Variazioni climatiche, Inquinamento atmosferico e patologie respiratorie allergiche

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Chairman World Allergy Organization Committee on
Climate Change and Allergic Respiratory Diseases
Adverse Respiratory Health Effects of Air Pollution

- A. Increased mortality
- B. Increased incidence of cancer.
- C. Increased incidence of lower respiratory tract infections.
- D. Increased exacerbations of diseases in persons with chronic cardiopulmonary or other diseases:
  - less able to cope with daily activity;
  - increased hospitality (both frequency and duration);
  - increased emergency ward or physician visits;
  - increased pulmonary medications;
  - decreased pulmonary functions.
- E. Increased frequency of symptomatic asthmatic attacks

Pyramid of respiratory effects of air pollution

Short-term vs. long-term effects

A continuum between?
Is there a relationship between outdoor, indoor and personal exposure to air pollutants?

- **PM 2.5**
- **VOCs**
- **EC**
- **PAHs**

In 1992 in China there were 600,000 cars.

In the year 2000 there were about 3,000,000 cars.

It is forecasted that in the year 2010 there will be more than 20,000,000 vehicles on the roads of China.

(Dublin 2004 European Conference on Environment)

E invece già nel 2007 c'erano oltre 30,000,000 veicoli in Cina
AMBIENT AIR POLLUTION AND LUNG FUNCTION DECREMENTS IN CHILDREN

- **Longitudinal studies**
  - Frischer et al, AJRCCM 1999; 160: 390
  - Jedrychowski et al, Environ Health Perspect 1999; 107: 669
  - Gauderman et al, AJRCCM 2000; 162: 1383
  - Avol et al, AJRCCM 2001; 164: 2067

- **Cross sectional studies**
  - Ware et al, ARRD 1986; 133: 834
  - Dockery et al, Environ Health Perspect 1996; 104: 506
  - Peters et al, AJRCCM 1999; 159: 768

Studies done in USA, South America, Europe and Asia

Correlazioni tra ricoveri ospedalieri per riacutizzazioni asmatiche e livelli di inquinamento atmosferico

Wong GW, Clin Exp Allergy 2001
Sunyer J, Thorax 1997
Anderson HR, Thorax 1998
Sunyer J, Occup Environ Med 2003
Lin M, Am J Epidemiol 2004
Fattori di Rischio di Allergia Respiratoria e di Asma

Agenti dell’inquinamento atmosferico sia esterno che interno (fumo di tabacco)

Allergeni

Interazioni tra allergeni, agenti inquinanti ed infezioni.

Suscettibilità genetica

Infiammazione delle vie aeree ed iperreattività bronchiale

Stress

Stile di vita

Farmaci come ASA

Infezioni, soprattutto virali

Esposizione occupazionale

Attività fisica non adeguatamente protetta da farmaci

What May Play a Role in Today´s Respiratory Allergy and Asthma?

Climate Change and Air Pollution
Aggressive allergens
Severe symptoms

Indoor Lifestyle
Persistent allergen exposure
Persistent symptoms

New Allergens
More and different allergens
Frequent symptoms

Stressful Lifestyle
Neuro-immune responses
Susceptive to allergy

New Allergens

Indoor Lifestyle

Climate Change and Air Pollution

Stressful Lifestyle

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What May Play a Role in Today´s Respiratory Allergy and Asthma?
Figura 1. Schematizzazione convenzionale dell'apparato respiratorio in vie aeree superiori e inferiori, e rispettive sezioni transverse ai diversi livelli.

(D’Amato G. Mediserve Ed. 2010)
Particle deposition is higher in asthmatic subjects as compared to healthy subjects

University of Rochester, New York

Total mass deposited (mcg)

At rest exercise At rest exercise

Healthy Asthmatic subjects

(Chalupa DC et al, Environ Health Perspect 2004 Jun; 112: 879-882)

London VI WORLD Asthma and COPD Forum
27-30 April 2013

Air Pollution, Climate Change and Increasing prevalence of Respiratory Allergy

Gennaro D’Amato

Director, Division of Respiratory and Allergic Diseases
Department of Chest Diseases
High Speciality Hospital A. Cardarelli
Napoli Italy
The massive increase in emissions of air pollutants due to economic and industrial growth in the last century made air quality an environmental problem of first order in a large number of European and North American countries and it is now an emerging problem in other regions of the world.

