How long-term pollen forecasts can improve demand planning for allergy products

Executive summary

In this paper, we aim to highlight the importance of long-term pollen intelligence in the demand planning of allergy products. We begin by exploring the changing characteristics of the pollen season worldwide and how it, combined with other environmental factors, affects the demand for allergy relief products. This shift presents both significant challenges and opportunities for retailers and pharmaceutical brands.

We also introduce Climachain, a cutting-edge solution that integrates climate data in demand planning, providing brands with a powerful tool for optimizing demand forecasts in response to environmental variables. ClimaChain helps improve operational efficiency, minimize opportunity costs, and align inventory levels with real-time market demand.

We then address the challenge of how existing demand planning practices within the pharma and retail sectors frequently *fail to adequately account for pollen levels' dynamic and seasonal variability*, resulting in **critical inefficiencies**. These include understocking during periods of heightened demand and overstocking during off-peak seasons, both of which can severely compromise business performance by leading to **missed sales, inventory holding costs, and diminished profitability**.

Quick view

Changing pollen seasons

Findings on how pollen seasons have changed globally over the last ten years for every region at a sub specie level

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Pollen to sales correlation

Research on how pollen levels correspond to a spike in the sales of antihistamines.

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Increasing forecast accuracy

Analyzing the uplift achieved from forecasting demand with pollen data vs using traditional non-climate methods.

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Understanding the changing pollen season and its impact on allergy products

Over the past few decades, climate change has significantly altered the nature of pollen seasons. Warmer temperatures and increased atmospheric CO_2 levels have extended the growing season for many plants, leading to longer periods of pollen release. In addition, plants are now producing more pollen than ever before, with some studies suggesting that pollen counts will double in certain regions by 2040[1]. These changes have made pollen seasons not only longer but also more intense, exacerbating the symptoms of those affected.

Ambee has researched the changing pollen patterns of the last decade, uncovering the following insights about its characteristics:

The global pollen dynamics of the decade

The total pollen has increased in the last decade, especially from 2020-22.
After a stable period from 2013 to 2019, global pollen levels surged significantly post-2020, exhibiting a substantial **13%** annual increase—the highest observed since 2005.

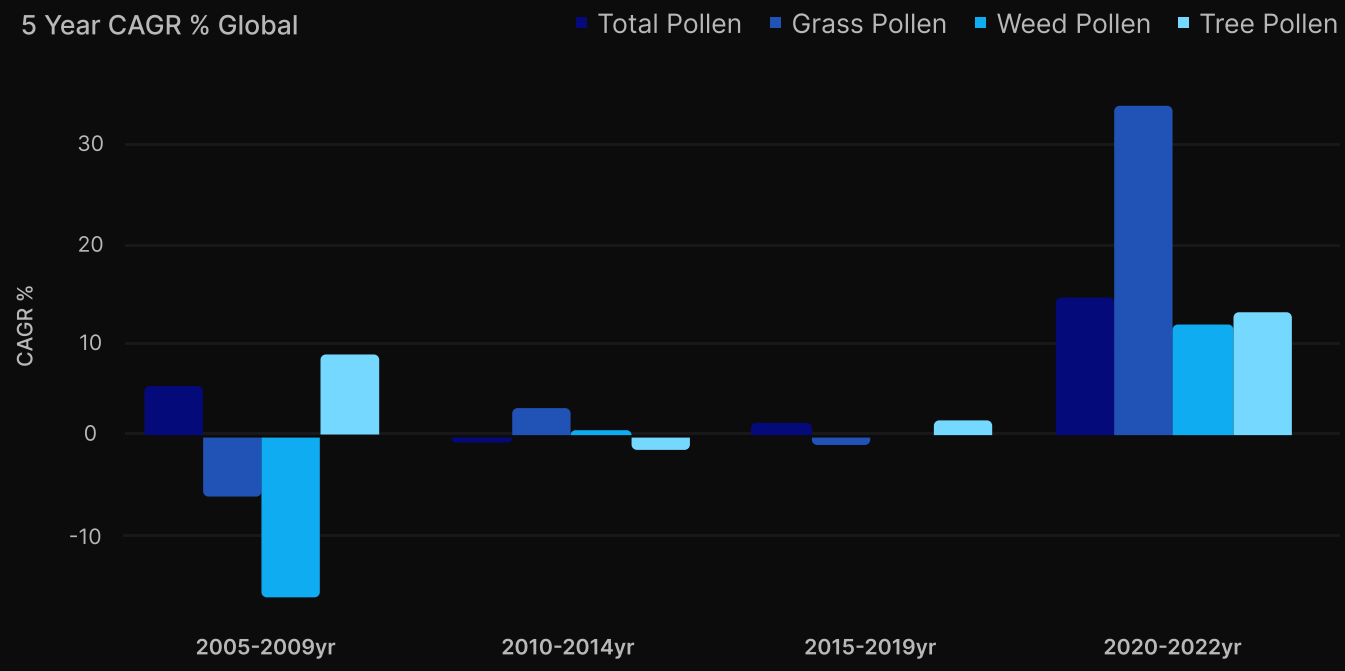


Fig 1: 5-year CAGR% of various pollen species globally. Clear spike seen from 2020-22.

[1]: https://www.sciencedaily.com/releases/2012/11/121109083736.htm

Regionally, Australia, China & the Middle East mirrored global pollen trends. Some fluctuations in other regions were as follows:

USA and Canada

- Weed pollen↓ from 2020 to 2022.
- Overall pollen ↑ significantly in 2021.
- 2022 saw the most pollen produced in 10 years.
- Southern cities and states like Texas showed higher pollen than northern ones.

UK

- Overall ↓ from 2020-2022.
- Mild 10-year decline

Japan

- Grass & weed pollen ↓
- Tree pollen ↑
- Net pollen ↑

Globally, grass pollen increased by >30%, contributing to a 13% overall rise in the last three years.

Pollen seasons have started earlier in the year.

