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Climate change and allergy: a call for action in Europe

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Abstract

This mini-review examines the link between climate change, air pollution, and aeroallergen-induced respiratory diseases in Europe. The articles selected in this mini-review highlighted the links between climate change, air pollutants and the impact on aeroallergen-induced respiratory disease. Searching data base PubMed returned results, but not all were relevant. The search conducted for a geographical scope of Europe after 2015 returned a large number of results, clinical studies, manuals, guidelines and recommendations from international recognized institutions or organizations, such as Global Initiative for Asthma (GINA), World Health Organisation (WHO) from which only published texts containing both general information and specific quantifiable information on climate change and air pollutants and their effects on health were selected. The findings highlight how environmental stressors interact to exacerbate allergic respiratory diseases, and emphasize the need for environmental policies.

Keywords

Climate change, allergy, asthma, air pollution

Introduction

The rise of respiratory allergic diseases has become a growing public health concern in Europe. Strongly linked to environmental transformations, that include air pollution, global warming and extreme weather events that are altering pollen production. Allergy is described as an exaggerated response from the body's immune system to otherwise inert substances present in the environment. Hypersensitivity refers to an inappropriate immune response to common, typically harmless antigens, manifesting along a continuum from minor conditions such as atopic dermatitis and rhinitis to more severe outcomes like asthma and anaphylaxis [1]. These immune-mediated diseases are increasingly influenced by external environmental factors. Recent research has shown that climate change can modify pollen production and allergenicity, extend pollen seasons, and alter the distribution of allergenic plants, leading to new sensitization and longer exposure windows. Allergic responses can be intensified and triggered by the interaction between pollen, air pollutants, and meteorological variables. Conditions that pose particular risk to vulnerable populations. Despite recognition of the link between climate change and allergic disease, dedicated health

strategies remain underdeveloped. It is important to keep in mind that while climate change alters pollen production and seasons, air pollution directly enhances pollen allergenicity and worsens respiratory symptoms [2].

The mini review aims to put together the latest evidence on how climate change and environmental pollution affect respiratory allergies and asthma across Europe.

Climate change and pollen allergy

Climate change, air pollution, and extreme weather conditions are some of the causes of the increasing prevalence and severity of respiratory allergies. For example, thunderstorms fragment the pollen grains into smaller and highly allergenic particles. Due to their size and number, they penetrate deeper into the lung and can trigger severe asthma attacks even in people with mild or undiagnosed pollen allergies. Also, greenhouse gas (GHG) resulting from human activities (burning fossil fuels, deforestation, and overall industrial processes) leads to climate change that can affect ecosystems and the geographic distribution of allergens. There is an urgent need for governmental actions to address climate resilience, which have to include the implementation of dedicated health plans on allergies and other health consequences related to climate change. We have conducted a pragmatic literature search of the current state of knowledge related to the impact of climate change on populations suffering from respiratory allergy.

Climate change has a significant impact on pollen production, allergenicity, and seasonal pollen dynamics, leading to increased risks of respiratory disorders for specific populations. The rise of carbon dioxide (CO_2) levels and temperature enhances annual pollen production and prolongs pollen seasons, increasing human exposure to allergens. Season pollen integral data suggests that climate change affects annual pollen production more directly than atmospheric transport, suggesting that forecasting models could predict future pollen burden and health related impacts [3].

The natural geographic distribution of allergenic plants is impacted and could be leading to longer flowering seasons [4]. Habitats and species density are shifting northward in the Northern Hemisphere, raising the risk of specific and new pollen sensitization in new areas. This increased allergen exposure can lead to respiratory symptom manifestations and sensitization appearing from the age of 4 years [5].

Meteorological impacts

Climate change directly impacts meteorological conditions and events, as it exacerbates extreme temperatures and increases the frequency and strength of events as thunderstorms, wildfires, and dust storms that contribute to increased pollen health-related risks [6].

Longer and more acute pollen seasons alongside rising allergic sensitization have direct consequences, such as enhancing the allergen content of pollen (e.g., birch pollen with higher allergenicity under warmer conditions) [3].

