doi.org/10.36721/PJPS/2026.40.15817.1

Global research trends and therapeutic evolution of biologic agents in allergic rhinitis: A bibliometric analysis

Xue Jiao Liu and Xu Hui Tai*
Department of Otorhinolaryngology, Air Force Hospital of the Northern Theater of the Chinese People's Liberation Army, No. 46 Xiaoheyan Road, Dadong District, Shenyang 110042, Liaoning Province, China

Abstract: **Background**: Allergic rhinitis (AR) is a prevalent immunoglobulin E (IgE)-mediated inflammatory disorder. Biologic agents are increasingly discussed for severe or refractory AR, but the global publication landscape and therapeutic evolution of this topic remain incompletely characterized. **Objectives**: To map global research trends, contributors, collaboration patterns and evolving biologic targets in AR from 2000 to 2025. **Methods**: English-language articles were retrieved from the Web of Science Core Collection using Boolean combinations of AR-related and biologic-agent terms. VOSviewer and the Bibliometrix R package were used to analyze publication growth, journals, countries, institutions, co-authorship, co-citation, bibliographic coupling and keyword co-occurrence. **Results**: A total of 546 articles were included. Publication output increased sharply after 2019 and reached 48 articles in 2022; the exploratory linear model showed moderate fit (R^2=0.5599). The United States had the highest publication count (142) and citations (7871), followed by China (68) and Japan (47). The Journal of Allergy and Clinical Immunology was the leading source (42 articles; 3720 cited-journal occurrences). Omalizumab was the most prominent biologic keyword (189 occurrences) and anchored the central anti-IgE/allergic-rhinitis coupling cluster (centrality 0.52; impact 3.74), probably reflecting its early anti-IgE rationale, long clinical experience and evidence base. Dupilumab showed a strong recent temporal signal (45 occurrences), while mepolizumab, benralizumab and newer agents such as tezepelumab, itepekimab and stapokibart remained less represented. **Conclusion**: Research on biologic agents for AR is expanding from anti-IgE-dominated studies toward type 2 endotype-based and personalized approaches. Bibliometric prominence should not be interpreted as direct therapeutic superiority and future AR-specific studies should evaluate long-term safety, cost-effectiveness and patient-centered outcomes.

Keywords: Allergic rhinitis; Biological products; Bibliometrics; Dupilumab; Omalizumab

Submitted on 18-12-2025 – Revised on 27-07-2026 – Accepted on 04-08-2026

Article in Press

INTRODUCTION

Allergic rhinitis (AR) is a non-infectious, immunoglobulin E (IgE)-mediated inflammatory disorder of the nasal mucosa (Bousquet *et al*., 2020; Nur Husna *et al*., 2022). It is among the most prevalent atopic diseases worldwide and affects patients across age groups and geographic regions. Epidemiological studies estimate that AR affects approximately 10% to 40% of the population, with some reports describing rates as high as 54.5% in highly developed and densely populated settings (Savoure *et al*., 2022; Chauhan and Bishnoi, 2023; Lokaj-Berisha and Gacaferri Lumezi, 2025). Urbanization, industrialization, environmental exposure and lifestyle changes have contributed to the increasing burden of AR (Bu and Lou, 2025; Liu *et al*., 2023; Liu and Liu, 2022; Zhang and Zhang, 2024).

Common allergenic triggers include pollens, house dust mites, animal dander, molds and cockroach allergens, whereas non-allergenic irritants such as tobacco smoke, perfumes and air fresheners may aggravate symptoms but do not act as classical allergens. Exposure in sensitized individuals produces sneezing, nasal itching, rhinorrhea, nasal obstruction and ocular symptoms such as itching and tearing (Luh Eka Damayanti, 2023; Wang *et al*., 2024). Because AR is chronic and recurrent, long-term pharmacotherapy, allergen avoidance and immunotherapy are often required, creating a sustained burden for patients and healthcare systems (Komnos *et al*., 2019).

Standard treatments include oral or intranasal antihistamines, intranasal corticosteroids, leukotriene receptor antagonists and allergen-specific immunotherapy. However, many patients continue to experience inadequate symptom control or difficulty with long-term adherence and treatment may be limited by tolerability, variable efficacy and adverse effects (Bachert and Noergaard Andreasen, 2016; Campisi *et al*., 2020; Gurung and Khadgi, 2024; Li *et al*., 2023; Sánchez and Castro, 2019). These limitations have encouraged interest in biologic agents that target defined immune pathways involved in type 2 inflammation.

In this manuscript, the terms "biologic agents" and "biologics" refer to therapeutic biological products, mainly monoclonal antibodies, that selectively target immune mediators. Examples include omalizumab

**Corresponding author:* e-mail: 18202418866@163.com; entdoctor463@163.com

targeting IgE, dupilumab targeting the interleukin (IL)-4 receptor alpha (IL-4Rα)/IL-13 pathway and mepolizumab or benralizumab targeting the IL-5 axis (Bachert *et al*., 2017; Casale, 2001; Sastre and Dávila, 2018). These agents modulate immune pathways rather than neutralizing individual allergens. Therefore, their clinical usefulness is expected to depend more on inflammatory endotypes, disease severity and comorbid allergic diseases than on a single allergen source.

Although several reviews have discussed biologics for AR, a focused bibliometric assessment can add value by identifying how the research field has evolved, which contributors and collaboration networks drive the topic and which therapeutic concepts are emerging. This study therefore evaluates global publication patterns, influential sources, collaborative structures, cited references and keyword evolution in biologic-agent research for AR from 2000 to 2025. The goal is not to rank drugs by clinical superiority, but to clarify the research trajectory and gaps that should guide future AR-specific investigations.

MATERIALS AND METHODS

Data source and search strategy

Publication data were obtained from the Web of Science Core Collection (WoSCC, Clarivate Analytics). WoSCC was used because it provides standardized bibliographic records, including titles, abstracts, authors, affiliations, keywords, references and citation information, which are required for bibliometric analysis. No other database or search engine was used for the main dataset; this choice was made to maintain consistency of citation indexing and affiliation metadata.

The search covered the period from 1 January 2000 to 26 September 2025. To minimize variation caused by database updates, retrieval and data recording were completed within a one-hour window on the same day. The search used Boolean operators and topic search (TS) fields as follows: TS=("Allergic Rhinitis" OR "Allergic Rhinitides" OR "Rhinitides, Allergic" OR "Rhinitis, Allergic") AND TS=("Biologic Therapy" OR Biologics OR "Monoclonal Antibodies" OR Omalizumab OR Dupilumab OR Mepolizumab OR Benralizumab OR Reslizumab OR Tezepelumab OR Lebrikizumab OR Tralokinumab OR Stapokibart). The full screening sequence is provided in table S1 and summarized in the research flow chart (Fig. 1).