Outdoor

Air pollution

Indoor

There are 20 cities expected to have > 10 million inhabitants by the year 2015 and two thirds of mankind are expected to live in megalopolis by 2020

Current projections suggest that the world population will be close to nine billion by 2050
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.

### Health Effects of Exposure to Ozone and PM$_{2.5}$

- coughing
- nose and throat irritation
- chest pain
- reduced lung function
- increased susceptibility to respiratory illness
- aggravation of asthma
- children with chronic lung disease are particularly at risk

- increased risk of cardiac arrest and premature death
- aggravation of asthma
- respiratory related hospital visits
- reduced lung function and chronic bronchitis
- work and school absences
- children with chronic lung disease are particularly at risk
Human exposures to O₃ have been shown to elicit a spectrum of acute responses including:


Relationship between air pollution and asthma exacerbations in children

*Original Article*

*Modifying Effect of Age on the Association between Ambient Ozone and Nighttime Primary Care Visits Due to Asthma Attack*

Shin Yamazaki¹, Masayuki Shima², Michiko Ando³, and Hiroshi Nitta⁴

**Conclusions:** An association was found between ozone and nighttime primary care visits for asthma attack in warmer months; the association was greater among preschool children.

*Original Article*

*Chronic Exposure to Ambient Ozone and Asthma Hospital Admissions among Children*

Shao Lin¹, Xia Liu¹, Linh H. Le², and Synt-An Huong³

**Conclusions:** Chronic exposure to ambient ozone may increase the risk of asthma admissions among children. Younger children and those in low socioeconomic groups have a greater risk of asthma than do other children at the same ozone level.
McConnell et al observed that the incidence of new diagnoses of asthma in children are associated with heavy exercise in communities with high concentrations of ozone and PM. As a consequence, air pollution and outdoor exercise could contribute to the development of asthma in children.

McConnell R, Berhane K, Gilliland F et al. Prospective study of air pollution and bronchitic symptoms in children with asthma. AJRCCM 2003;168:790-797

Can air pollution induce a new-onset asthma?

Traffic-Related Air Pollution and Asthma Onset in Children: A Prospective Cohort Study with Individual Exposure Measurement

CONCLUSIONS: In this cohort, markers of traffic-related air pollution were associated with the onset of asthma. The risks observed suggest that air pollution exposure contributes to new-onset asthma.
Can air pollution induce a new-onset asthma?

- Higher Allergenicity
  "There is an interaction between air pollutants and allergens that exacerbates the development of atopy and the respiratory symptoms of allergic disease." ¹

- Higher Airway Responsiveness
  "In atopic subjects, exposure to air pollution increases airway responsiveness to aeroallergens." ¹

- More Allergens
  "Increased ... air temperature significantly influences the pollen production, and subsequent atmospheric pollen concentration". ¹²³

³ Cecchi L,D’Amato G et al Allergy 2010
Effects of climate change on environmental factors in respiratory allergic diseases

G. D’Amato* and L. Cecchi**

*Division of Respiratory and Allergic Diseases, Department of Chest Diseases, High Specialty Hospital “A. Vanvitelli”, Naples, Italy. **Internal Medicine Division of Allergology, University of Florence, Florence, Italy.

- Earlier start, increase of length and intensity of pollen season
- Increase of pollutants levels
- Increase of heavy precipitation events (e.g. thunderstorms)
- Increased occurrence of episodes of long-distance transport of pollen and pollutants
- Reduced susceptibility to antihistamines:
  - (due to increase in winter temperature)

D’Amato & Cecchi, Clin Exp Allergy, 2008
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.
ERS EAACI Task Force on Climate Change, Air Pollution and Respiratory Diseases

ERS POSITION STATEMENT
Climate change and respiratory disease: European Respiratory Society position statement