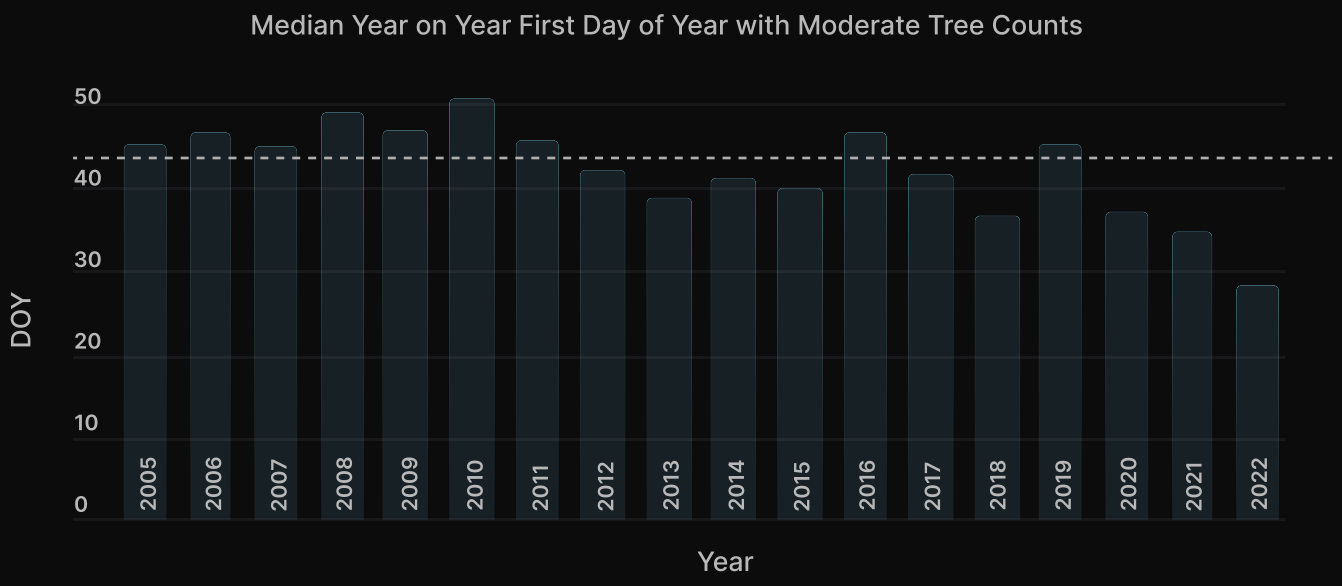


Fig 2.: Median of the first day of the year with moderate tree pollen counts.

Globally, days with 'moderate' tree pollen counts have kept occurring earlier in the year, notably from 2020-22, especially in Europe. Other places varied, but grass pollen seasons worldwide have stayed fairly steady.

The total pollen has increased in the last decade.