The inclusion criteria were English-language articles related to biologic-agent research in AR or closely related nasal allergic conditions. The exclusion criteria were non-English records, reviews, editorials, meeting abstracts, letters and other non-article document types. Two authors independently performed retrieval, screening and verification of final record numbers. Disagreements were resolved by rechecking the WoSCC records and only records agreed upon by both authors were included.

Because this is a bibliometric study based on publication metadata rather than a systematic review of clinical outcomes, no trial-level risk-of-bias assessment or publication-quality scoring was applied. Potential interpretive biases arising from database restriction, English-language inclusion, citation age, cross-disease overlap and industry-affiliated research output were instead examined and presented in the discussion and limitations sections.

Bibliometric and visualized analysis

Bibliometric analyses were performed using VOSviewer version 1.6.20 and the Bibliometrix R package. Annual time slices were applied to capture temporal changes in publication output. The analysis covered journals, authors, documents, countries, institutions and keywords. Collaboration networks, co-citation networks, bibliographic coupling, keyword co-occurrence and topic-trend maps were generated to summarize the intellectual structure and thematic evolution of AR biologic-agent research.

Before keyword analysis, terms with identical or near-identical meanings were normalized to reduce fragmentation. For example, differences in capitalization, hyphenation and singular/plural forms were harmonized and terms such as "anti-IgE" and "anti IgE" were merged. The normalized keyword matrix was then analyzed using co-occurrence and clustering algorithms. No manual deletion of institution names was performed, because affiliations are objective bibliographic metadata; however, institution names were interpreted cautiously and were not treated as evidence of endorsement or clinical superiority.

RESULTS

Annual growth trend analysis

The initial search identified 1094 records from WoSCC. After applying the predefined time span, document-type and language criteria, 546 English-language articles were included for analysis (Table S1). These articles were published in 218 journals. The overall annual growth rate was 5.09%. Publication counts were relatively stable before 2019 but increased sharply thereafter, reaching 48 articles in 2022 and remaining high through 2025 (Fig. 2).

The exploratory linear regression model suggested an upward trend in publication output ($y=1.2362x+4.3108$), but the explanatory power was moderate ($R^2=0.5599$). Therefore, the projection should be interpreted only as a descriptive indication of continued research activity, not as a confident forecast of future publication volume.

Article in Press

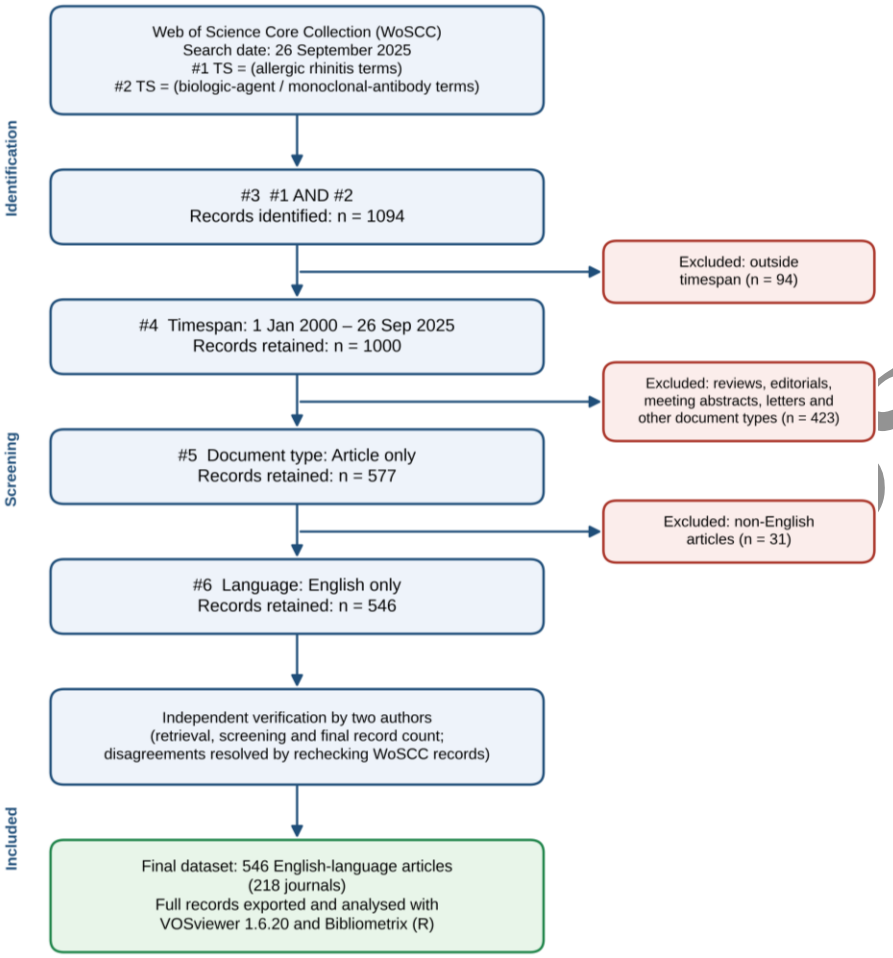


Fig. 1: Research flow chart of the dataset, from the initial Web of Science Core Collection search to the final 546 English-language articles included in the bibliometric analysis. TS: topic search.