Endorsed by EAACI and ERS Task force on “Climate change, air pollution and respiratory diseases”
Chairpersons: G.D’Amato and I.Annesi

- Global warming affects start, duration and intensity of pollen season
- Air pollution is associated with mortality and morbidity for respiratory and cardiovascular diseases.
- PM and ozone are aggravating factors of asthma and increase the effects of airborne allergens with different mechanisms.
- Living near heavy traffic roads is associated with impaired respiratory health and lung development.
- Subjects living in urban areas tend to be more affected by plant-derived respiratory disorders than those living in rural areas

Sep; 65(9):1073-81 Allergy, 2010.
Climate Change, Migration and Allergic Respiratory Diseases: An Update for the Allergist

Gennaro D’Amato (Chair), MD; Menachem Rottem, MD; Ronal Dahl, MD; Michael Blaiss, MD; Erminia Ridolo, MD; Lorenzo Cecchi, MD; Nelson Rouffe, MD; Cassim Mesada, MD; Ignacio Amognati, MD; Isabella deMestrez-Musacchio, MD; for the WAO Climate Change, Migration and Allergy Special Committee

Climate change affects allergic respiratory diseases

In a review from the World Allergy Organization’s Special Committee on Climate Change and Allergy (WAO Journal, July 2011), D’Amato et al report that local climate changes coupled with air pollution and altered weather patterns may have a significant effect on the frequency and severity of allergic respiratory diseases. Climate changes have affected local plant growth, as well as pollen production and dispersion, resulting in earlier and longer pollination seasons that potentially could lead to increased duration of symptoms in sensitized subjects. Alterations in local vegetation and airborne allergens caused by climate change can result in new pollen sensitization and increased prevalence of allergic respiratory disease. Editor’s note: For those readers interested in this topic, further articles on the relationship among climate change, air pollution, and allergy can be found in the January 2012 issue of the Journal of Allergy and Clinical Immunology.

Committee chair Gennaro D’Amato, from High Specialty Hospital A. Cardarelli, Naples, Italy, commented on the importance of this topic: “Strategies to reduce climate changes and air pollution are political in nature, but citizens 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.”
Climate interacts with outdoor exposure to NO₂ increasing the risk for allergic rhinitis and asthma in people exposed to high stable temperature.

Today’s allergens are particularly aggressive

There is hypothesis that air pollutants promote airway sensitization by inducing changes in the allergenic content of airborne particles carrying antigens such as pollens.

The “urban climate effect”

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

Emberlin et al CEA 1999; Beggs CEA 2002; D’Amato et al ERJ2002; Allergy2007; CEA2008; JIACI 2010

Production of allergenic pollen by ragweed (Ambrosia artemisiifolia) is increased in CO2 enriched atmospheres.


A doubling of the atmospheric CO2 concentration stimulated ragweed-pollen production by 61%.
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

Brunekreef et al, Lancet, 2000
Ozone affects pollen viability and NAD(P)H oxidase release from Ambrosia artemisiifolia pollen

Stefania Pasquallini, Emma Tedeschini, Giuseppe Freguitti, Nicola Wopner, Fatima Ferreira, Gennaro D’Amato, and Luisa Ederli

1Department of Applied Biology, University of Perugia, Perugia, Italy
2Department of Molecular Biology, CD Laboratory for Allergy Diagnosis and Therapy, University of Olsztyn, Olsztyn, Poland
3Division of Respiratory and Allergic Diseases. A. Cardarelli’ Hospital, Naples, Italy

Highlights

- Ozone reduces the viability of ragweed pollen.
- ROS and allergens of ragweed pollen were not affected by Ozone exposure.
- Ozone enhances the activity of the ROS-generating enzymes NAD(P)H oxidase.
- Ozone increases ragweed pollen allergenicity through NAD(P)H-oxidase stimulation.