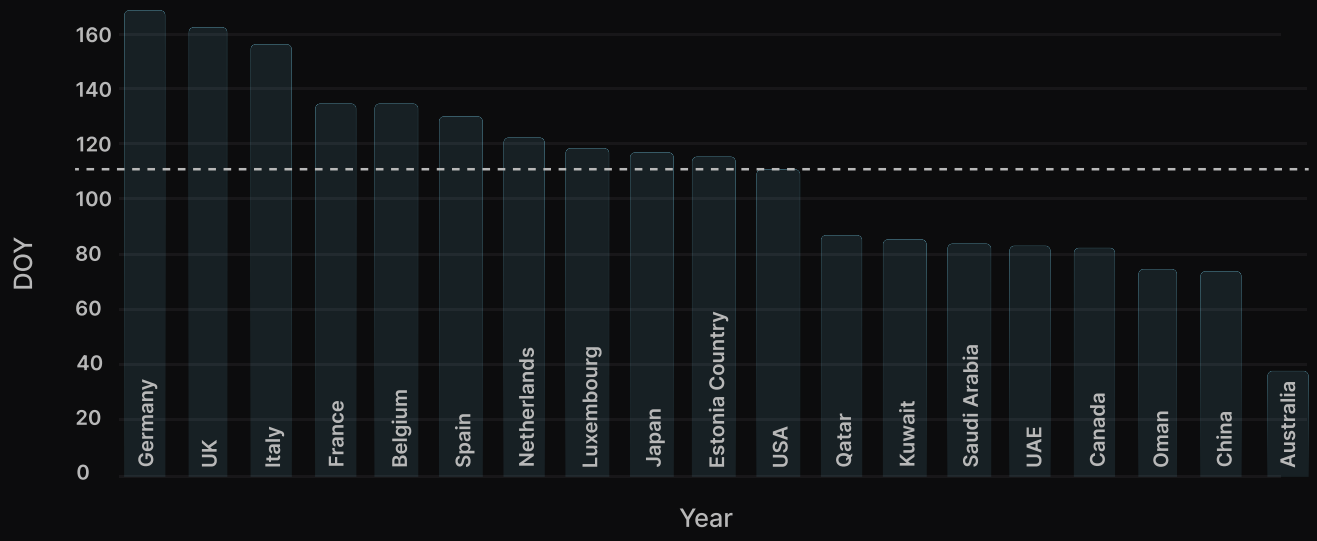


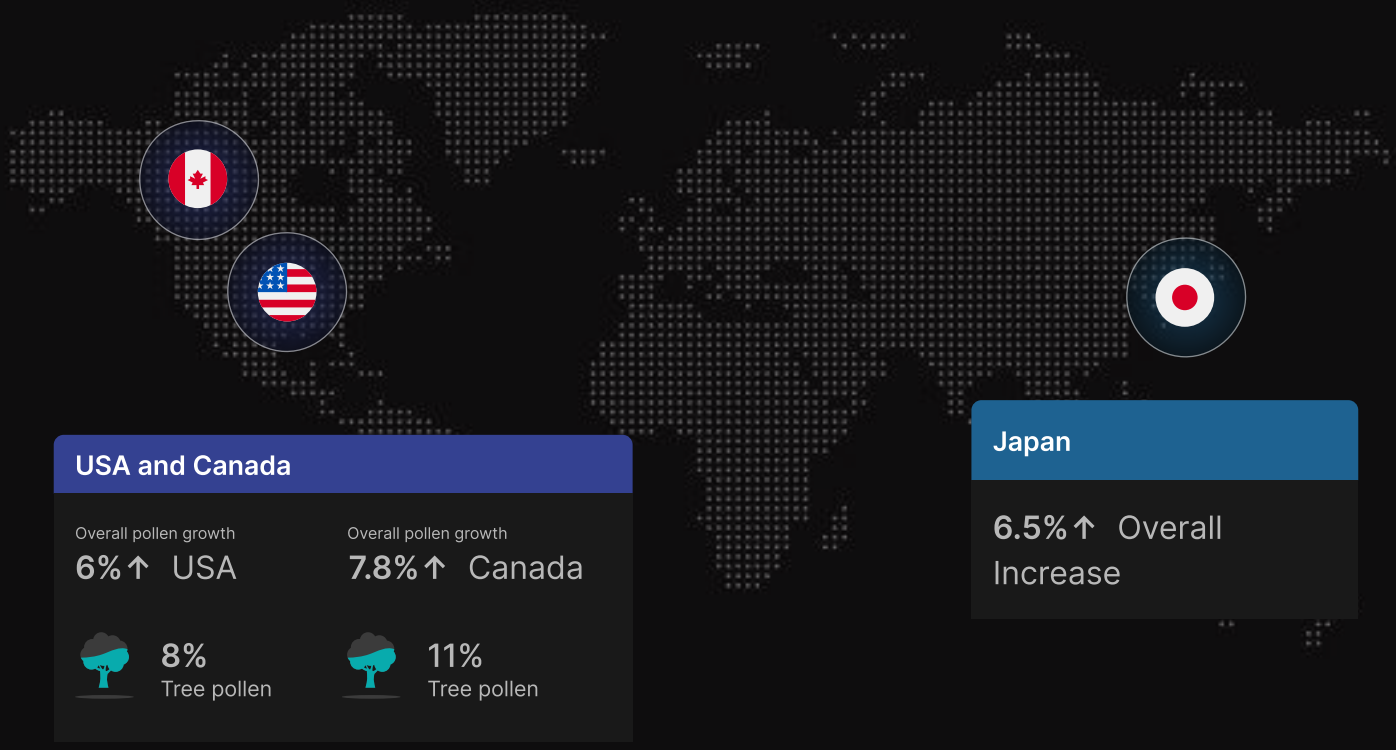
Fig 3.: Average country-wise total pollen count

In this decade, the UK had the highest overall pollen, second only to Germany. Japan and the USA had average levels. Canada, China, the Middle East, and Australia had less pollen–with Australia having the least due to more grass than tree pollen. Weed pollen was negligible in Asia and Australia.

Regions to look out for

Many European countries faced increased pollen from 2020 to 2022–except for the UK, which saw a slight decline.

During the same period, the USA and Canada saw significant overall pollen growth (6% and 7.8%, respectively), mainly from tree pollen (8% for the USA and 11% for Canada). Other regions also had increased pollen. Japan experienced a notable 7% rise in tree pollen in the last three years, contributing to a 6.5% overall increase.



The reason behind this phenomenon is grounded in plants' biology and climate change's impact on their life cycles. As temperatures rise earlier in the year, plants begin their reproductive cycles sooner, leading to an earlier start to pollen season. The prolonged warm weather also extends the end of the season, allowing plants to continue producing pollen well into the autumn. Furthermore, higher levels of CO_2 have been shown to increase the amount of pollen produced per plant, resulting in a denser concentration of airborne allergens[2].

Several allergic diseases, particularly asthma and hay fever, are deeply influenced by environmental factors, with pollen being one of the most potent triggers. Pollen, the fine powder, is carried by the wind and inhaled by people, leading to allergic reactions in susceptible individuals.

Alongside pollen, air quality, temperature, and greenhouse gases are other interconnected environmental catalysts that exacerbate allergic diseases by increasing allergic sensitization.

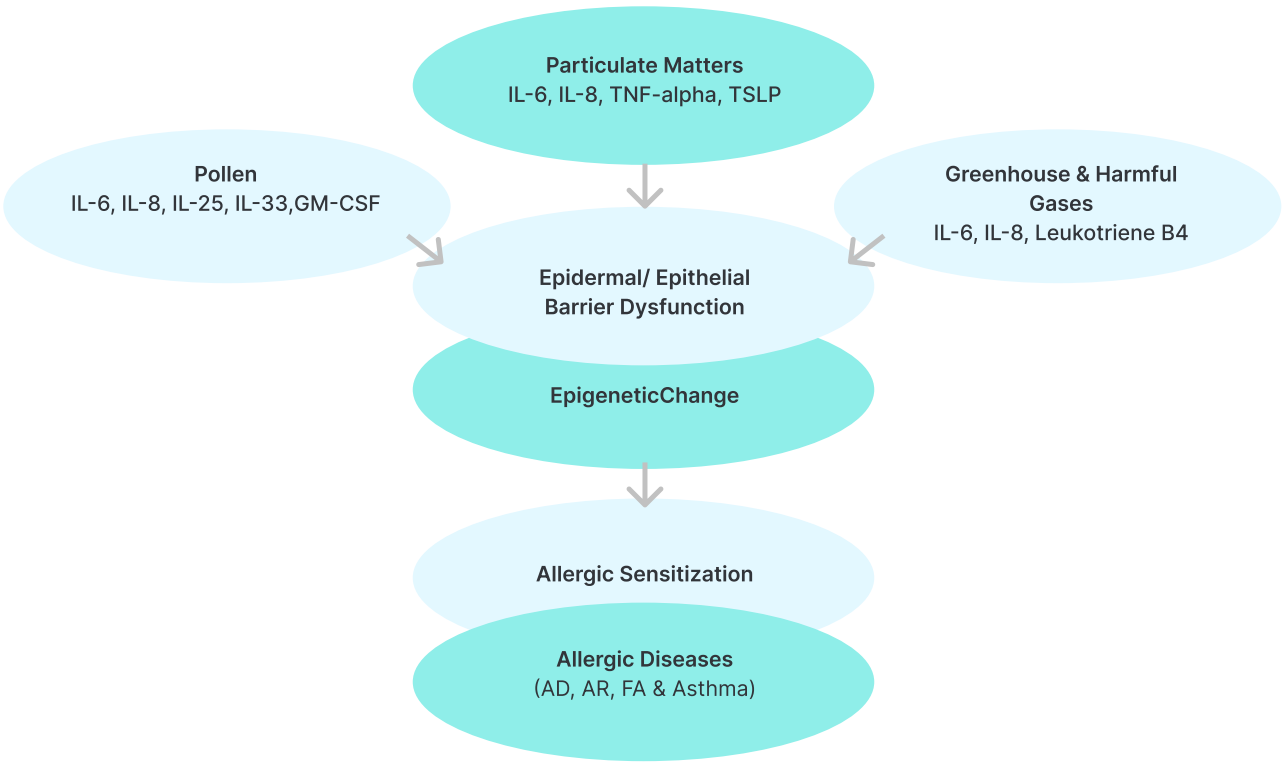


Fig 4.: Mechanisms of epithelial barrier dysfunction, epigenetic changes, allergic sensitization, and allergic diseases induced by environmental factors. (Source)

[2] : Allergies are getting worse with climate change. (2023, April 14). News. https://www.hsph.harvard.edu/news/hsph-in-the-news/allergies-are-getting-worse-with-climate-change/

Understanding these shifts in pollen and other environmental factors, therefore, becomes even more crucial for companies dealing with over-the-counter relief products, as this impact extends to various classes of drugs.

