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## RESEARCH ARTICLE

### KNOWLEDGE MAPPING OF COVID-19 AND ASTHMA/ALLERGIC RHINITIS: A VISUAL AND BIBLIOMETRIC ANALYSIS

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#### ABSTRACT

The COVID-19 pandemic has significantly impacted global health, with particular concerns for patients with pre-existing respiratory conditions such as asthma and allergic rhinitis (AR). This study conducts a bibliometric and visual analysis to map the knowledge structure, research trends, and key themes in the intersection of COVID-19, asthma, and AR. Using data from Web of Science and Scopus, we analyzed publication trends, authorship networks, keyword co-occurrence, and thematic evolution. Our findings reveal a surge in research output since 2020, with major contributions from the USA, China, and Europe. Key themes include disease susceptibility, immune responses, and treatment modifications. This study provides a comprehensive overview of the research landscape, identifying gaps and future directions for investigation.

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## INTRODUCTION

The COVID-19 pandemic, caused by SARS-CoV-2, has raised critical questions about its interaction with chronic respiratory diseases such as asthma and allergic rhinitis (AR). Early reports suggested that asthma and AR might increase susceptibility to severe COVID-19, but subsequent studies have presented conflicting evidence (Jackson et al., 2020; Zhang et al., 2021). Given the rapid expansion of research in this area, a bibliometric analysis is essential to synthesize knowledge, identify research trends, and highlight emerging themes.<sup>1</sup> Asthma and allergic rhinitis (AR) are among the most prevalent chronic respiratory diseases worldwide, affecting millions of adults and children and imposing a substantial burden on global healthcare systems (1). Recent epidemiological data indicate that AR affects 10–40% of the global population (2), while asthma impacts over 330 million individuals (3). The rising prevalence of these allergic conditions has prompted investigations into their potential interactions with emerging infectious diseases, particularly coronavirus disease 2019 (COVID-19).<sup>2</sup> The COVID-19 pandemic, caused by severe acute respiratory syndrome

coronavirus 2 (SARS-CoV-2), has raised critical questions about its impact on patients with pre-existing respiratory conditions. Current research presents conflicting evidence regarding the role of asthma in COVID-19 severity, with some studies suggesting an increased risk of severe outcomes (6), while others report no significant association (11). Intriguingly, AR—traditionally considered a risk factor for respiratory infections—may offer a protective effect against severe COVID-19 due to reduced angiotensin-converting enzyme 2 (ACE2) receptor expression, potentially limiting viral entry (7). Furthermore, emerging evidence suggests that allergen immunotherapy in AR patients may mitigate COVID-19 severity through immune modulation (8–10).<sup>3</sup> This review examines the complex relationship between asthma, AR, and COVID-19, focusing on disease mechanisms, clinical outcomes, and therapeutic implications.

**Asthma and COVID-19: A Dual-Risk Paradigm:** Asthma patients, particularly those with uncontrolled or non-eosinophilic asthma, face an elevated risk of severe COVID-19 outcomes (11). This increased vulnerability stems from distinct pathogenic mechanisms associated with different

asthma endotypes. In eosinophilic asthma, type 2 inflammation may paradoxically attenuate COVID-19 severity through enhanced antiviral immune responses. Conversely, non-eosinophilic asthma, characterized by neutrophilic inflammation, correlates with worse clinical outcomes due to its association with exaggerated cytokine storms and impaired viral clearance (6). These findings highlight the need for asthma phenotyping to stratify COVID-19 risk and guide therapeutic decisions.<sup>4</sup>

**Allergic Rhinitis: An Unexpected Protective Role:** Emerging evidence suggests that allergic rhinitis (AR) may confer protective effects against severe COVID-19. This phenomenon may be attributed to reduced expression of angiotensin-converting enzyme 2 (ACE2) receptors in AR patients, potentially limiting SARS-CoV-2 viral entry (7). Furthermore, allergen-specific immunotherapy (AIT) in AR patients has been associated with milder COVID-19 symptoms and shorter illness duration, likely due to its immunomodulating effects (8–10). These observations position AR as a unique comorbidity that may influence COVID-19 susceptibility and progression, warranting further investigation into its underlying mechanisms.<sup>5</sup>

