Climate Change and Respiratory Allergy

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What Has Changed over the Last 50 years?

Increased Temperatures
Increased Pollution
Increased CO₂ levels
Increased Allergy

In the last 50 years 50% of pluvial forests of our Planet have been destroyed.

Each year 13 millions of forests hectares are destroyed or deteriorated.

Each hour about 50 hectares of wood disappear.

The greenhouse effect

Food cultivation on wasted areas of tropical pluvial forests determined about 35% of deforestation in South America, 70% in African and 50% in Asian countries.

The International Panel on Climate Change (IPCC) concluded in its Report that global warming is unequivocal and that human activity is the main driving force very likely causing most of the rise in temperatures since 1950.
CO₂ is the most important anthropogenic greenhouse gas and about 75% of CO₂ emissions during the past 20 years resulted from fossil fuel burning.

Source: IPCC, 2007 (Working group I)

Anthropogenic CO₂ input

Long-term effects of CO₂: time to stabilization

After CO₂ emissions are reduced and atmospheric concentrations stabilize, surface air temperature continues to rise slowly for a century or more.

D’Amato G, et al

Facebook. A new trigger for asthma?
The Lancet, Vol 376; Nov 20, 2010 p1740

76 Millions of tons of CO₂ produced by internet in 2002
650 Millions of tons in 2010

D’Amato G, et al

Social Networks: a new source of psychological stress or a way to enhance self-esteem? Negative and positive implications in bronchial asthma. JACI In press

Current knowledge of effects of climate change on respiratory allergy is provided by epidemiological and experimental studies on the relationship between asthma and environmental factors, such as meteorological variables, airborne allergens and air pollution.
Climate Change and Air Pollution lead to:

- **Higher Allergenicity**
  
  "There is an interaction between air pollutants and allergens that exacerbates the development of atopy and the respiratory symptoms of allergic disease."

- **Higher Airway Responsiveness**

  "In atopic subjects, exposure to air pollution increases airway responsiveness to aeroallergens."

- **More Allergens**

  "Increased air temperature significantly influences the pollen production, and subsequent atmospheric pollen concentration."

2. Clin Exp Allergy 2006; Allergy 2007; Clin Exp Allergy 2006;JACI 2010;
### Effects of climate change on environmental factors in respiratory allergic diseases

**D’Amato & Cecchi**

- Earliest start, increase of length and intensity of pollen seasons
- Earlier occurrence of episodes of long-distance transport of pollens and pollens


### The "urban climate effect"

The plants flower earlier in urban areas than in rural areas with earlier pollination of about 2-4 days.

**D’Amato & Cecchi, Clin Exp Allergy 2005**

### The Possible Ways by which Atmospheric Pollution May Increase Allergy

- Enhancement of Sensitization
- Enhancement of Organ Hypersensitivity
- Triggering Episodes of Disease
- Enhanced Pollen Production and Antigenicity

**Emberlin et al CEA 1999, D’Amato et al Allergy 2007**

### What is the Association Between Weather / Climate Variability & Pollen Trends?

- Studies on plant responses to elevated CO2 indicate that plants exhibit enhanced photosynthesis and reproductive effects and produce more pollen.

**Emberlin et al CEA 1999, D’Amato et al Allergy 2007**
A doubling of the atmospheric CO2 concentration stimulated ragweed-pollen production by 61%.

Ozone affects pollen viability and NAD(P)H oxidase release from Ambrosia artemisiifolia pollen

**Highlights**
- O3 reduces the viability of exposed pollen.
- 35% of all allergens of exposed pollen were not affected by O3 exposure.
- O3 enhances the activity of the ROS-generating enzyme NAD(P)H oxidase.
- O3 increases exposed pollen allergenicity through NAD(P)H-oxidase stimulation.

**Relation between airborne pollen concentrations and daily cardiovascular and respiratory-disease mortality**

"In a time-series study in the Netherlands, we found a strong association between the day-to-day variation in pollen concentrations and that of deaths due to cardiovascular disease, chronic obstructive pulmonary disease, and pneumonia."