Allergic diseases	Environmental trigger	Effect on demand	Examples of drug
Seasonal Allergic Rhinitis (Hay Fever)	Pollen (trees, grasses, weeds)	High pollen counts lead to increased symptoms and higher demand for relief medications.	Loratadine Cetirizine Fluticasone
Asthma	Air pollutants (PM2.5, ozone, NO2), Pollen	Poor air quality exacerbates asthma symptoms, increasing the need for maintenance and rescue medications.	Ventolin Floven Montelukast
Allergic Conjunctivitis	Pollen, Airborne allergens	Increased pollen and pollutants cause eye irritation, leading to higher usage of eye drops and treatments.	Zaditor Naphazoline Olopatadine
Atopic Dermatitis	Air pollutants (PM2.5, ozone), Pollen	Environmental allergens can worsen skin conditions, driving demand for topical treatments and moisturizers.	Hydrocortisone cream, Tacrolimus (Protopic), Eucerin
Chronic Obstructive Pulmonary Disease (COPD)	Air pollutants (PM2.5, ozone, NO2)	Poor air quality leads to COPD exacerbations, increasing the use of maintenance and emergency medications.	Spiriva Budesonide Daliresp
Sinusitis	Airborne allergens, Air pollutants	Allergens and pollutants can trigger or worsen sinus infections, leading to a higher demand for treatment.	Amoxicillin, Fluticasone Pseudoephedrine
Allergic Contact Dermatits	Airborne allergens	Exposure to airborne allergens can cause skin reactions, increasing the use of topical and systemic treatments.	Hydrocortisone cream, Diphenhydramine
Urticaria (Hives)	Airborne allergens, Air pollutants	Allergens and pollutants can trigger hives, leading to increased use of antihistamines and corticosteroids.	Cetirizine Prednisone Diphenhydramine

Fig. 5: How environmental factors shape the demand for various types of drugs

Within the ever-expanding OTC market, these allergy medications occupy a significant share and will continue to do so. Clear evidence of this is seen in the Rx-to-OTC switches made in the last decade. Unsurprisingly, antihistamine and pollen-impacted product categories have seen the **most switches**.

Ingredient	Adult Dosage	Product Category	Date of OTC approval	Product examples
Fluticasone propionate (NDA)	50mcg/spray	Infranasal steroid for upper respitory allergies	July 23, 2014	Flonase Allergy Relief (GlaxoSmithKline)
Budesonide (NDA)	32 mcg/ spray	Infranasal steroid for allergic rhinitis	March 23, 2015	Rhinocort Allergy Spray (McNeil)
Adapalene (sNDA)	0.1% gel, once daily	Acne	July 8, 2016	Differin Gel (Galderma)
Fluticasone furoate (sNDA)	27.5 mcg/spray	Intranasal steroid for allergic rhinitis	August 2, 2016	Flonase Sensimist Allergy Relief (GlaxoSmithKline)
Levocetirizine dihydrocloride (NDA)	5mg	Antihistamine	January 31, 2017	Xyzal Allergy 24HR (Chattem)
Brimonidine tartrate (NDA)	0.025% ophthalmic solution	Relief of redness of the eye due to minor eye irritations	December 22, 2017	Lumift (Bausch + Lomb)
Diclofenac sodium (sNDA)	1% topical gel, 4 times per day	Topical pain	February 14, 2020	Voltaren Arthritis Pain (GSK)
Olopatadine hydrochloride (sNDA)	0.1% ophthalmic spray, twice daily	Antihistamine and redness reliever	February 14, 2020	Pataday Twice Daily Relief (Alcon)
Olopatadine hydrochloride (sNDA)	0.2% ophthalmic spray, once daily	Antihistamine	February 14, 2020	Pataday Twice Daily Relief (Alcon)
Acetaminophen and ibuprofen (NDA)	500 mg acetaminophen and 250 mg ibuprofen, every 8 hrs.	Oral analgesic	February 28, 2020	Advil Dual Action with Acetaminophen (GSK)
Olopatadine hydrochloride (sNDA)	0.7% ophthalmic spray, twice daily	Antihistamine	July 13, 2020	Pataday Once Daily Relief Extra Strength (Alcon)
Ivermectin (sNDA)	0.5% lotion, single use tube	Lice treatment	October 27, 2020	Sklice (Arbor)

Fig 6: Ingredients and dosages transferred from Rx-to-OTC status by FDA since 1975. Environmental conditions impact the demand for the highlighted products. (source)

As pollen becomes a **year-round** challenge and more consumers look to self-medicate, the demand for many allergy relief products (see Fig. 5), such as antihistamines, decongestants, and nasal sprays, becomes crucial to track accurately. In the following section, we'll demonstrate empirical proof showing how changing environmental patterns result in demand and sales shifts for allergy relief drugs.

The direct relationship between high pollen and allergy incidences and allergy drug sales

The correlation between pollen levels and allergic incidences is well-established in medical research: **higher pollen levels almost invariably lead to an increase in the number of people seeking relief from allergy symptoms**[3].

Our data analysis reveals a statistically significant correlation between pollen levels and incidences of allergic diseases. Specifically, our research showed a notable increase in pollen exposure in 2024 compared to 2023, corresponding to a rise in the population affected by allergic diseases during the same period.

Clear correlation between total pollen levels and the number of people affected identified.

By correlating local pollen trends and reported instances of allergic diseases, we found that, overall, there was a significant correlation. The higher the pollen levels, the greater the impact on the population.

