

LETTER TO THE EDITOR

Climate change and outdoor aeroallergens related to allergy and asthma: Taking the exposome into account

To the Editor

Observed and projected changes of climate have multiple effects on production, distribution and allergenicity of aeroallergens, which are the main triggers of allergic rhinitis and allergic asthma. Global warming has reached 1°C compared to the preindustrial era, and it is estimated to increase up to 1.5°C between 2030 and 2052.¹ Long-lived greenhouse gases, and above all carbon dioxide (CO₂), are among the main factors affecting plants and moulds. Also extreme events, such as thunderstorms and flooding, are projected to increase in frequency and intensity in the next decades.

Climate change is one of the emerging environmental factors affecting development and exacerbations of allergic diseases, which have been under the spotlight of research in the last decade. Increased sensitisation rates and allergic diseases result from earlier shifts of airborne pollen seasons, increased pollen abundance and invasive allergenic plant species induced by climate change.² The greenhouse gas NO₂ was shown to increase the allergenicity of birch, ragweed, oak and plane tree pollen.³ An extended duration and an increased pollen load was linked to global warming consistently with previous observations and projections² although with some loco-regional and taxa-specific differences. Furthermore, climatic changes through increasing atmospheric CO₂ levels and changes in the fungal growth medium may impact the ability of allergenic fungi such as *Aspergillus fumigatus* to induce allergies.⁴

Under current climate change scenarios, extreme events such as thunderstorms are expected to increase. Although mechanisms remain to be clarified, there is evidence in favour of a causal relationship between an increase in the number of asthma attacks and thunderstorms during pollen and mould seasons in patients suffering from pollen or mould allergy. Likely, during a thunderstorm pollens and moulds break and cold downdrafts carry their fragments to ground level where they constitute a highly respirable allergenic aerosol that may induce asthma crisis in sensitized subjects. In the thunderstorm asthma epidemic of Melbourne, Australia in 2016, hospitals were inundated with patients with severe asthma attacks induced by allergens of grass pollens. There were more than 9000 patients including 10 subjects with fatal attacks and thousands of calls to firefighters and the police as well as to general practitioners. Being outdoor during the thunderstorm in the grass, pellitory, olive tree pollen or moulds seasons and having allergic rhinitis or noncontrolled asthma are risk factors for severe asthma attacks.⁵

As for other chronic noncommunicable diseases, the concept of exposome, that encompasses all environmental exposures that an individual experiences from conception onwards, has been proposed also for allergic diseases.⁶ Climate and aeroallergens were recently included in the nonspecific and specific external exposome, respectively, which influences the internal exposome.³ Early life exposure is of paramount importance for the development of respiratory allergies, while the trigger effect of aeroallergens can be defined as a “multiple-hit exposure” because it changes over life-time.⁷ The mechanisms of pollen-induced respiratory allergy are more complex than previously thought and a “pollen exposome” might be envisaged for representing the multiple factors which determine its allergenicity (Figure 1). Similarly to the human external exposome, besides the IgE-specific response to allergens of pollen, other specific environmental factors contribute to trigger symptoms in allergic patients, namely environment-environment interactions such as endotoxin content associated to bacteria on the pollen surface,⁸ pollen microbiome in general,⁹ and plants and hosted microorganisms, such as fungi, and pollen-air pollution interaction. Lastly, environment-human interactions, as the consequence of a combination of environmental factors to which the individual is exposed also contribute.

As the evidence of a negative effect of climate change on allergic diseases is accumulating, there is a strong need to take actions both as citizens and health professionals. Information on mitigation measures should be disseminated in any occasion and educational activities for schoolchildren, students and general population supported. Adaptation strategies are crucial for reducing the impact of climate change on pollen-allergic patients. As pollen and moulds seasons have become more variable in the last decades, real-time information and/or short-term aerobiological and air quality forecasts should be implemented and made available on a larger geographical scale. Mobile technology is able to disseminate this type of information, together with symptoms and quality of life data collection, as shown in recent studies.¹⁰

The tragic thunderstorm asthma event in Melbourne is emblematic of the potential risk for public health of such extreme events. At the same time, it highlighted the importance of adopting adaptation measures able to minimise the impact. Identification of patients at risk together with integrated weather, pollen and air quality forecasts are the first steps for implementing watch/warning systems for thunderstorm asthma and extreme events in general. Social

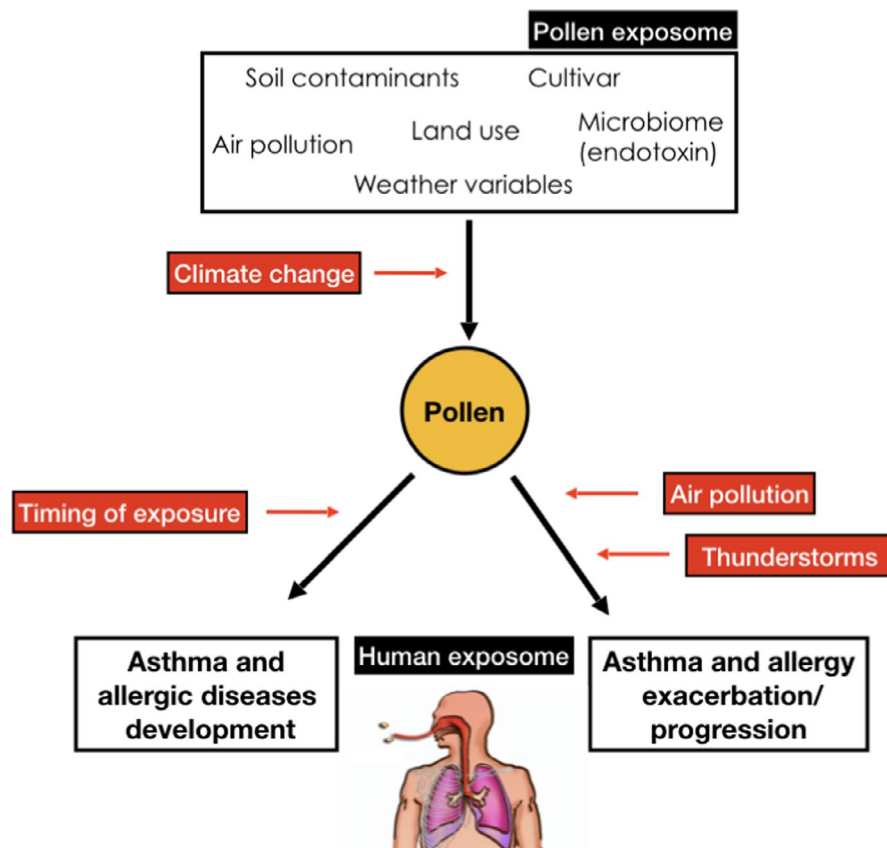


FIGURE 1 Pollen exposome and its effects on allergic diseases and asthma

media are able to reach most of the population and can spread alert real-time. Such alert systems cannot be created without research, however. Exposome provides researchers with a conceptual platform for approaching the relationship between environment and allergy and for creating multidisciplinary project consortia, but much more effort is needed. Indeed, mechanisms of interaction between weather variables, air pollutants and outdoor allergens and how this interaction affects allergic symptoms are still to be clarified. Furthermore, there is need for improving our ability to measure and forecast pollen, moulds and air pollutants levels at a personal level or, less feasible, at a lower spatial scale.

CONFLICT OF INTEREST

Dr Annesi-Maesano has nothing to disclose. Dr D'Amato has nothing to disclose. Dr Cecchi has nothing to disclose.

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