Thunderstorm asthma is a phenomenon in which thunderstorms fragment pollen grains into smaller and highly allergenic particles that penetrate deeper into the lungs, triggering severe asthma attacks. Thunderstorm asthma events are a rising public health concern, affecting both sensitized and non-sensitized individuals. One such event was observed in 2004 in Naples. In 2016 in Australia, a thunderstorm asthma event led to 10 deaths and sent about 9,000 hospitalizations for severe asthma [7]. The first one was characterized in 1983, in the United Kingdom (UK). Since then, over 20 other events were reported. In the UK, another thunderstorm was recorded in June 2023 with a dramatic increase in European Union (EU) attendances due to asthma all over England [8].

Air pollution and respiratory allergies

Air pollutants are also responsible and enhance allergic diseases (Figure 1). They modify the shape, size, and allergenicity of pollen grains, enhancing their inflammatory potential. Studies show that diesel pollutants and resulting fine particles have pro-inflammatory effects, which combined with an increasing allergen concentration worsen allergic manifestations.

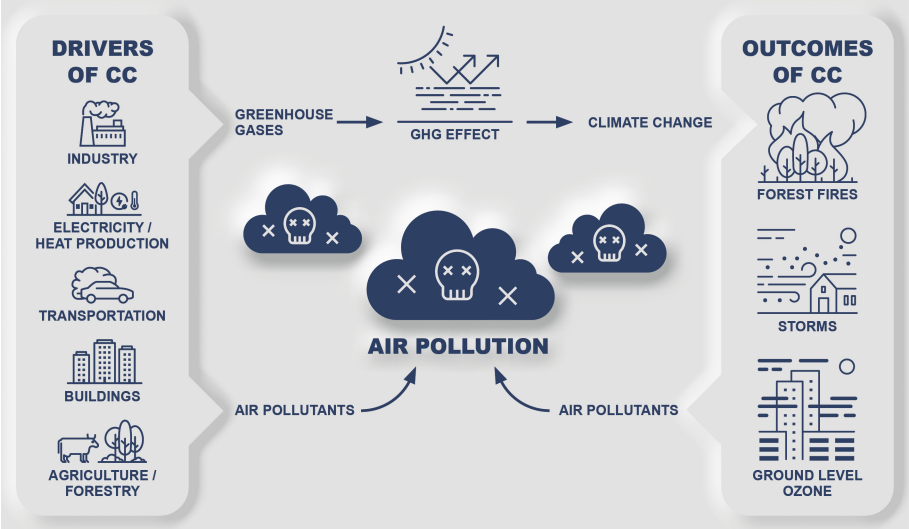

Figure 1. Drivers of CC. An overview of the negative impact of human activities and how they drive CC by emitting GHG and air pollutants, leading to, for example, storms, ground level ozone, and forest fires. Adapted with permission from [9]. CC: climate change; GHG: greenhouse gas. © 2021 Published by Elsevier Inc. on behalf of the American Academy of Allergy, Asthma & Immunology

Finally, ozone (O_3) increases pollen allergenicity and impairs airway defenses. In Mediterranean regions, sunny days (ultraviolet light converts nitrogen dioxide into O_3) create "summer smog" that worsens asthma and allergic inflammation. Up to 60% of the inhaled O_3 is absorbed by the nasal airways, with the remainder reaching the lower airways [6]. O_3 is a prototypic oxidant pollutant that can generate reactive oxygen species in the airways when inhaled, that can lead to oxidative stress [10]. In recent studies, it has been shown that O_3 concentration enhances the potential of birch pollen. Higher O_3, correlates with increased levels of Bet v 1, and heightened immune response in sensitized individuals. These studies suggest that O_3, acts as a key environmental factor enhancing birch pollen allergenicity, which can potentially exacerbate allergic symptoms [11]. Bet v 1, is one of the most allergenic pollen produced by trees, with over 100 million people allergic to its pollen [12].

According to the World Health Organisation (WHO), by 2050, 50% of the population will suffer from allergy disorders resulting from the acceleration of air pollution associated with toxic gas emissions and climate change [13].

Biological and environmental interactions

Climate change and pollution act as significant plant stressors, modifying pollen allergenicity via reactive oxygen specifies and proteomic plasticity in plants. Stress increases allergenic proteins in ragweed, a potent aeroallergen in Europe, especially in Eastern Europe, Italy, and France. In many European countries, the prevalence of ragweed sensitization is above 2.5% (up to a maximum of 20% in Denmark and 50% in Hungary) [14].

Public health impacts

Vulnerable populations, including children, the elderly, and low-income communities, due to overlapping risk factors (social determinants, reduced access to medical care), are the populations experiencing the most climate change-related respiratory health issues (Figure 2). For example, urban environments have been associated with a higher prevalence of allergic disease, suggesting that early-life exposure to pollutants impacts allergic sensitization and disease development [15, 16].