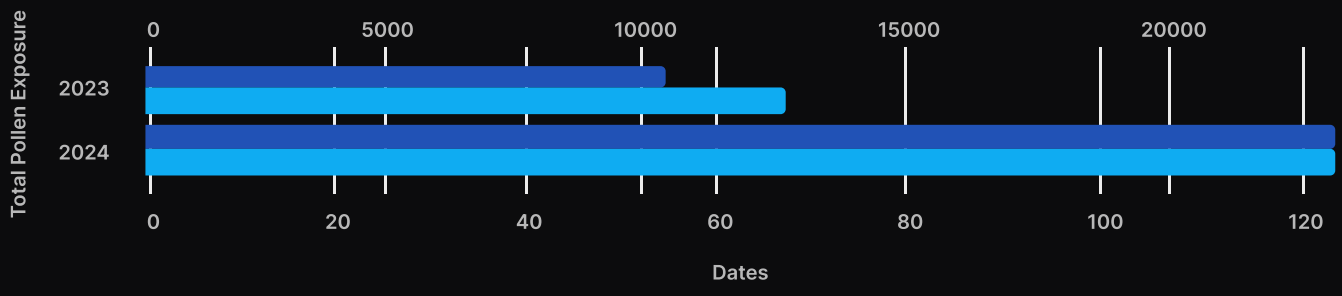


Fig 7. Pollen and allergy are trending upwards YoY. Source: Ambee

According to our research, in 2024, there was a significant increase in pollen exposure compared to 2023, with a rise of 20%. This increase in pollen levels has directly impacted public health, as evidenced by a corresponding 17.2% rise in the population affected by allergic diseases during the same period compared to the previous year.

[3]: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5351353/

The direct impact of pollen levels on allergy medication sales is both intuitive and empirically validated. One notable study[4] investigated the relationship between tree pollen levels and over-the-counter (OTC) allergy medication sales in the New York City metropolitan area. The study found a significant association between peak tree pollen levels and spikes in allergy medication sales, with the strongest correlation observed at a two-day lag.

Building on this, Ambee furthered its research to understand the correlation between pollen levels and the sales of antihistamine medications. We employed Multiple General Linear Models (GLMs) to predict sales at daily, weekly, and monthly intervals, utilizing Ambee's historical dataset, which includes detailed pollen data (tree, grass, weed) from 2016 to 2019.

[4] : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3658798/

Ambee's research reveals a 71% correlation between pollen levels and antihistamine sales.

We obtained a publicly available dataset containing six years of sales information for various drug categories from a single Serbian pharmacy to gather the necessary data. This dataset allowed us to analyze the sales patterns over time. For the pollen data, we utilized Ambee's historical dataset, which provided information on different types of pollen, such as tree, grass, and weed, along with their corresponding risk levels. This data covered the years 2016 to 2019.

1. In general, out of the three classes of daily, weekly, and monthly–normalized monthly comparisons showed us the most clear and consistent correlations.

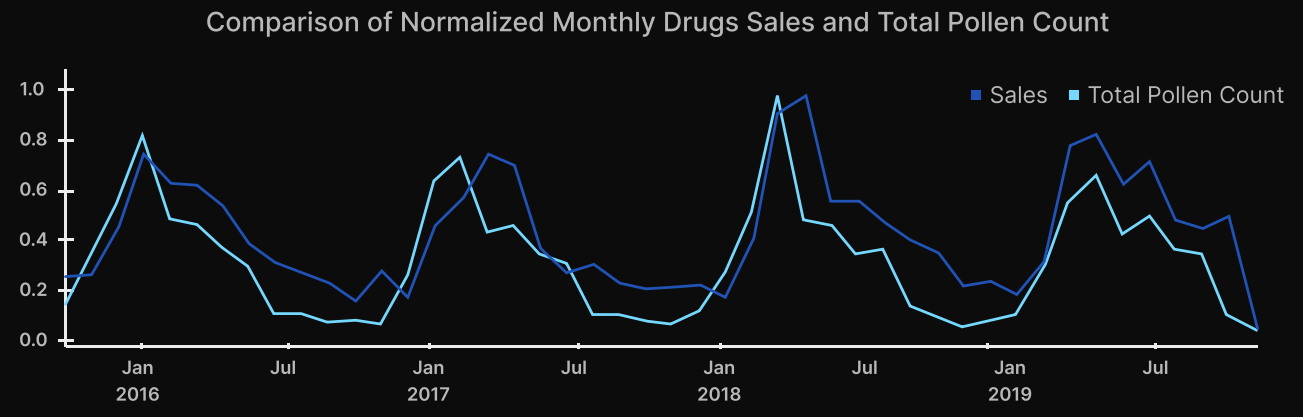


Fig 8. Monthly drug sales and pollen count comparison

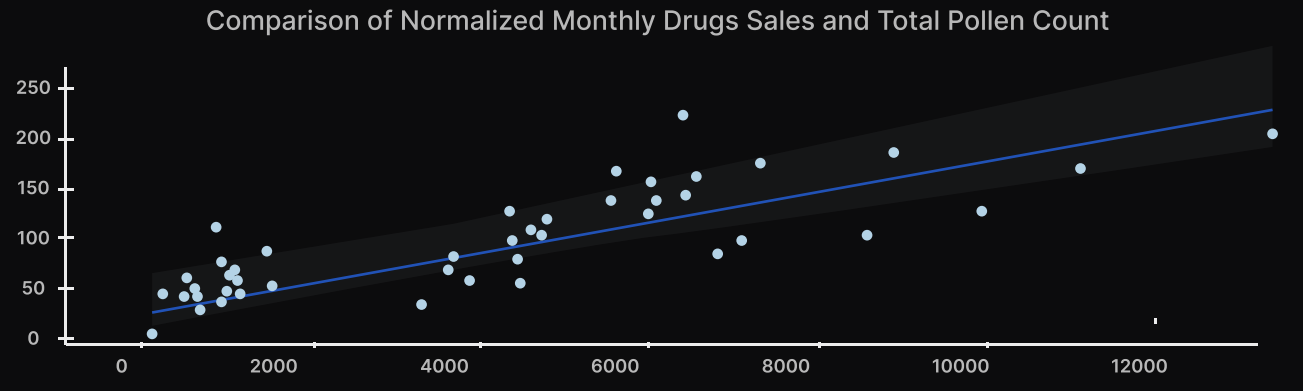


Fig 9. Monthly drug sales and pollen count comparison

2. However, the best model was achieved by modeling the next month's total sales using the current month's pollen. This model had an R^2 score of 0.71. This suggests that approximately 71% of the variation in total sales can be attributed to the fluctuations in the total pollen count.