**Results**

Poaceae Betula and Rumex weekly concentrations were positively associated to mortality.

**Climate Changes favour production also of Airborne Small Allergen-carrying Particles**

- Pollen fragments
- Starch granules and other cytoplasmic granules
- Non-pollen plant parts (from inflorescences, leaves or Ubisch bodies)
- Non-plant particulate matter (allergens transferred through physical contact or by leaching from the surface of the pollen grain to other airborne small particles).
Changes are also occurring in the amount, intensity, frequency and type of precipitation as well as the increase of extreme events, like heat waves, droughts, floods and hurricanes.

Association between a thunderstorm and an asthma outbreak with 26 asthmatic subjects treated in Birmingham Hospital in 36 hours compared with 2-3 cases in the same time in the days preceding the thunderstorm.

London 25 June 1994


Thames Regions Accident and Emergency Trainer Association. A major outbreak of asthma associated with a thunderstorm: experience of accident and emergency departments and patients characteristics BMJ 1996;312:604-4

Also this phenomenon was followed by a rapid increase in hospital or general practitioner visits for asthma. No unusual levels of air pollution were noted at the time of these epidemics but there was a strong association with grass pollen.


Wagga Wagga 30 oct 1997
Napoli 4 June 2004 (D’Amato G et al Allergy 2007)

7 patients received treatment in emergency departments and one was admitted to an intensive care unit for acute respiratory insufficiency.

Napoli 4 June 2004

All subjects were allergic to *Parietaria*.

Five subjects had a history of asthma, whereas two had a history of only rhinitis.

The extraordinarily long persistence in the atmosphere of *Parietaria* pollen in Mediterranean area is responsible for a multiseasonal symptomatology.


The pollinic allergens are located in the walls or in the cytoplasm

- cytoplasm
- R.E.
- Nucleus
- plastids

Orbicul

The potential role of orbicules (Ubish bodies) as vector of allergens.

D’Amato G - Z Erkrank Atm Org 1981
Pacini E Franchi QQ - Plant Syst Evol 1993
Vinckier S Smets E - Allergy 2001
D’Amato G - Allergy 2007
D’Amato G et al Clin Exp Allergy 2005
D’Amato G et al Allergy 2007; JACI 2010; ERR 2012

Pulimood TB et al suggest sensitization to Alternaria species to play a key role in thunderstorm-related asthma.

Marks GB and Bush RK: It’s blowing in the wind: new insights into thunderstorm-related asthma. J Allergy Clin Immunol 2007;120:520-2

Marks and Bush provide a review of environmental factors involved in asthma epidemics, listing necessary conditions to make them possible. They cited fungal spores and grass pollen as the unique airborne allergens that are implicated in the pathogenesis of thunderstorm-related asthma. This is not completely true.
The occurrence of epidemics is closely linked to thunderstorm. The thunderstorm related epidemics are limited to late spring and summer when there are high levels of airborne pollen grains. There is a close temporal association between the arrival of the thunderstorm, a major rise in the concentration of pollen grains and the onset of epidemics.

1- The evidence about thunderstorm related epidemics of rhinitis and asthma exacerbations:

1) The occurrence of epidemics is closely linked to thunderstorm
2) The thunderstorm related epidemics are limited to late spring and summer when there are high levels of airborne pollen grains
3) There is a close temporal association between the arrival of the thunderstorm, a major rise in the concentration of pollen grains and the onset of epidemics

2- The evidence about thunderstorm related epidemics of rhinitis and asthma exacerbations:

4) Subjects with pollen allergy, who stay indoors with window closed during thunderstorm, are not involved
5) There are not high levels of gaseous and particulate components of air pollution.
6) There is a major risk for subjects who are not under antiasthma correct treatment, but subjects with allergic rhinitis and without previous asthma can experience severe bronchoconstriction.

Risk of relapse of thunderstorm-related asthma

The link between thunderstorm and asthma begins to be known. What is less know is the fact that relapse of thunderstorm-related asthma attacks is possible.