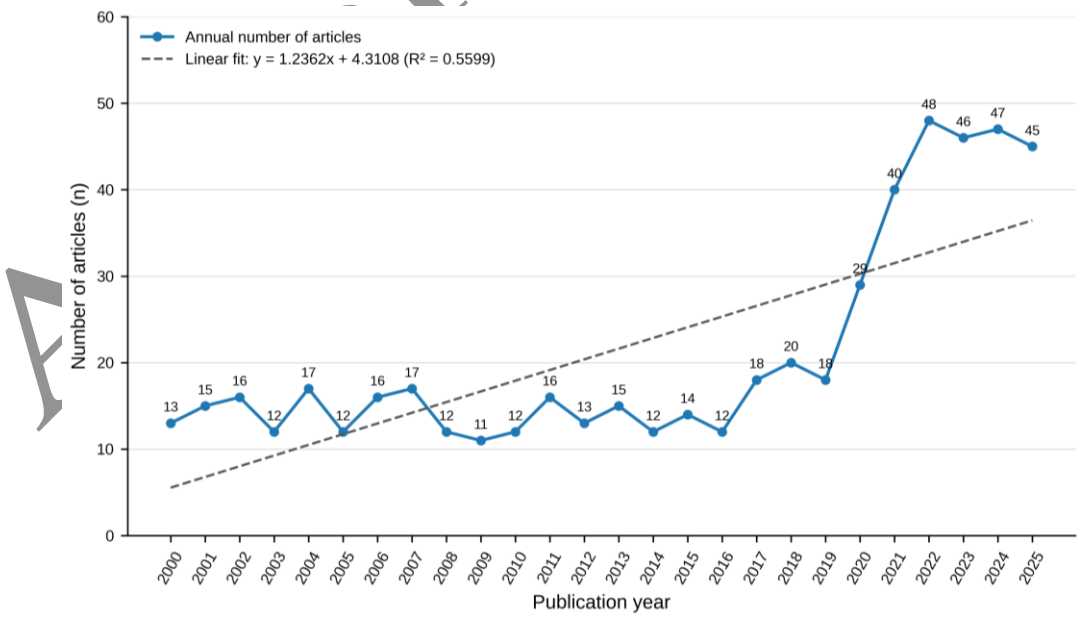


Fig. 2: Annual publication trend from 2000 to 2025. The fitted line is exploratory because the regression model showed only moderate explanatory power (R^2=0.5599).

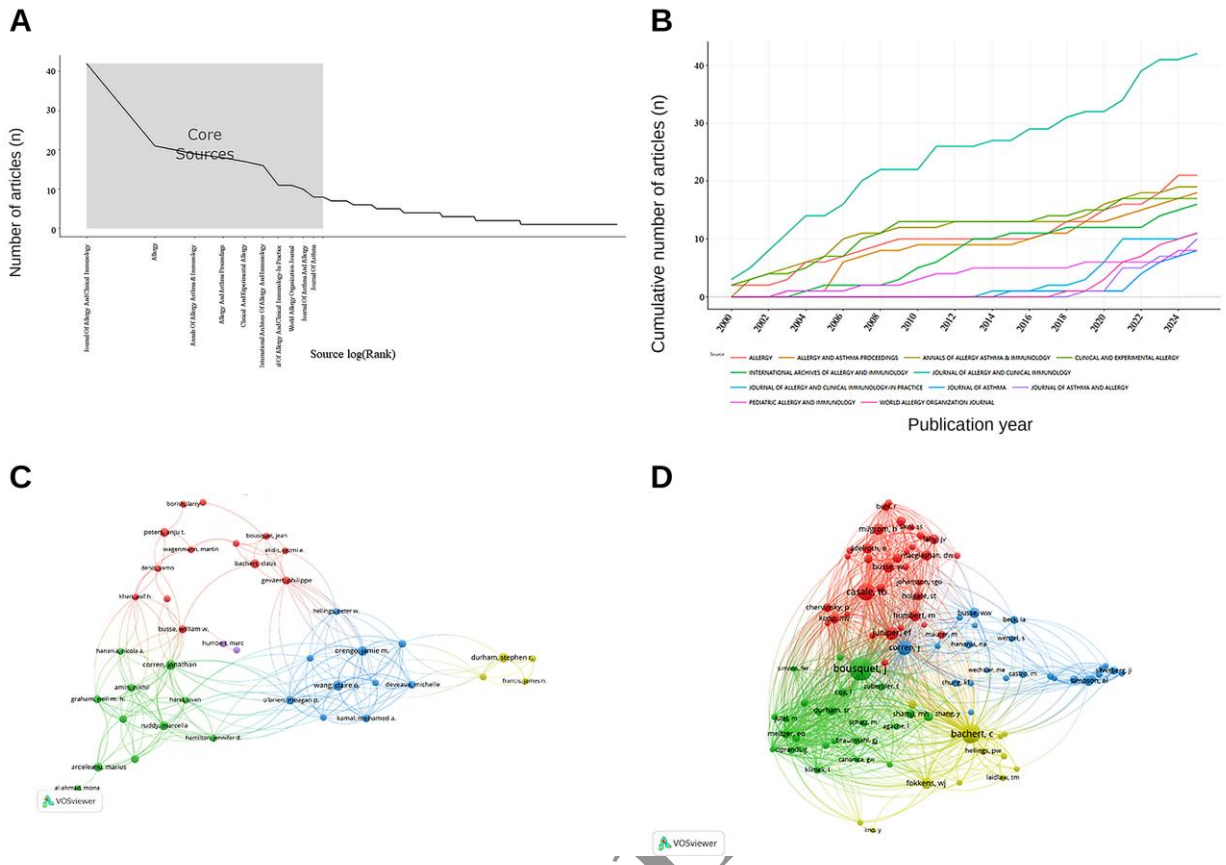


Fig. 3: Journal and author networks. (A) Core journals according to Bradford's law of scattering; (B) Production of the top journals over time; (C) Co-authorship network; (D) Co-citation author network.

Table 1: Top 10 journals by publication volume.

Rank	Journal	Count	JCR	Impact factor (2025)	Country
1	Journal of Allergy and Clinical Immunology	42	Q1	11.2	United States
2	Allergy	21	Q1	12.0	England
3	Annals of Allergy, Asthma & Immunology	19	Q1	4.7	United States
4	Allergy and Asthma Proceedings	18	Q3	2.2	United States
5	Clinical and Experimental Allergy	17	Q1	5.2	England
6	International Archives of Allergy and Immunology	16	Q3	1.8	Switzerland
7	Journal of Allergy and Clinical Immunology: In Practice	11	Q1	6.6	Netherlands
8	World Allergy Organization Journal	11	Q2	4.3	England
9	Journal of Asthma and Allergy	10	Q2	3.0	New Zealand
10	Journal of Asthma	8	Q3	1.3	United States

JCR: Journal Citation Reports.

Source and journal analysis

Bradford analysis and publication counts showed that a small number of journals contributed a substantial share of the literature (Fig. 3A). The Journal of Allergy and Clinical Immunology ranked first with 42 articles, followed by Allergy with 21 articles and Annals of Allergy, Asthma & Immunology with 19 articles (Table 1). Production trends for the top journals increased after 2016, with the Journal of Allergy and Clinical Immunology showing the most sustained growth (Fig. 3B).

Cited-journal analysis showed a similar concentration of influence. The Journal of Allergy and Clinical Immunology had 3720 cited-journal occurrences, followed by Allergy with 1610 occurrences and Clinical and Experimental Allergy with 857 occurrences (Table 2). These findings indicate that AR biologic-agent research is disseminated mainly through allergy, immunology and respiratory journals.