As the most impactful manifestation of allergies, allergic asthma is a major public health concern. To reduce allergy and asthma related risk, public prevention campaigns and education are crucial. The Global Initiative for Asthma (GINA) report on the burden of this disease has estimated that 400 million people in the world suffer from allergic rhinitis and 300 million from asthma [17]. The total cost of asthma for the

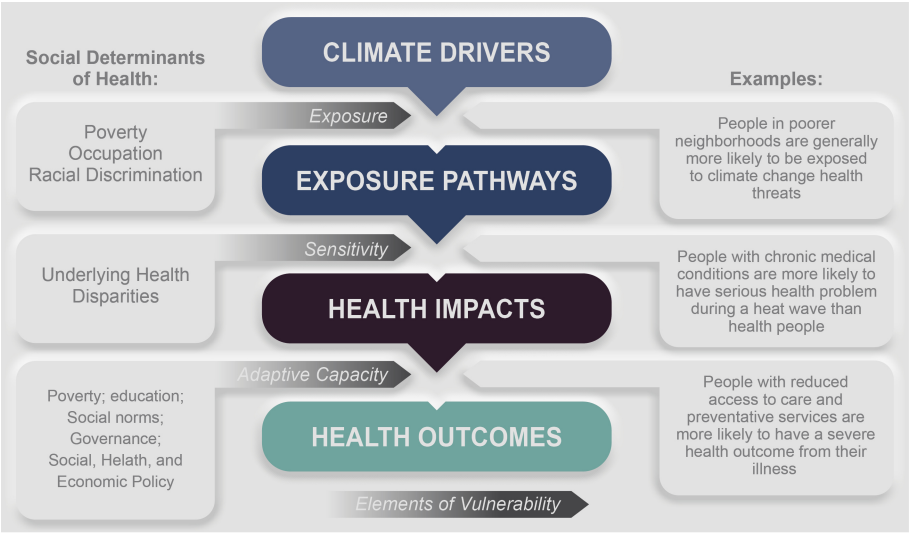

Figure 2. Social determinants of health. Adapted from [16]. Overview of how social determinants of health influence people's vulnerability to climate change

European Union is estimated at €3 billion, while the annual economic cost of premature deaths from air pollution across Europe was estimated by WHO at US$1.431 trillion, with an overall cost that includes health impacts and mortality from air pollution of US$1.575 trillion [13].

Climate change impacts both pollen distribution and production, directly increasing prevalence, frequency and severity of allergy manifestations and its most debilitating consequence, allergic asthma, a major public health concern.

In addition, pollution generated by human activity worsens CO_2, O_3, and small particle levels, exacerbating allergic reactions, affecting lung airways and causing inflammation. These combined factors lead to a significant worsening of allergic manifestations.

There is an urgent need for the implementation of impactful public actions, such as limiting the proliferation of highly allergenic species (e.g., ragweed, birch), particularly in urban areas and reducing pollution due to human activities. The adverse effects of human activities and climate change on allergic conditions could be reduced through the implementation of effective and targeted interventions (Figure 3). In addition, proactive, systematic and large communication campaigns on pollutants and pollen levels crossed with weather forecasts could anticipate and prevent significant health damage for allergic populations. In response, the European Union has established the Ambient Air Quality Directive to regulate and monitor air pollutants that pose a risk to public health.

Finally, the increasing prevalence and severity of allergic manifestations will need to be managed. As of today, the number of allergologists is decreasing whilst prevalence and allergy diseases and their severity increase. This creates bottlenecks and strong access barriers for patients who cannot be managed by specialists in due time and receive appropriate diagnosis and treatments. Optimizing the allergic patients' pathway will allow appropriate disease management by specialists and other healthcare providers, as well as access to an appropriate therapeutic arsenal, including both symptomatic rescue medication and targeted disease modifying treatments such as allergen immunotherapy. Allergen immunotherapy is, due to its mode of action, the only therapy that can change the course of the allergic disease and reduce the severity of allergic manifestations due to climate change.

Conclusions

- Minimize climate change and pollution effects: Act urgently to limit the proliferation of highly allergenic plants (e.g., ragweed, birch), particularly in urban settings, and reduce pollution caused by human activities to mitigate the worsening impact of global warming on allergies and asthma.

