

# Scientific Reports in Medicine

## Review

## Global Warming and Allergy

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### Abstract

Climate change, triggered by anthropogenic carbon dioxide emissions, may lead to increased morbidity and mortality in allergic diseases due to factors such as elevated and novel pollen production, storms, high temperatures, migration with exposure to air pollution, increased humidity, indoor mold and fungal proliferation, ozone elevation, biodiversity loss, and alterations in the microbiota. Strategies should be developed to reduce greenhouse gases and chemical and biological air pollutants, to inform the public accurately, and to implement preventive and therapeutic measures during high-allergen seasons.

**Keywords:** Allergic diseases, Global warming, Climate change, Asthma, Allergic rhinitis, Allergic conjunctivitis, Atopic dermatitis

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## INTRODUCTION

Global warming is one of the most significant challenges of the twenty-first century. It refers to an increase in the average atmospheric temperature of the Earth caused by elevated levels of methane, carbon dioxide, chlorofluorocarbons, and various other pollutants, resulting in the greenhouse effect (1,2). Global warming is expected to cause numerous direct and indirect health problems in humans, one of which is an increase in allergic conditions. Genetic predisposition as well as environmental triggers such as foods, dust mites, pollens, molds, and animal dander may precipitate allergic diseases. Climate change influences both the levels and geographic distribution of aerosolized allergens (3). Allergic diseases affect approximately 20% of the global population (5). Climate change, in conjunction with increased air pollution and urbanization, contributes to the rising prevalence of allergic diseases (4). The increased prevalence cannot be explained solely by genetic factors (6). The phenotypes of allergic conditions such as atopic eczema, food allergy, asthma, allergic rhinitis, and allergic conjunctivitis can be significantly influenced by environmental factors (5,6). Global warming directly impacts the increase in allergic diseases through elevated particulate matter (PM) and pollen counts, and indirectly through droughts, floods, water pollution, migration, and heat waves, negatively affecting all allergic diseases from the prenatal period to death (7). Rising temperatures can directly or indirectly affect epithelial barriers of the skin and respiratory tract. Water pollution resulting from global warming and urbanization may also impair epithelial integrity, thereby exacerbating allergies (8). Climate change and global warming increase cadmium and zinc contamination in groundwater through leaching of heavy metals (9). Exposure to these potentially harmful metals has been reported to affect the T-cell population in umbilical cord blood, thereby contributing to the development of allergic diseases (10). Additionally, climate change reduces microbial diversity in the soil; coupled with increased hygiene, more time spent indoors, and reduced exposure to

green spaces, farm animals, and pets, this has adverse effects on immune health. Reduced gut microbiota diversity has been linked to allergic, inflammatory, and autoimmune diseases. The gut microbiota plays a key role in the development of food allergies (10). Climate change, by increasing migration, urbanization, air pollution, and pollen exposure, also elevates the risk of developing respiratory conditions such as asthma (11).

### Asthma and Allergic Rhinitis

The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in 2022 emphasized that respiratory diseases, particularly asthma, are climate-sensitive (12). The airway from the larynx to the alveolar wall is predominantly innervated by vagal nerves containing transient receptor potential (TRP) channels. TRPV1 and TRPV4 receptors are sensitive to temperatures above 42°C and between 22–40°C, respectively. These receptors are activated when hot air is inhaled (13,14). High temperatures and heat waves directly increase asthma exacerbations and hospital admissions (15–17). Climate change-induced heavy rains and flooding promote indoor humidity and mold growth in affected households, negatively impacting indoor air quality (18). Thunderstorm asthma refers to a surge in asthma cases following thunderstorms during periods of high pollen counts. In 2016, a thunderstorm asthma outbreak occurred in Melbourne, Australia. The combination of storm, wind, and high humidity caused ryegrass pollen grains to swell and rupture under strong winds, releasing microscopic particles capable of reaching deeper airways. Rapid meteorological changes—such as a sudden 10°C temperature drop and humidity levels exceeding 70% within an hour—exacerbated the event's severity. This outbreak resulted in 10 deaths and 9,000 emergency department presentations. Patients with allergic rhinitis but without a prior asthma diagnosis were at significant risk. Increased humidity also leads to proliferation of mold spores, raising indoor aeroallergen exposure and worsening respiratory

allergic symptoms. Populations with asthma and allergic rhinitis are particularly vulnerable to global warming (19–21). Ozone, a major greenhouse gas and potent oxidant, is associated with airway irritation, inflammation, oxidative stress, reduced lung function, and increased epithelial barrier permeability. In addition to pollen, weather, and air quality, ozone can influence the severity of pollen allergy symptoms. Globally, 8–20% of asthma-related emergency visits are attributed to ozone exposure (22).

### Allergic Conjunctivitis

Global warming also plays a role in allergic conjunctivitis exacerbations. Climate change increases the availability rather than the structural changes of pollen grains and fungal spores (23,24). Evidence suggests that rising temperatures and elevated carbon monoxide levels have direct effects on plants and pollen production (25). Elevated carbon dioxide levels are thought to increase pollen production in plants (26). Menzel's study, covering the period 1951–1996 in Europe, found that flowering and pollen production periods started earlier and lasted longer over time (27). Pollen is one of the most prominent triggers of allergic conjunctivitis, exerting effects via direct histamine release. Increases are expected with global warming.

### Atopic Dermatitis

Increased temperatures due to global warming lead to more sweating, and the salts and other substances in sweat aggravate itching and inflammation in already sensitive skin. As atopic dermatitis worsens, higher glucose levels in sweat may delay wound healing (28). During extreme weather events such as Hurricane Katrina in the USA in 2005, flooding led to increased mold proliferation both indoors and outdoors (29). Individuals with atopic dermatitis may develop allergic reactions to molds and perceive them as high threats, leading to exacerbated skin irritation (30). These factors collectively intensify itching, irritation, and inflammation in atopic skin.

### Food Allergy

Climate change may alter the geographic distribution and growing conditions of food crops, leading to population exposure to new plant-derived foods and potentially reshaping regional patterns of food allergy (31). Shifts in cultivation areas may introduce allergenic proteins to previously unexposed populations, increasing the risk of sensitization.

Elevated atmospheric carbon dioxide levels have also been shown to influence plant physiology and allergen expression. Studies in peanut cultivars demonstrate changes in biomass and allergenicity under increased carbon dioxide conditions, suggesting that atmospheric changes can modify both the quantity and immunogenic properties of allergenic proteins (31). Within the One Health framework, climate-related environmental stressors may further affect plant defense mechanisms and allergen production, potentially influencing food allergy patterns at the population level (32).

## CONCLUSION

Global warming and climate change have significant effects on allergic and atopic diseases. Continuous monitoring of these climate-related changes, surveillance of particulate matter and pollutants, creation of pollen maps, development of emergency weather alert systems, and public awareness campaigns to prevent greenhouse gas emissions are essential. The anticipated increase in extreme weather events in the near future will likely result in new allergic attacks, diagnoses, and disease exacerbations. A comprehensive One Health approach should be adopted to address these challenges (32).

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The authors declare that they have no conflict of interests regarding content of this article..

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## Ethical Declaration

Since this study is a review article, ethics committee approval is not required, and the Helsinki Declaration rules were followed to conduct this study.

## Authorship Contributions

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