Article

Table 2: Top 10 cited journals ranked by frequency.

Rank	Cited journal	Frequency	JCR	Impact factor (2025)	Country
1	Journal of Allergy and Clinical Immunology	3720	Q1	11.2	United States
2	Allergy	1610	Q1	12.0	England
3	Clinical and Experimental Allergy	857	Q1	5.2	England
4	Journal of Immunology	719	Q2	3.4	United States
5	American Journal of Respiratory and Critical Care Medicine	635	Q1	19.4	United States
6	Annals of Allergy, Asthma & Immunology	618	Q1	4.7	United States
7	New England Journal of Medicine	512	Q1	78.5	United States
8	European Respiratory Journal	444	Q1	21.0	England
9	Journal of Allergy and Clinical Immunology: In Practice	410	Q1	6.6	Netherlands
10	International Archives of Allergy and Immunology	344	Q3	1.8	Switzerland

JCR: Journal Citation Reports.

Table 3: Top 10 countries ranked by publication count.

Rank	Country	Count	SCP	MCP (%)
1	USA	142	110	22.5
2	China	68	61	10.3
3	Japan	47	43	8.5
4	Italy	43	35	18.6
5	Germany	37	26	29.7
6	England	26	15	42.3
7	Korea	16	15	6.3
8	France	15	9	40.0
9	Turkey	13	7	46.2
10	Spain	12	11	8.3

SCP: single-country publication; MCP: multiple-country publication.

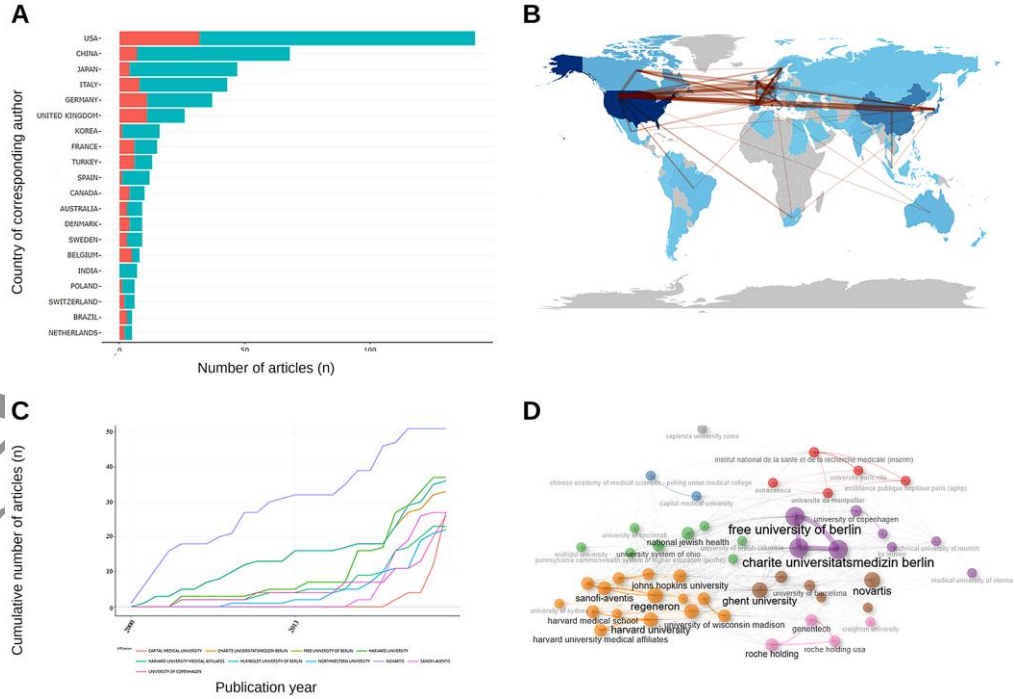


Fig. 4: Country and institution networks. (A) Corresponding-author countries showing single-country publications and multiple-country publications; (B) Country collaboration world map; (C) Institutional production over time; (D) Institutional collaboration network.

Article in Press

Table 4: Top 10 institutions ranked by frequency.

Rank	Institution	Count
1	Novartis	51
2	Harvard University	37
3	Free University of Berlin	36
4	Humboldt University of Berlin	36
5	Charite Universitatsmedizin Berlin	33
6	Capital Medical University	27
7	Sanofi-Aventis	27
8	University of Copenhagen	26
9	Harvard University Medical Affiliates	23
10	Northwestern University	22

Institutional names are reported exactly as bibliographic affiliation metadata and do not imply endorsement or commercial preference.

Co-authorship and co-citation author analysis

The co-authorship network identified five major author clusters (Fig. 3C). The largest cluster included Bachert C and Peters AT, while other clusters centered on Corren J, Graham NMH, Wang CQ, Orengo JM, Durham SR and Humbert M. Dense intra-cluster links showed frequent collaboration within specialized research groups, while cross-cluster links indicated that the field also contains intergroup cooperation.

The co-citation network showed stronger interconnection among intellectual contributors (Fig. 3D). Casale TB, Juniper EF, Bousquet J, Corren J and Bachert C were among the most cited authors. The network suggests that the knowledge base of AR biologic-agent research is built on shared references from anti-IgE, asthma, chronic rhinosinusitis and type 2 inflammation studies.

Country and institution analysis

Country-level analysis showed that the United States ranked first in publication count (142), followed by China (68), Japan (47), Italy (43) and Germany (37) (Table 3). The United States also had the highest citation count (7871), followed by Germany (2618) and England (1902) (Table S2). The corresponding-author country analysis indicated that single-country publications predominated in several high-output countries, although multiple-country publications were visible in North America, Europe and parts of Asia (Figs. 4A-B).

Institutional analysis showed that universities, hospitals and industry-affiliated institutions all contributed to the field (Table 4). The top institutional outputs included Novartis (51), Harvard University (37), Free University of Berlin (36), Humboldt University of Berlin (36) and Charite Universitatsmedizin Berlin (33). Temporal institutional trends showed accelerated output after 2020, including rapid recent growth from Capital Medical University (Fig. 4C). The institutional collaboration network placed European academic institutions and industry-affiliated nodes within dense regional networks, while National Jewish Health served as an interregional bridge (Fig. 4D).

Cited references and bibliographic coupling analysis

The most globally cited reference in the dataset was the 2001 study by Busse W on omalizumab in severe allergic asthma (Busse et al., 2001), which received 1033 citations, followed by Weidinger S on atopic dermatitis with 901 citations (Fig. 5A). These highly cited publications demonstrate the strong contribution of comorbid type 2 inflammatory diseases to the AR biologics citation landscape.