- Enhance awareness and communication: Implement systematic, large-scale communication campaigns to inform proactively vulnerable populations on pollen/pollutant levels and weather forecasts.
- Optimize patient care pathways: Address the declining number of allergists by streamlining patient pathways, enabling timely access to accurate diagnosis and treatments by allergy specialists and other healthcare professionals.
- Enable allergic patients to have access to allergen immunotherapy: Support and expand access to allergen immunotherapy as it remains the sole therapeutic approach capable of modifying allergic disease progression, effectively managing disease increase and severity exacerbated by climate change.

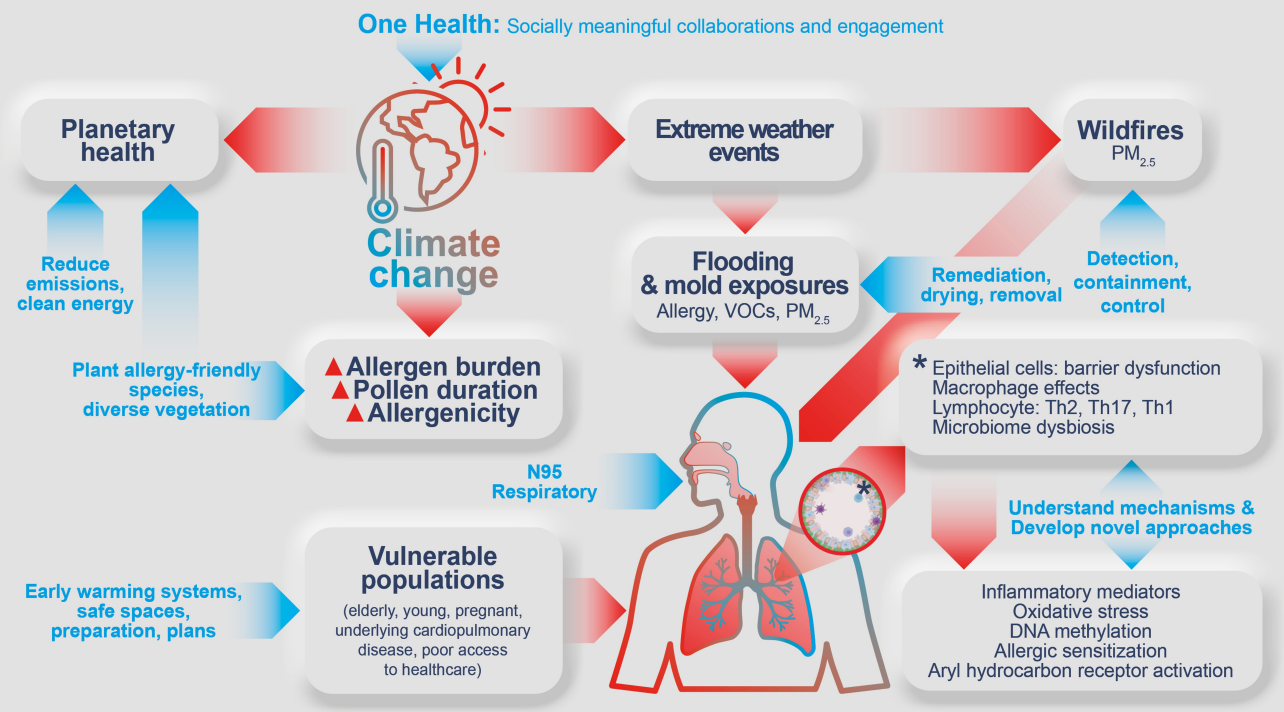

Figure 3. Consequences and actions to mitigate the effects of allergy. Overview of the negative consequences (red arrows) attributed to climate change with approaches and interventions to mitigate the adverse allergy and immunology health consequences (blue arrows). VOC: volatile organic compounds; $PM_{2.5}$: particulate matter with a diameter of less than 2.5 μm. Adapted with permission from [18]. © 2024 American Academy of Allergy, Asthma & Immunology

Abbreviations

CO_2: carbon dioxide

EU: European Union

GHG: greenhouse gas

GINA: Global Initiative for Asthma

O_3: ozone

UK: United Kingdom

WHO: World Health Organisation

Declarations

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Author contributions

LV: Conceptualization, Investigation, Writing—original draft, Writing—review & editing. The author has read and approved the submitted version.

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The author declares that there are no conflicts of interest.