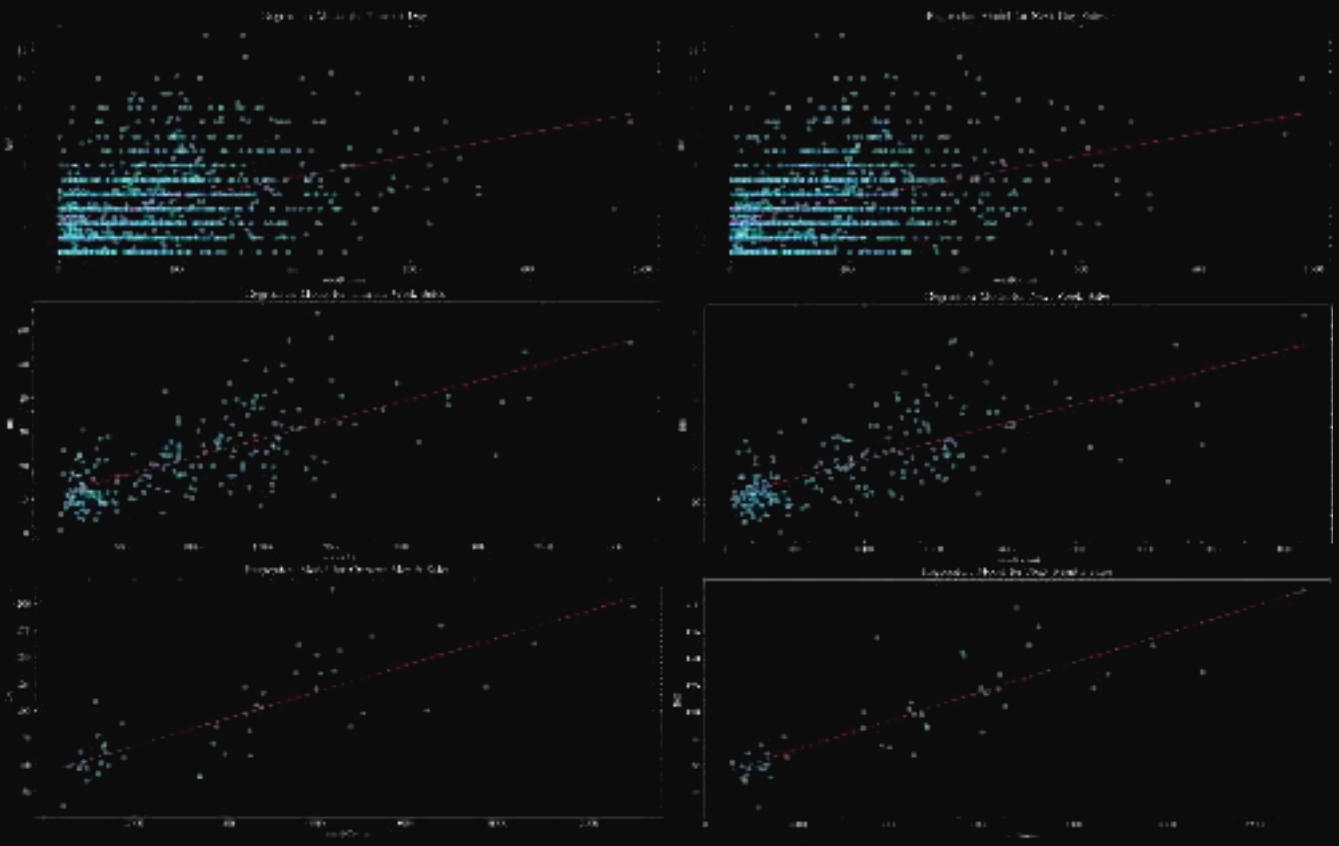


Fig.10: Impact of allergens on antihistamine sales

The inference is clear: when pollen peaks and symptoms occur, sales or the demand for allergy relief drugs would also rise. However, as strong as this correlation is, most current demand forecasting techniques are limited by their lack of pollen (and other climactic) intelligence, thus unable to capture this demand, resulting in significant missed sales for retailers and pharmaceuticals alike.

In the next section, we'll discuss the repercussions of climate-blind demand planning for such products and also highlight some of the results we've seen with the integration of climate data.

Key takeaways:

Global changes in pollen seasons:

Pollen seasons are shifting worldwide, beginning earlier, extending longer, and becoming more intense. Combined with worsening air quality and increased greenhouse gas emissions, this is leading to heightened allergic sensitization. Consequently, these environmental changes directly influence the demand for various over-the-counter (OTC) medications.

Impact of pollen levels on medication sales:

Elevated pollen levels result in more frequent allergic reactions, establishing a strong correlation between pollen concentrations and the sales of allergy-relief medications, such as antihistamines.

Inefficiencies in demand forecasting:

Although the correlation between pollen levels and medication sales is recognized, it is not effectively utilized in the demand planning of allergy drugs.

How pollen-blind demand planning leads to significant opportunity costs

Pollen levels vary dramatically from one region to another, even within the same city. For allergy brands, relying on general or broad weather forecasts can result in overstocking in some areas and understocking in others. This is where hyperlocal pollen data becomes invaluable. With the ability to track specific pollen concentrations at the store level, brands can accurately predict when and where demand will peak.