Bibliographic coupling at the document level identified four major clusters (Fig. 5B). The largest and most central cluster (n=89) focused on omalizumab, anti-IgE and AR, with an average centrality of 0.52 and an average impact of 3.74. In this context, centrality indicates the degree to which a cluster connects different parts of the coupled literature, while impact reflects relative citation influence. Thus, the anti-IgE/omalizumab cluster functions as both a bridging and influential knowledge base. Another cluster focused on asthma, dupilumab and atopic dermatitis (n=39; centrality 0.36; impact 2.44), indicating that recent AR biologic research is increasingly linked to broader type 2 inflammatory-disease literature. The remaining clusters were related to omalizumab, asthma, AR and general biologics, with lower centrality and impact values.

Keyword analysis

After normalization of synonymous terms, the most frequent keywords were "asthma" (210), "omalizumab" (189), "efficacy" (80), "IgE" (79), "immunotherapy" (59), "expression" (57), "anti-IgE" (46), "quality-of-life" (46), "dupilumab" (45) and "safety" (44) (Table 5; Fig. 5C). The high rank of asthma and chronic rhinosinusitis shows that a substantial portion of the literature overlaps with related airway and type 2 inflammatory diseases.

Article in Press

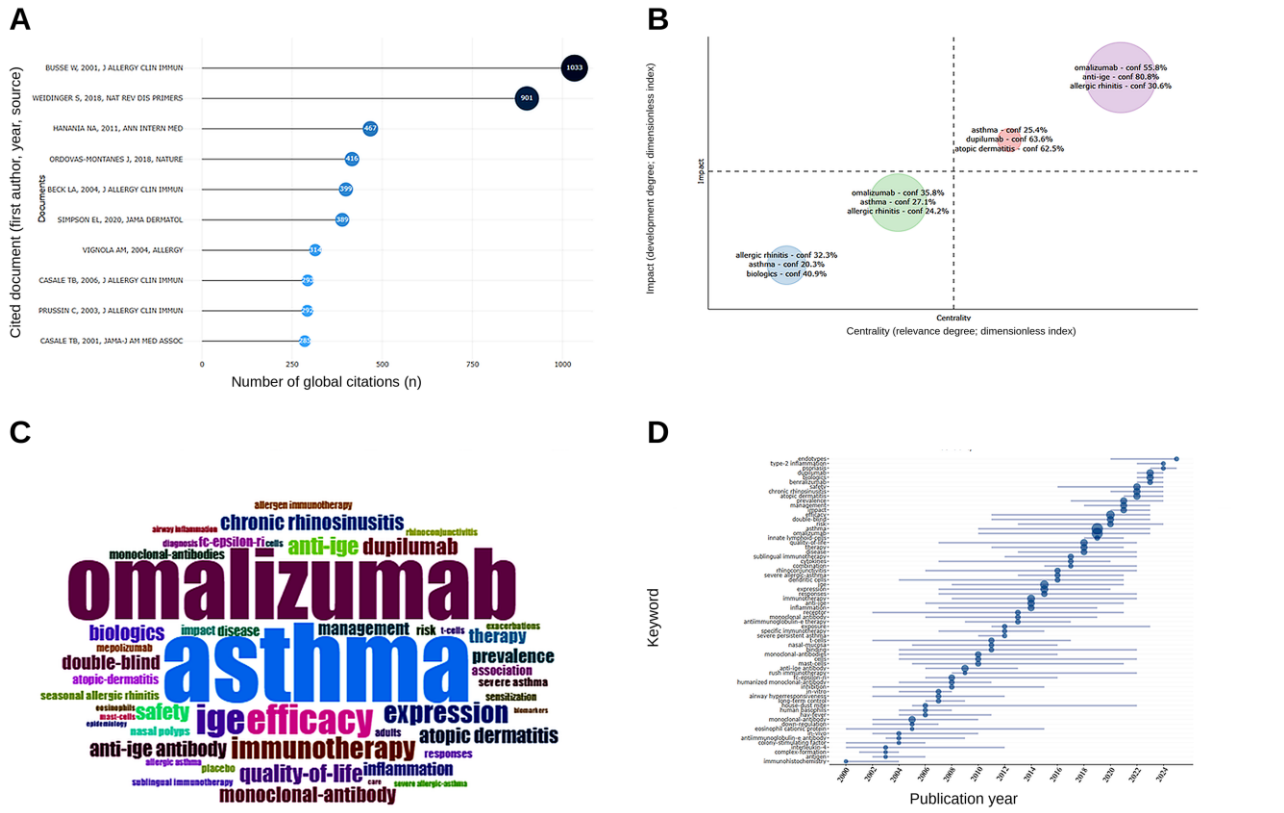


Fig. 5: Citation and keyword evolution. (A) Most globally cited references; (B) Bibliographic coupling clusters; (C) Keyword word cloud after synonym merging; (D) Topic-trend map over time.

Table 5: Top 20 keywords ranked by frequency.

Rank	Keyword	Frequency
1	asthma	210
2	omalizumab	189
3	efficacy	80
4	IgE	79
5	immunotherapy	59
6	expression	57
7	anti-IgE	46
8	quality-of-life	46
9	dupilumab	45
10	safety	44
11	chronic rhinosinusitis	42
12	monoclonal antibody	42
13	anti-IgE antibody	41
14	atopic dermatitis	41
15	biologics	41
16	double-blind	39
17	therapy	38
18	prevalence	37
19	management	35
20	inflammation	34

Topic-trend analysis showed that earlier studies focused on immunohistochemistry, IgE and omalizumab, whereas more recent themes included dupilumab, biologics, benralizumab, type 2 inflammation, psoriasis and endotypes (Fig. 5D). This temporal shift suggests movement from single-target anti-IgE research toward phenotype- and endotype-oriented strategies.

Article In

Table 6: Qualitative comparison of major biologic-agent groups discussed in allergic rhinitis research.