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Consent to publication

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References

1. Dougherty JM, Alsayouri K, Sadowski A. Allergy. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025. [PubMed]
2. D'Amato G, Chong-Neto HJ, Monge Ortega OP, Vitale C, Ansotegui I, Rosario N, et al. The effects of climate change on respiratory allergy and asthma induced by pollen and mold allergens. Allergy. 2020;75:2219–28. [DOI] [PubMed]
3. Beck I, Jochner S, Gilles S, McIntyre M, Buters JT, Schmidt-Weber C, et al. High environmental ozone levels lead to enhanced allergenicity of birch pollen. PLoS One. 2013;8:e80147. [DOI] [PubMed] [PMC]
4. Weber RW. Current and Future Effects of Climate Change on Airborne Allergens. Curr Allergy Asthma Rep. 2024;24:373–9. [DOI] [PubMed]
5. Lindqvist M, Leth-Møller KB, Linneberg A, Kull I, Bergström A, Georgellis A, et al. Natural course of pollen-induced allergic rhinitis from childhood to adulthood: A 20-year follow up. Allergy. 2024;79:884–93. [DOI] [PubMed]
6. D'Amato G, Pawankar R, Vitale C, Lanza M, Molino A, Stanziola A, et al. Climate Change and Air Pollution: Effects on Respiratory Allergy. Allergy Asthma Immunol Res. 2016;8:391–5. [DOI] [PubMed] [PMC]
7. D'Amato G, Annesi-Maesano I, Cecchi L, D'Amato M. Latest news on relationship between thunderstorms and respiratory allergy, severe asthma, and deaths for asthma. Allergy. 2019;74:9–11. [DOI] [PubMed]

8. Diver S, Symon F, Satchwell J, Lipscombe H, Green RH, Woltmann G, et al. Under the weather: an epidemic thunderstorm asthma event in Leicester, June 2023. BMJ Open Respir Res. 2025;12: e002588. [DOI] [PubMed] [PMC]
9. Pacheco SE, Guidos-Fogelbach G, Annesi-Maesano I, Pawankar R, D' Amato G, Latour-Staffeld P, et al.; American Academy of Allergy, Asthma & Immunology Environmental Exposures and Respiratory Health Committee. Climate change and global issues in allergy and immunology. J Allergy Clin Immunol. 2021;148:1366–77. [DOI] [PubMed]
10. Arjomandi M, Wong H, Tenney R, Holland N, Balmes JR. Effect of ozone on allergic airway inflammation. J Allergy Clin Immunol Glob. 2022;1:273–81. [DOI] [PubMed] [PMC]
11. Visez N, Hamzé M, Vandenbossche K, Occelli F, de Nadaï P, Tobon Y, et al. Uptake of ozone by allergenic pollen grains. Environ Pollut. 2023;331:121793. [DOI] [PubMed]
12. Dbouk T, Visez N, Ali S, Shahrour I, Drikakis D. Risk assessment of pollen allergy in urban environments. Sci Rep. 2022;12:21076. [DOI] [PubMed] [PMC]
13. WHO Regional Office for Europe, OECD. Economic cost of the health impact of air pollution in Europe: Clean air, health and wealth. Copenhagen: WHO Regional Office for Europe; 2015.
14. Pashley CH, Satchwell J, Edwards RE. Ragweed pollen: is climate change creating a new aeroallergen problem in the UK? Clin Exp Allergy. 2015;45:1262–5. [DOI] [PubMed]
15. Maio S, Baldacci S, Tagliaferro S, Angino A, Parmes E, Pärkkä J, et al. Urban grey spaces are associated with increased allergy in the general population. Environ Res. 2022;206:112428. [DOI] [PubMed]
16. Crimmins A. Chapter 9 Populations of Concern: THE IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN THE UNITED STATES: A Scientific Assessment [Internet]. [Cited 2025 Jul 15]. Available from: https://doi.org/10.7930/J0Q81B0T
17. Pawankar R, Bunnag C, Khaltaev N, Bousquet J. Allergic Rhinitis and Its Impact on Asthma in Asia Pacific and the ARIA Update 2008. World Allergy Organ J. 2012;5:S212–7. [DOI] [PubMed] [PMC]
18. Poole JA, Nadeau KC. Climate Change and the Practice of Allergy and Immunology. J Allergy Clin Immunol Pract. 2025;13:295–7. [DOI] [PubMed]