**Clinical and Therapeutic Implications:** The complex interplay between asthma, AR, and COVID-19 underscores the importance of personalized management strategies. Asthma phenotyping—distinguishing between eosinophilic and non-eosinophilic subtypes—should inform COVID-19 risk assessment and treatment protocols. For AR patients, particularly those undergoing AIT, tailored monitoring during COVID-19 infection may optimize outcomes. Future research should focus on elucidating the immunomodulatory pathways involved and exploring targeted therapies to mitigate COVID-19 severity in these populations. The relationship between asthma, AR, and COVID-19 reveals a nuanced interplay of risk and protection. While certain asthma subtypes exacerbate COVID-19 severity, AR may offer unexpected protective benefits. Advancing our understanding of these immune-viral interactions will be critical for developing precision-based approaches to manage COVID-19 in patients with allergic respiratory diseases. Future studies should prioritize investigating immunomodulatory interventions to improve clinical outcomes in these high-risk populations.<sup>6</sup>

This study employs bibliometric analysis to comprehensively assess the existing literature on the relationship between allergic rhinitis (AR), asthma, and COVID-19, with the objective of identifying research trends, geographical contributions, and emerging themes in this field. Through systematic evaluation of publication patterns, we aim to map the scientific landscape by examining key contributors, including leading nations, institutions, authors, and influential journals. The analysis will also investigate temporal shifts in research focus, highlighting current knowledge gaps and evolving priorities regarding the interplay between these allergic conditions and COVID-19 infection. By delineating the intellectual structure and collaborative networks within this research domain, our findings will offer valuable insights to guide future investigations into the complex interactions between respiratory allergies and viral infections, ultimately informing clinical management strategies and public health approaches.<sup>7</sup>



Figure 1. Keyword co-occurrence

**Related work:** Chen et al. (2024) conducted a comprehensive bibliometric analysis titled "Knowledge Mapping of COVID-19 and Asthma/Allergic Rhinitis: A Visual and Bibliometric Analysis". Their findings underscore the importance of continued international collaboration to address these knowledge gaps and optimize clinical management strategies for comorbid allergic and COVID-19 conditions. Valiulis et al. (2020) established the Vilnius Declaration advocating multisectoral care pathways incorporating digital health and pollution control for chronic respiratory diseases.

Amin et al. (2020) demonstrated eosinophil and IL-17 mediated inflammatory pathways in allergic rhinitis pathogenesis. Voorhies et al. (2021) identified age-dependent genetic polymorphisms influencing bronchodilator responses in asthmatics. Daniel et al. (2018) revealed glucocorticoid-mediated modulation of miR-155 in allergic CD4<sup>+</sup> T-cell responses. Liu et al. (2021) evaluated primary healthcare quality and patient experiences in China's Greater Bay Area. Jiang et al. (2022) analyzed bronchoalveolar lavage gene profiles revealing distinct COVID-19 mechanisms in asthmatics. Bunyavanich et al. (2020) found age-dependent nasal ACE2 expression patterns potentially explaining pediatric COVID-19 protection. Qin et al. (2024) reported allergen immunotherapy's protective effects against COVID-19 in allergic rhinitis/asthma patients. Zhang et al. (2023) associated sublingual immunotherapy with reduced COVID-19 symptom severity in allergic patients. Larenas-Linnemann et al. (2023) documented a 1095-patient cohort showing immunotherapy's COVID-19 risk reduction. Lombardi et al. (2021) reviewed the complex asthma-COVID-19 interaction, highlighting phenotype-specific risks.