A young lady who experienced near fatal asthma in concomitance with a thunderstorm in June 2004 was admitted again in the emergency room department of Cardarelli hospital in Naples on 24 May 2011 for an attack of near fatal asthma.

During the second admission she was partly protected by regular inhalation (morning and evening) of salmeterol 50 mcg and fluticasone 250 mcg. The diagnosis was the same.

Although thunderstorm-associated asthma outbreaks are not frequent, it is possible to observe in clinical practice single cases of patients with deterioration of the allergic respiratory symptoms during a thunderstorm.
There is a role for cold or thunderbolts and electricity in atmosphere?

Take home message:
Subjects affected by pollen allergy should be alert to the danger of being outdoors during a thunderstorm in the pollen season.

"He inhaled a breath of humid morning breeze and let in nitrogen, oxygen, argon, xenon & radon, steam, carbon monoxide, nitrogen dioxide, tetra-ethyl lead, benzene, some mould spores, a bacteria fleet, anonymous body hair, a pigeon ectoparasite, anemophilous pollen, a drop of sulphur dioxide flown from a distant factory, and a particle of dust carried by the night sirocco.

In other words he breathed air of the city"

(Stefano Benni "Achille piè veloce", Mondadori, Italy, 2003)

Measures for reducing the effects of urban air pollution and pollen allergy:

- Decreasing use of fossil fuels and controlling vehicle emissions.
- Reducing the private traffic in towns.
- Improving the public transport.
- Planting in cities non-allergenic trees.

Moreover, eating antioxidant foods might decrease detrimental effect of air pollution.

ERS EAACI Task Force on Climate Change, Air Pollution and Respiratory Diseases

Strategies to reduce climate changes and air pollution are political in nature, but citizen and in particular health professionals and societies must raise their voices in the decision process to give strong support for clean policies on both national and international levels.

Thanks
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The average first flowering date of 385 British plant species has advanced by 4.5 days during the past decade compared with the previous four decades: 16% of species flowered significantly earlier in the 1990s than previously, with an average advancement of 15 days in a decade.

Set up of a warning system for thunderstorm asthma in at-risk countries:

- **Health system**
  - Selection of at-risk population
  - Guidelines for preventive measures and rescue therapy
- **Weather service**
  - Thunderstorms warning system
- **Alert service**
  - SMS, email
  - Broadcast
- **General population**
  - Emergency rooms and intensive care units
- **At risk subjects**
  - SMS, email

Determinants of climate changes:

Climate change is occurring as a result of greenhouse gas (GHG) (water, CO$_2$, CH$_4$, N$_2$O), emissions from:

- Anthropogenic factors: fossil fuel combustion from energy supply, transport, agriculture, industry, forestry, waste, and commercial and residential buildings.
- Natural factors: like spontaneous combustion (wild fires due to elevated temperatures, volcanoes ...).
Association between a thunderstorm and an asthma outbreak with 26 asthmatic subjects treated in Birmingham Hospital in 36 hours compared with 2-3 cases in the same time in the days preceding the thunderstorm.

Ozone affects pollen viability and NAD(P)H oxidase release from Ambrosia artemisiifolia pollen.

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Abstract
Air pollution is frequently proposed as a cause of the increased incidence of allergy in industrialised countries. We investigated the impact of ozone (O(3)) on reactive oxygen species (ROS) and allergen content of ragweed pollen (Ambrosia artemisiifolia). Pollen was exposed to acute O(3) fumigation, with analysis of pollen viability, ROS and nitric oxide (NO) content, activity of nicotinamide adenine dinucleotide phosphate (NAD[P]H) oxidase, and expression of major allergens. There was decreased pollen viability after O(3) fumigation, which indicates damage to the pollen membrane system, although the ROS and NO contents were not changed or were only slightly induced, respectively. Ozone exposure induced a significant enhancement of the ROS-generating enzyme NAD(P)H oxidase. The expression of the allergen Amb a 1 was not affected by O(3), determined from the mRNA levels of the major allergens. We conclude that O(3) can increase ragweed pollen allergenicity through stimulation of ROS-generating nicotinamide adenine dinucleotide phosphate oxidase.