Most traditional demand planning systems only typically rely on historical sales data and generalized market trends to forecast demand. **While these models may be effective in predicting baseline demand, they often fail to account for the sudden and unpredictable spikes in demand caused by environmental factors such as pollen levels.**

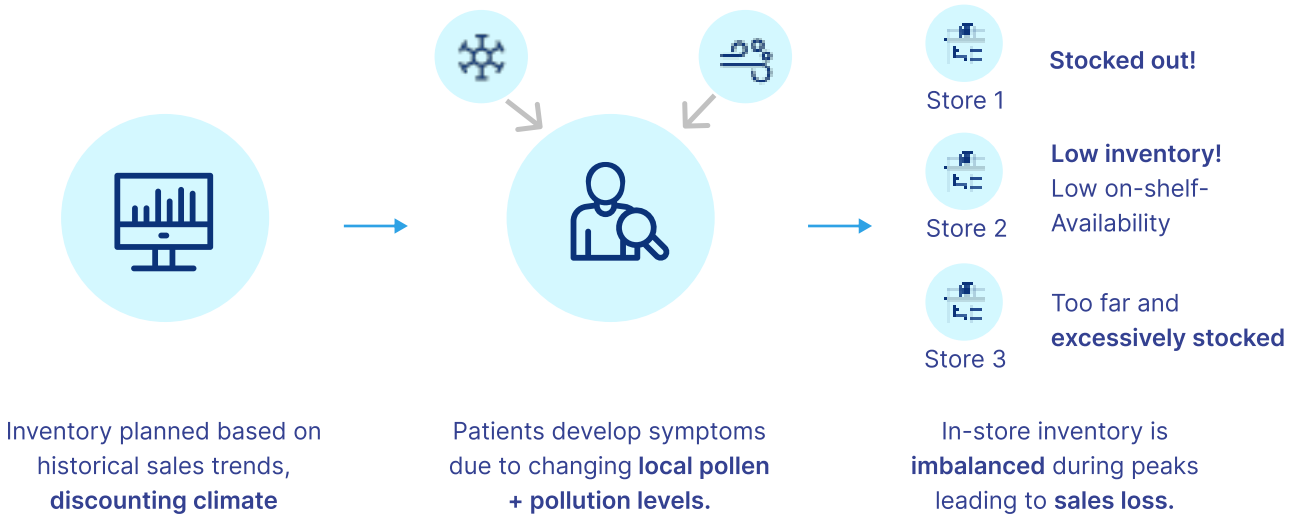


Fig.11: Hyperlocal pollen levels trigger allergy symptoms and create an inventory problem

Calculating the opportunity cost is particularly relevant in this context to understand the full extent of this inventory challenge. **When a retailer fails to stock sufficient quantities of allergy medications during a peak pollen season, the opportunity cost is the revenue that could have been generated from those missed sales.** On the other hand, the opportunity cost of overstocking is the capital tied up in unsold inventory, which could have been invested in other areas of the business to generate a higher return.

This opportunity cost can be estimated by first analyzing the total potential missed sales from understocking and stockouts, and then correlating pollen levels to understand how much of these potential missed sales can be explained by pollen.

Missed sales due to imbalanced inventory

Imbalanced inventory is common and costly during peak pollen season. When inventory levels are insufficient to meet the heightened demand, it leads to lower on-shelf availability or stockouts, resulting in missed sales and frustrated customers who are unable to find the relief they seek. This scenario can be particularly damaging during periods of high pollen counts when consumers are actively searching for allergy medications.

The repercussions of imbalanced inventory can be measured in two scenarios: one where the in-store stock falls below the ideal stock threshold (understocking) and another where no stock is available at all. In both cases, the missed sales can be quantified by calculating the anitcipated sales of the product, given the ideal stock was available.

Across two leading allergy majors, pollen data explained up to 80% of missed sales opportunities in multiple regions across the United States

Conversely, overstocking occurs when inventory levels exceed actual demand, resulting in excess stock that may remain unsold, leading to costly write-offs. Overstocking is often the result of overestimating demand or failing to accurately predict the end of the pollen season, leaving pharmacies with a surplus of allergy medications that are no longer needed once pollen levels decline.

Both understocking and overstocking highlight the challenges of pollen-blind planning. **Without incorporating forecasted pollen data into demand planning, pharmacies risk significant opportunity costs—whether in the form of missed sales due to stockouts or wasted resources due to unsold inventory.**

When analyzing multiple retail channels and SKUs, the effect of missed sales becomes even more pronounced, presenting a sizeable challenge for any stakeholder. However, by using long-term and hyperlocal pollen intelligence in several cases, we have seen it emerge as a comprehensive solution.

Case in point: 30-day pollen data achieves up to 42% uplift in forecast accuracy achieved compared to traditional forecasting

We integrated Ambee's 30-day pollen forecast into an industry standard demand forecast and compared the results v/s actual sales for multiple regional clusters. Among those, the R2 scores for a particular cluster revealed 47% improvement (average 40% uplift across 3 clusters studied) in accuracy using pollen data.

With pollen forecast:

60% (83% during pollen peak)

Traditional:

13% (31% during pollen peak)

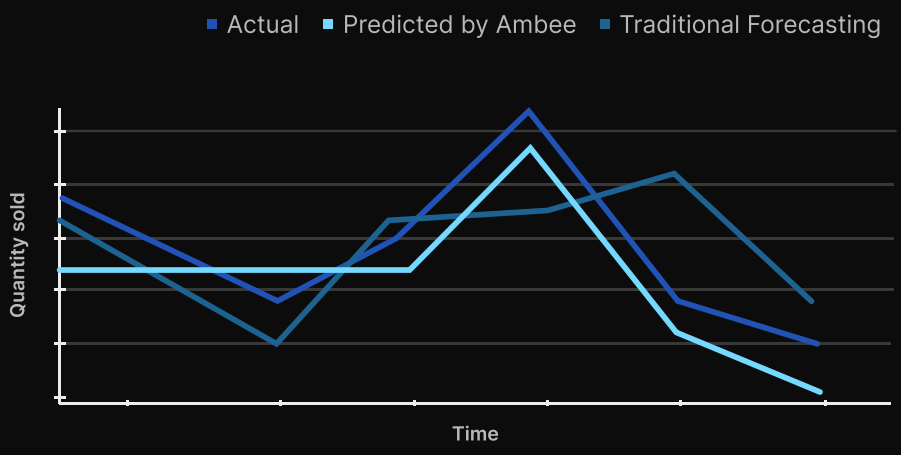


Fig 12.: Comparison between pollen-based demand forecasts and traditional demand forecasts v/s actual sales

Accurate pollen-driven demand forecasts are instrumental in mitigating both understocking and overstocking scenarios across different clusters. By integrating precise predictions from historical sales and pollen data, businesses can align their inventory levels more effectively with anticipated consumer demand.

Traditional ERPs are typically designed to manage and analyze existing internal data but often overlook critical climate variables that can significantly impact planning. To effectively respond to climate-driven demand fluctuations, businesses need more advanced, integrated systems that combine rich environmental intelligence with forecasting capabilities

Key takeaways:

Pollen-less demand forecasts:

Most traditional demand forecasts rely on historical sales data and general market trends. However, these models often miss sudden and unpredictable demand spikes driven by environmental factors like pollen levels.