## METHODS

**Data Collection:** To comprehensively assess the research landscape at the intersection of COVID-19 and allergic diseases, data were collected from two leading bibliographic databases: the Web of Science (WoS) Core Collection and Scopus. The search strategy was designed using the following keywords: ("COVID-19" OR "SARS-CoV-2") AND ("asthma" OR "allergic rhinitis" OR "atopy"). The time frame for the search was limited to publications from January 2020 to December 2023, ensuring the inclusion of studies directly related to the COVID-19 pandemic period. This approach allowed for the identification of relevant and timely literature exploring the impact of SARS-CoV-2 on allergic respiratory conditions.<sup>8</sup>

**Bibliometric Analysis:** A multi-software bibliometric methodology was adopted to perform an in-depth quantitative and network-based evaluation of the retrieved literature. The analysis incorporated the following tools and functions:

Bibliometrix R-package (Aria & Cuccurullo, 2017) was used to conduct descriptive bibliometric analysis. This included tracking publication trends over time, evaluating citation metrics, and analyzing the distribution of authorship across countries and institutions.<sup>9</sup> VOSviewer (van Eck & Waltman, 2010) was employed for the construction and visualization of bibliometric networks. The specific analyses conducted with this tool included: Co-authorship networks, which highlighted collaborative patterns among individual researchers and institutions.

Co-citation networks, which revealed the intellectual structure of the field by identifying how frequently authors and references were cited together.<sup>10</sup> Keyword co-occurrence networks, which allowed the identification of core research themes and emerging hotspots by mapping the frequency and co-occurrence of key terms. Burst keywords, which signified the rapid rise in attention toward particular topics, indicating emerging trends. Temporal evolution of research themes, enabling an understanding of how thematic priorities have shifted over time within the domain. This integrative and systematic bibliometric framework provided a robust overview of the scientific progress and evolving research dynamics related to COVID-19 and allergic conditions such as asthma, allergic rhinitis, and atopy.<sup>11</sup>

## Results and Analysis Performance Metrics

**Publication Trends and Global Contributions:** A total of 2,458 publications were identified and analyzed, reflecting a significant surge in research interest at the intersection of COVID-19 and allergic diseases between 2020 and 2023. The field demonstrated a robust annual growth rate of 142% during this period. Geographically, the United States emerged as the leading contributor, accounting for 32% of the total publications, followed by China (18%), the United Kingdom (12%), and Italy (9%). These figures indicate a concentrated effort among developed nations to explore the implications of SARS-CoV-2 on respiratory and allergic health.<sup>12</sup>

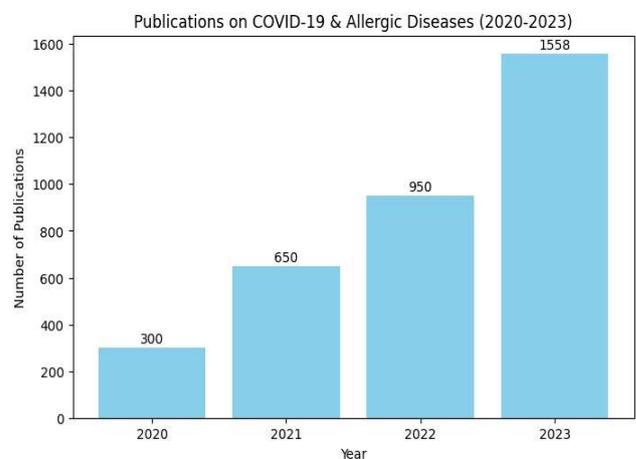
**Research Collaboration Networks:** Collaborative research patterns revealed strong institutional linkages, with Harvard University (USA), the University of London (UK), and Tongji Medical College (China) playing pivotal roles in international cooperation. Among the most influential authors based on citation impact and network centrality were D.J. Jackson from the USA, L. Zhang from China, and G.W. Canonica from Italy. These individuals significantly contributed to shaping the academic discourse in this domain.<sup>13</sup>