Agent or group	Main target	Bibliometric position in this study	Clinical interpretation for allergic rhinitis	Treatment burden and compliance considerations	References
Omalizumab	IgE	Highest biologic-specific keyword frequency (189) and dominant anti-IgE coupling cluster	Extensive AR and comorbid-asthma evidence; prominence probably reflects early availability, anti-IgE rationale and long clinical experience rather than low cost alone	Repeated subcutaneous dosing and high drug cost may limit routine AR use; may be more acceptable for severe disease or comorbid allergic conditions	Casale, 2001; Casale *et al*., 2001; Casale *et al*., 2006; Vignola *et al*., 2004; Hanania *et al*., 2011; Bozek *et al*., 2022; Arslan *et al*., 2025
Dupilumab	IL-4 receptor alpha / IL-13 pathway	Emerging keyword (45) with strong recent temporal signal	Represents a shift toward type 2 endotype-based therapy; AR-specific conclusions remain partly supported by comorbid asthma, atopic dermatitis and chronic rhinosinusitis evidence	Regular subcutaneous administration; compliance may improve when one therapy addresses several type 2 comorbidities	Sastre and Dávila, 2018; Simpson *et al*., 2020; Yamani *et al*., 2024
Mepolizumab, benralizumab and reslizumab	IL-5 or IL-5 receptor axis	Lower AR-specific frequency; mainly connected to eosinophilic airway disease	Potential relevance for eosinophilic or comorbid phenotypes, but direct AR-only evidence is limited	Dosing schedules differ among agents; patient selection is essential to avoid unnecessary burden and cost	Bachert *et al*., 2017; Harvey *et al*., 2020; Lombardo *et al*., 2020
Tezepelumab, itepekimab, lebrikizumab, tralokinumab and stapokibart	Upstream epithelial cytokines or IL-4/IL-13 pathway	Recent or weakly represented in the current AR bibliometric dataset	Promising future directions, but sparse AR-specific publications limit quantitative comparison	Long-term safety, affordability and real-world adherence remain unresolved for AR-specific use	Menzies-Gow *et al*., 2021; Wechsler *et al*., 2021; Kosloski *et al*., 2022; Zhao *et al*., 2025

This table provides qualitative interpretation only. It does not replace head-to-head clinical efficacy, cost-effectiveness or adherence studies. References: sources in the reference list supporting each row. AR: allergic rhinitis; IL: interleukin.

DISCUSSION

This bibliometric analysis shows that AR biologic-agent research has expanded substantially since 2019. The increase likely reflects several concurrent drivers rather than a single AR-specific event: broader clinical adoption of biologics in type 2 inflammatory diseases, rising availability of monoclonal antibodies, increasing interest in precision immunotherapy and publication behavior during and after the coronavirus disease 2019 (COVID-19) pandemic. Cross-disease spillover from asthma, atopic dermatitis and chronic rhinosinusitis also contributed to the observed publication surge.

The research landscape is geographically concentrated in the United States, Europe and parts of Asia. This pattern probably reflects differences in research funding, regulatory approval pathways, biologic reimbursement systems, specialty allergy networks and access to large clinical trial infrastructures. Climate and allergen exposure may also influence clinical demand, but the present bibliometric data alone cannot prove that environmental exposure directly drives publication output (Jyothirmayi, 2020). Therefore, geographic dominance should be interpreted as a combined result of scientific capacity, healthcare systems, industry participation and disease burden.

The keyword profile demonstrates both the strength and limitation of the dataset. The frequent appearance of "asthma" and "chronic rhinosinusitis" supports the united-airway and type 2 inflammation concept (Campuzano-Revilla, 2022), but it also means that AR-specific conclusions must be interpreted with caution. Many biologic studies include patients with AR as a comorbidity or secondary outcome rather than as the primary disease. Thus, bibliometric prominence indicates research attention, citation influence and network position, not direct therapeutic superiority for AR.

Omalizumab remained the most influential biologic in this analysis. Its dominance is probably explained by its early development as an anti-IgE monoclonal antibody, biological plausibility for IgE-mediated rhinitis, long clinical experience and several early AR or AR-related clinical studies (Casale, 2001; Casale *et al*., 2001; Casale *et al*., 2006; Vignola *et al*., 2004). Omalizumab has also been studied in patients with multiple allergic comorbidities, which increases its representation in bibliometric networks (Bozek *et al*., 2022; Chong *et al*.,

Article in Press

2023; Noeiaghdam *et al*., 2025). However, its bibliometric lead should not be interpreted as proof that it is uniformly superior or cost-effective for all AR patients. Dupilumab showed a different pattern. Although its overall keyword frequency was lower than that of omalizumab, the temporal trend map placed dupilumab among recent hotspots. This suggests that AR biologic research is moving toward IL-4/IL-13 pathway blockade and type 2 endotype-based treatment. The evidence base remains influenced by asthma, atopic dermatitis and chronic rhinosinusitis studies, so AR-only randomized trials and real-world studies are still needed before firm therapeutic conclusions can be drawn (Sastre and Dávila, 2018; Simpson *et al*., 2020; Yamani *et al*., 2024).

Mepolizumab, benralizumab and reslizumab were less prominent in AR-specific networks, which may reflect their closer connection to eosinophilic asthma or chronic rhinosinusitis with nasal polyps than to isolated AR (Bachert *et al*., 2017; Harvey *et al*., 2020; Lombardo *et al*., 2020). Newer agents, including tezepelumab, itepekimab, lebrikizumab, tralokinumab and stapokibart, were only weakly captured in the present AR bibliometric dataset because publications remain limited, recent or concentrated in non-AR indications (Kosloski *et al*., 2022; Menzies-Gow *et al*., 2021; Wechsler *et al*., 2021; Zhao *et al*., 2025). Their future role in AR should be evaluated through disease-specific efficacy, long-term safety and cost-effectiveness studies.

Biologic agents should not be expected to work equally against all common allergens because they do not neutralize pollen, mites, molds or animal dander directly. Instead, they interfere with immune pathways, such as IgE signaling or type 2 cytokine activity. Their effectiveness is therefore more likely to depend on immunological endotype, severity, biomarkers and comorbid diseases than on a specific allergen source. This distinction is clinically important because patients sensitized to different allergens may share a treatable type 2 pathway, while patients with similar allergen exposure may differ in biologic responsiveness.

Table 6 summarizes the major biologic groups in terms of target, bibliometric position and clinical interpretation. The comparison emphasizes that available bibliometric evidence can support hypothesis generation but cannot substitute for head-to-head clinical trials. Cost, dosing interval, treatment duration, long-term adherence and patient preference remain insufficiently compared across biologics in AR. Future studies should therefore combine bibliometric monitoring with clinical effectiveness, pharmacoeconomic and real-world adherence data.

