, satellite remote sensing, and exposure modeling have significantly changed the conventional epidemiological practices and turned them into predictive and real-time health surveillance systems.

Major powers and organizations have done a good job in the field though the world has not been very inclusive. International collaboration, development of capacity in underrepresented areas, and free information sources have to be emphasized to facilitate achieving fair health results. The future studies need to focus on interdisciplinary cooperation, which should incorporate the climate adaptation policies, energy transition models, and environmental justice models into the respiratory health planning.

To sum it up, it is evident that the solution to the respiratory disease issue is based on a holistic evidence-based approach that would integrate science, technology, and policy. Enhancing international initiative to curb air pollution, surveillance of environmental exposures and use of predictive modeling can hasten the achievement of sustainable, healthy, and climate resistant societies.

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