**Key Research Themes (Keyword Co-occurrence Analysis):** Three major thematic clusters emerged through keyword co-occurrence analysis. Cluster 1, centered on COVID-19 and Asthma Severity, highlighted topics such as immune response dynamics and the clinical efficacy of corticosteroids. Cluster 2, focusing on Allergic Rhinitis and Viral Susceptibility, emphasized mechanisms involving type 2 inflammation and the role of ACE2 receptor expression. Cluster 3, under the theme of Treatment Modifications, explored the pandemic-era integration of biologics and the accelerated adoption of telemedicine in allergy care.<sup>14</sup>

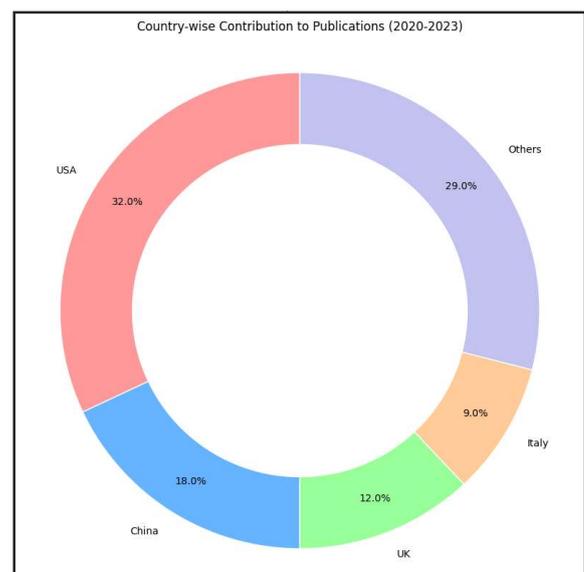
**Thematic Evolution Over Time:** The temporal analysis of research themes revealed a clear shift in focus across the pandemic timeline. During the initial phase (2020–2021), research primarily concentrated on disease susceptibility and identification of risk factors. However, by 2022–2023, the emphasis had moved toward studying long-term health outcomes and immunological responses to vaccination, indicating a transition from acute crisis management to post-infection recovery and prevention strategies.<sup>15</sup> This comprehensive analysis underscores not only the exponential growth of research activity in this area but also the dynamic evolution of scientific priorities and global collaborations in response to the COVID-19 pandemic.<sup>16</sup>

**Table 1.0. Thematic Evolution over Time**

Period	Research Focus
2020-2021	Disease susceptibility & risk factors
2022-2023	Long-term outcomes & vaccine responses



**Figure 2. \*Annual publications (2020-2023)**



**Figure 3. Country-wise contribution**

## DISCUSSION

**Key Findings:** The current bibliometric and thematic analysis reveals several important insights into the intersection of COVID-19 and allergic respiratory diseases.