Repercussions of imbalanced inventory:

Understocking during high pollen periods leads to missed sales,while overstocking results in excess inventory and write-offs.

Opportunity costs:

Effective demand planning is crucial to avoid missed sales from understocking during peak pollen seasons and excess inventory from overstocking. Analyzing pollen data alongside inventory levels helps quantify the opportunity costs of these issues.

Introducing ClimaChain – enhanced forecast accuracy for allergy brands

ClimaChain is Ambee's cutting-edge demand planning solution, specifically designed for allergy and other OTC brands. It seamlessly integrates Ambee's hyperlocal pollen, pollution, and weather data with inventory information to deliver highly accurate demand forecasts. As climate change increasingly affects consumer needs, ClimaChain helps you stay ahead by aligning your inventory with on-ground environmental conditions.

How does ClimaChain work?

ClimaChain merges two critical data streams: Ambee's granular environmental data and your existing inventory and PoS data. By combining your historical sales data with Ambee's climate insights, ClimaChain delivers rolling 30-day demand forecasts to anticipate demand fluctuations driven by climate triggers.

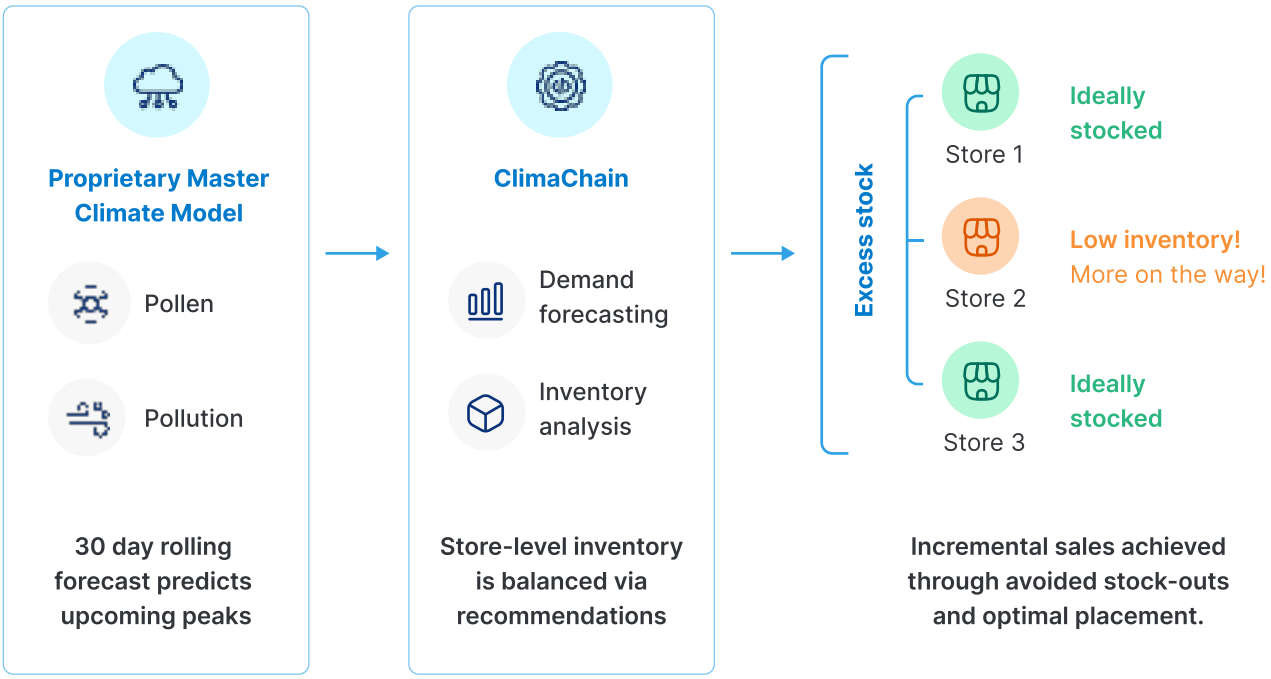


Fig.13.: ClimaChain combines Ambee's proprietary pollen data with historical sales data to generate rolling 30-day forecasts

What do you get out of ClimaChain?

Leading allergy brands are already harnessing the power of ClimaChain to revolutionize their demand planning. With climate data integrated directly into your demand planning, you can avoid costly stockouts during peak allergy seasons, ensure continuous product availability, and unlock the potential for increased sales.

Brands using ClimaChain have seen up to a **30%** reduction* in stockouts, potentially leading to a **5%** increase in sales and improved category share.

*Preliminary results from a live use case indicating reduced stockouts and increased availability due to an uplift in demand forecast accuracy at a store-SKU level.

How to get started

To get started, contact us today and receive a free first analysis—your first step toward smarter, climate-aware demand and inventory planning.

Contact us

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Glossary

Allergy:
Allergy occurs when a person reacts to substances in the environment that are harmless to most people. These substances are known as allergens. Examples of allergies include allergic rhinitis (hay fever), eczema, hives, and asthma.

Allergic reactions:
occur when the immune system responds to an allergen by producing antibodies, particularly immunoglobulin E (IgE). This response can trigger the release of histamine and other inflammatory mediators, resulting in symptoms such as hives, swelling, and difficulty breathing.

Allergic diseases:
refer to conditions affecting the respiratory system, primarily caused by allergic reactions. This includes allergic rhinitis and asthma, where the airways become inflamed due to exposure to allergens.

Antihistamines:
Antihistamines are medications that block the action of histamine, a chemical released during an allergic reaction. By inhibiting histamine's effects, these drugs help alleviate symptoms such as itching, sneezing, and runny nose. They are commonly used to treat allergic rhinitis and other allergy-related conditions.

Decongestants:
Decongestants are medications that relieve nasal congestion by constricting blood vessels in the nasal passages, reducing swelling and mucus production. They are often used in conjunction with antihistamines to treat symptoms of colds and allergies, providing temporary relief from nasal blockage.

Nasal spray:
Nasal sprays are delivery systems for medications directly into the nasal passages. They can contain various active ingredients, including antihistamines, corticosteroids, or saline solutions, and are used to treat nasal congestion and other symptoms associated with allergies and respiratory conditions. Corticosteroid nasal sprays are particularly effective in reducing inflammation in allergic rhinitis.