The strong presence of industry-affiliated institutions should also be interpreted critically. Bibliometric records count affiliations and citations objectively, but citation frequency may be affected by sponsorship, trial size, journal visibility, marketing-driven research priorities and the longer citation window of older studies. Older highly cited omalizumab studies therefore occupy a core position because of long-term academic impact, but this may underrepresent the importance of recent AR-specific trials or emerging agents. This study has several limitations. First, the dataset was restricted to WoSCC, so relevant studies indexed only in Scopus, PubMed or regional databases may have been missed. Second, excluding non-English articles may underrepresent research from non-English-speaking regions and may skew geographic or institutional patterns. Third, the search strategy was designed around established biologic terms and may not fully capture very recent agents or studies indexed mainly under comorbid diseases. Fourth, bibliometric methods evaluate metadata rather than patient-level efficacy and safety, so the results should not be used as clinical treatment rankings. Finally, citation-based measures favor older publications and highly visible journals, which may inflate perceived influence relative to newer AR-specific evidence.

CONCLUSION

Research on biologic agents for AR has entered a period of rapid expansion since 2019, with increasing publication output, international collaboration and thematic diversification. Omalizumab remains the historical and bibliometric core of the field, mainly because of its early anti-IgE rationale and long evidence base, while dupilumab and other type 2 pathway agents represent the most visible emerging direction. The main take-home message is that AR biologic research is shifting from single-target, drug-centered exploration toward endotype-based and patient-centered precision treatment. Future studies should prioritize AR-specific clinical trials, biomarker-guided selection, long-term safety, cost-effectiveness and real-world adherence rather than relying on bibliometric prominence alone.

Acknowledgments
None.

Authors' contributions
Xue Jiao Liu and Xu Hui Tai: Jointly contributed to the conception and design of the study, literature retrieval, data verification and interpretation. Xue Jiao Liu: Drafted the initial manuscript. Xu Hui Tai: Reviewed and revised the manuscript and supervised language and content editing. Both authors approved the final version of the manuscript and agree to be accountable for the integrity of the work. AI-assisted language editing was used only to improve grammar, clarity and formatting; all scientific content, analyses and final interpretations were reviewed and approved by the authors.

Article in Press

Funding
There was no funding.

Data availability statement
The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical approval
Not applicable. This bibliometric study used publicly available publication metadata and did not involve human participants, identifiable personal data or animals.

Conflicts of interest
The authors declare no conflict of interest.

Consent to publication
The authors confirm that the manuscript is original, has not been published previously in any language or format and is not currently under consideration elsewhere. No identifiable personal information, clinical images or individual patient data are included.

REFERENCES

Arslan B, Pacaci Cetin G, Seker S, Bozkurt Yilmaz HE, Aktas Yapici E, Koyluce S, Acar E and others (2025). Omalizumab home injection versus hospital administration in severe asthma: Impact on asthma control. *Allergy Asthma Proc*., **46**(4): 274-279.

Bachert C and Noergaard Andreasen J (2016). Cost-effectiveness of immunotherapy in the treatment of seasonal allergic rhinitis: Identifying product-specific parameters of relevance for health care decision-makers and clinicians. *Int. Arch. Allergy Immunol*., **168**(3): 213-217.

Bachert C, Sousa AR, Lund VJ, Scadding GK, Gevaert P, Nasser S, Durham SR and others (2017). Reduced need for surgery in severe nasal polyposis with mepolizumab: Randomized trial. *J. Allergy Clin. Immunol*., **140**(4): 1024-1031.e14.

Beck LA, Marcotte GV, MacGlashan Jr D, Togias A and Saini S (2004). Omalizumab-induced reductions in mast cell FcepsilonRI expression and function. *J. Allergy Clin. Immunol*., **114**(3): 527-530.

Bousquet J, Anto JM, Bachert C, Baiardini I, Bosnic-Anticevich S, Canonica GW, Melen E and others (2020). Allergic rhinitis. *Nat. Rev. Dis. Primers*, **6**(1): 95.

Bozek A, Kozlowska R, Misiolek M, Scierski W and Gawlik R (2022). Omalizumab added to allergen immunotherapy increased the effect of therapy in patients with severe local allergic rhinitis. *Hum. Vaccin. Immunother*., **18**(6): 2097818.

Bu F and Lou Z (2025). A review of recent progress in the mechanisms and effectiveness of acupuncture for treating allergic rhinitis. *Int. J. Gen. Med*., **18**: 1-10.

Busse W, Corren J, Lanier BQ, McAlary M, Fowler-Taylor A, Della Cioppa G, van As A and Gupta N (2001). Omalizumab, anti-IgE recombinant humanized monoclonal antibody, for the treatment of severe allergic asthma. *J. Allergy Clin. Immunol*., **108**(2): 184-190.

Campisi L, Yong PFK, Kasternow B and Karim MY (2020). Illustrative case series and narrative review of therapeutic failure of immunotherapy for allergic rhinitis. *Allergy Rhinol*., **11**: 2152656720943822.

Campuzano-Revilla GP (2022). Allergic rhinitis: Keys for the clinician. *Mex. J. Med. Res. ICSA*, **10**(19): 34-40.

Casale TB (2001). Anti-immunoglobulin E (omalizumab) therapy in seasonal allergic rhinitis. *Am. J. Respir. Crit. Care Med*., **164**(Suppl. 1): S18-S21.

Casale TB, Busse WW, Kline JN, Ballas ZK, Moss MH, Townley RG, Mokhtarani M and others (2006). Omalizumab pretreatment decreases acute reactions after rush immunotherapy for ragweed-induced seasonal allergic rhinitis. *J. Allergy Clin. Immunol*., **117**(1): 134-140.

Casale TB, Condemi J, LaForce C, Nayak A, Rowe M, Watrous M, McAlary M and others (2001). Effect of omalizumab on symptoms of seasonal allergic rhinitis: A randomized controlled trial. *JAMA*, **286**(23): 2956-2967.

Chauhan V and Bishnoi S (2023). Role of Aralia racemosa in management of allergic rhinitis. *Int. J. Homoeopathic Sci*., **7**(1): 283-286.

Chong W, Li H and Wang J (2023). Therapeutic efficacy of omalizumab in children with moderate-to-severe allergic asthma combined with chronic sinusitis. *Front. Allergy*, **4**: 1236798.

Gurung U and Khadgi S (2024). Intranasal corticosteroid spray usage in patients with allergic rhinitis: Correctness in technique and compliance. *J. Inst. Med. Nepal*, **46**(1): 1-6.

Hanania NA, Alpan O, Hamilos DL, Condemi JJ, Reyes-Rivera I, Zhu J, Rosen KE and others (2011). Omalizumab in severe allergic asthma inadequately controlled with standard therapy: A randomized trial. *Ann. Intern. Med*., **154**(9): 573-582.