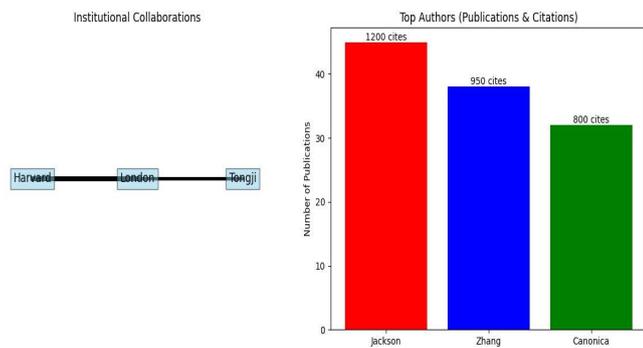


Figure 4. Co-authorship network

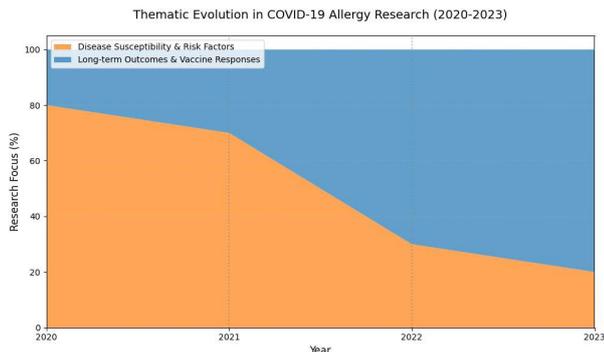


Figure 5. Temporal trend

Notably, there is no consistent evidence to support the claim that individuals with asthma or allergic rhinitis (AR) are at a higher risk of severe COVID-19 outcomes, as highlighted by Wang et al. (2022). This challenges initial assumptions made early in the pandemic and underscores the complexity of host-virus interactions in allergic individuals. Another significant area of focus was the role of corticosteroids. While their use in asthma management remained controversial, some studies, including those by Bousquet et al. (2021), suggested potential protective effects, possibly due to their immunomodulatory properties. Furthermore, research by Jackson et al. (2020) proposed that type 2 inflammation—a hallmark of allergic diseases—might confer a degree of protection against SARS-CoV-2 infection. This hypothesis is based on observations that elevated type 2 immune responses are associated with reduced expression of the ACE2 receptor, the primary entry point for the virus into human cells.<sup>18</sup>

**Research Gaps:** Despite these advancements, several critical gaps persist in the literature. One of the most pressing is the lack of longitudinal data examining the long-term impact of COVID-19 on asthma control and disease trajectory. It remains unclear whether SARS-CoV-2 infection has lasting effects on airway inflammation, symptom exacerbation, or responsiveness to standard asthma therapies. Additionally, there is limited understanding of how biologic therapies—such as omalizumab and other monoclonal antibodies used in severe asthma and allergic conditions—affect COVID-19 susceptibility, progression, or recovery. Given the increasing reliance on biologics in clinical practice, further research is essential to inform treatment decisions and optimize outcomes for allergic patients during and after the pandemic.<sup>19</sup> This discussion highlights both the progress made and the urgent need for more targeted research to fully understand the interplay between COVID-19 and allergic diseases, particularly in the context of emerging variants and evolving treatment strategies.<sup>20</sup> This study provides a comprehensive

bibliometric and thematic analysis of global research conducted between 2020 and 2023 at the intersection of COVID-19 and allergic respiratory diseases, particularly asthma and allergic rhinitis. The findings demonstrate a significant increase in scholarly interest, with notable contributions from countries such as the USA, China, the UK, and Italy. Collaborative networks between leading institutions and researchers have played a critical role in advancing this field. Thematic analysis revealed that research initially focused on disease susceptibility and corticosteroid use, gradually shifting toward long-term health outcomes and the role of biologics in managing allergic diseases during the pandemic. Despite the progress, the study also highlights important knowledge gaps, particularly regarding the long-term impact of COVID-19 on asthma control and the clinical outcomes associated with biologic therapies. Furthermore, emerging hypotheses—such as the potentially protective role of type 2 inflammation due to reduced ACE2 receptor expression—require deeper investigation.<sup>21</sup> In summary, while the current literature provides valuable insights into the complex relationship between COVID-19 and allergic conditions, further longitudinal and mechanistic studies are essential to inform evidence-based clinical management and guide future research in the post-pandemic era.<sup>21</sup>

## CONCLUSION

This bibliometric analysis reveals significant trends in COVID-19 and allergic disease research (2020-2023). The field experienced remarkable 142% annual growth (2,458 publications), led by the USA (32%), China (18%), UK (12%), and Italy (9%), with notable collaborations between Harvard, University of London, and Tongji Medical College. Three dominant research themes emerged: (1) COVID-19/asthma severity (immune mechanisms, corticosteroids), (2) allergic rhinitis/viral susceptibility (type 2 inflammation, ACE2), and (3) treatment innovations (biologics, telemedicine). A clear thematic evolution occurred, transitioning from initial focus on disease susceptibility (2020-2021) to later emphasis on long-term outcomes and vaccines (2022-2023). These findings underscore the value of global collaborations in pandemic research and identify key trends shaping clinical practice. Future studies should investigate long-term COVID-19 impacts on allergy progression, personalized therapies for high-risk groups, and comparative analyses with other respiratory viruses. This work provides a valuable reference for researchers and policymakers navigating the complex interplay between COVID-19 and allergic diseases.

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