Harvey ES, Langton D, Katelaris C, Stevens S, Farah CS, Gillman A, Harrington J and others (2020). Mepolizumab effectiveness and identification of super-responders in severe asthma. *Eur. Respir. J*., **55**(5): 1902420.

Jyothirmayi K (2020). Analysis of distribution of allergens and its seasonal variation in allergic rhinitis. *J. Med. Sci*., **5**(3): 59-62.

Komnos ID, Michali MC, Asimakopoulos AD, Basiari LV and Kastanioudakis IG (2019). The effect of allergic rhinitis on quality of life in patients suffering from the disease: A case-control study. *Int. J. Otolaryngol. Head Neck Surg*., **8**(4): 121-131.

Kosloski MP, Kalliolias GD, Xu CR, Harel S, Lai CH, Zheng W, Davis JD and Kamal MA (2022).

Article in Press

Pharmacokinetics and pharmacodynamics of itepekimab in healthy adults and patients with asthma: Phase I first-in-human and first-in-patient trials. *Clin. Transl. Sci*., **15**(2): 384-395.

Li P, Wang N, Kai L, Si J and Wang Z (2023). Chronic intranasal corticosteroid treatment induces degeneration of olfactory sensory neurons in normal and allergic rhinitis mice. *Int. Forum Allergy Rhinol*., **13**(10): 1889-1905.

Liu LL, Gong Z, Tang L and Yan ZF (2023). A novel and alternative therapy for persistent allergic rhinitis via intranasal acupuncture: A randomized controlled trial. *Eur. Arch. Otorhinolaryngol*., **280**(6): 2773-2783.

Liu Y and Liu Z (2022). Epidemiology, prevention and clinical treatment of allergic rhinitis: More understanding, better patient care. *J. Clin. Med*., **11**(20): 6062.

Lokaj-Berisha V and Gacaferri Lumezi B (2025). Increased thyroxine levels of patients with allergic rhinitis. *Sci. Rep*., **15**(1): 2667.

Lombardo N, Pelaia C, Ciriolo M, Della Corte M, Piazzetta G, Lobello N, Viola P and Pelaia G (2020). Real-life effects of benralizumab on allergic chronic rhinosinusitis and nasal polyposis associated with severe asthma. *Int. J. Immunopathol. Pharmacol*., **34**: 2058738420950851.

Luh Eka Damayanti N (2023). Allergic rhinitis. *KESANS Int. J. Health Sci*., **2**(12): 1065-1077.

Menzies-Gow A, Corren J, Bourdin A, Chupp G, Israel E, Wechsler ME, Brightling CE and others (2021). Tezepelumab in adults and adolescents with severe, uncontrolled asthma. *N. Engl. J. Med*., **384**(19): 1800-1809.

Noeiaghdam R, Esmaeilzadeh H, Faramarzi M, Moshfeghinia R, Fallahi MS, Alyasin S, Nabavizadeh H and Mortazavi N (2025). Omalizumab efficacy in chronic rhinosinusitis patients with recurrent nasal polyps: An open-label, single-center, randomized, controlled study. *Ann. Otol. Rhinol. Laryngol*., **134**(9): 692-702.

Nur Husna SM, Tan HTT, Md Shukri N, Mohd Ashari NS and Wong KK (2022). Allergic rhinitis: A clinical and pathophysiological overview. *Front. Med*., **9**: 874114.

Prussin C, Griffith DT, Boesel KM, Lin H, Foster B and Casale TB (2003). Omalizumab treatment downregulates dendritic cell FcepsilonRI expression. *J. Allergy Clin. Immunol*., **112**(6): 1147-1154.

Sanchez G and Castro C (2019). Prescription profile and clinical outcomes in patients with allergic rhinitis treated with oral antihistamines or nasal corticosteroids. *Int. Arch. Otorhinolaryngol*., **23**: 325-330.

Sastre J and Davila I (2018). Dupilumab: A new paradigm for the treatment of allergic diseases. *J. Investig. Allergol. Clin. Immunol*., **28**(3): 139-150.

Savoure M, Bousquet J, Jaakkola JJK, Jaakkola MS, Jacquemin B and Nadif R (2022). Worldwide prevalence of rhinitis in adults: A review of definitions and temporal evolution. *Clin. Transl. Allergy*, **12**(3): e12130.

Simpson EL, Paller AS, Siegfried EC, Boguniewicz M, Sher L, Gooderham MJ, Beck LA and others (2020). Efficacy and safety of dupilumab in adolescents with uncontrolled moderate-to-severe atopic dermatitis: A phase 3 randomized clinical trial. *JAMA Dermatol*., **156**(1): 44-56.

Vignola AM, Humbert M, Bousquet J, Boulet LP, Hedgecock S, Blogg M, Fox H and Surrey K (2004). Efficacy and tolerability of anti-immunoglobulin E therapy with omalizumab in patients with concomitant allergic asthma and persistent allergic rhinitis: SOLAR. *Allergy*, **59**(7): 709-717.

Wang Y, Zhang L, Shi B and Luo J (2024). Trends and research foci in immunoregulatory mechanisms of allergic rhinitis: A bibliometric analysis (2014-2024). *Front. Immunol*., **15**: 1443954.

Wechsler ME, Ruddy MK, Pavord ID, Israel E, Rabe KF, Ford LB, Maspero JF and others (2021). Efficacy and safety of itepekimab in patients with moderate-to-severe asthma. *N. Engl. J. Med*., **385**(18): 1656-1668.

Yamani I, Bu Saeed K, Alsulami A, Sait S, Althumali AH, Bu Saeed KM and Althumali A (2024). Efficacy of biologic therapies in the management of allergic rhinitis: A systematic review. *Cureus*, **16**(10): e71555.

Zhang F, Liao J, Qian Y, Niu X, Wei J, Li M, Guo D and Zhu P (2024). Real-world effectiveness of omalizumab in chronic urticaria: A clinical observational study. *Int. Arch. Allergy Immunol*., **185**(7): 718-728.

Zhang Y and Zhang L (2024). Current challenges with adherence to pharmacotherapy in allergic rhinitis. *Expert Opin. Pharmacother*., **25**(4): 335-338.

Zhao Y, Zhang L, Wu L, Yang B, Wang J, Li Y, Li J and others (2025). Long-term efficacy and safety of stapokibart for moderate-to-severe atopic dermatitis: 52-week results from a phase 3 trial. *Allergy*, **80**(5): 1348-1357.

Article in Press