NAD(P)H = nicotinamide adenine dinucleotide phosphate oxidase.
**Crisi epidemiche di asma da soia**

- 1950-1960 New Orleans
- 1970-1980 Cartagena e Barcellona
- 1981-1987 26 nuovi episodi a Barcellona
- 1993 Napoli

“cluster” di gravi crisi di asma con evidenza anatomo-patologica (nei morti) di un meccanismo di tipo “anafilattico”

**Dispersione atmosferica della polvere dei silos portuali**

**Fattori meteorologici**
(direzione del vento, inversione termica, ecc.)

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

D’Amato G et al Allergy 2007; Clin Exp Allergy 2008; JIACI 2010; ERR 2012

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

D’Amato G - Z Erkrank Atm Org 1981
Pacini E Franchi GG - Plant Syst Evol 1993
Vinekler S Smets E - Allergy 2001
D’Amato G - Allergy 2001
D’Amato G et al Clin Exp Allergy 2005
D’Amato G et al Allergy 2007; JIACI 2010

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;312:601-4

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.
7 patients received treatment in emergency departments and one was admitted to an intensive care unit for acute respiratory insufficiency.
Under wet conditions or during thunderstorms pollen grains may, after rupture by osmotic shock, release part of their cytoplasmic content into the atmosphere.


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.

- Orbiculs

Hydrated pollen on a wet surface:

- Lipid drops
- Proteins
- Starch
“the arrival of a thunderstorm was accompanied by a large increase in the concentration of ruptured pollen grains”
Thunderstorm-related asthma: Not only grass pollen and spores

To the Editor:

Gennaro D’Amato, MD*  
Lorenzo Cecchi, MD*  
Gennaro Lucardi, MD*

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Review article

Thunderstorm-asthma and pollen allergy

Thunderstorms have been linked to asthma episodes, especially during the pollen season, and there are descriptions of asthma compounds associated with thunderstorms, which occurred in several cities, predominantly in Europe. A recent study has suggested that atmospheric particles and gases from thunderstorms can be inhaled by asthma sufferers, potentially triggering asthma attacks. The review article highlights that thunderstorm-related asthma attacks are characterized by an increase in the number of asthma exacerbations, with a peak during the pollen season. The article also points out that thunderstorm-related asthma attacks can be triggered by the interaction of pollutants with pollen particles, leading to the formation of new allergens. The article concludes that further research is needed to understand the mechanisms behind thunderstorm-related asthma attacks and to develop effective strategies to prevent them.
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 and on 28 May 2012 for other two attacks of near fatal asthma (the last, in 2012, in pregnancy).
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?
The evidence about thunderstorm related epidemics of rhinitis and asthma exacerbations:

1) The occurrence of epidemics is closely linked to thunderstorms.
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.
4) Subjects with pollen allergy, who stay indoors with window closed during thunderstorms, are not involved.
5) 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.

Take home message:
Subjects affected by pollen allergy should be alert to the danger of being outdoors during a thunderstorm in the pollen season.
D’Amato G, et al
Facebook. A new trigger for asthma?
The Lancet, Vol 376;Nov20,2010 p1740

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. JIACI 2012

D’Amato G, Cecchi L,
Social Networks and bronchial asthma. Curr Opin Allergy Clin Immunol. Feb 13 (1) 87-91;2013

76 Millions of tons of CO2 produced by Internet in 2002
700 Millions of tons in 2012

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.
• Conclusioni: In pazienti con asma severo refrattario alla terapia, il soggiorno in altitudine migliora i parametri clinici e funzionali e riduce la richiesta di corticosteroidi, indipendentemente dalla presenza di atopia

1. Basso livello di acari, spore fungine e pollini
2. Diretto beneficio fisiologico della bassa viscosità dell’aria che riduce le resistenze respiratorie
3. Riduzione dello stress psicologico e lavorativo
4. Esposizione ad alti livelli di UV che stimolano la produzione di vitamina D, modulando l’attività del sistema immunitario
Key messages

- Exacerbation of asthma (in asthmatic subjects)
- Adjuvant effect on allergic sensitization
- Possible induction of new onset asthma
- Clinical effects determined by genetic susceptibility
- Possible relationship with stress and socioeconomic deprivation
- Possible effects for exposure during pregnancy and early-life
- Possible reduction of the response to drugs

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.
Inquinamento atmosferico, variazioni climatiche e patologie respiratorie, AIPO 2012

Inquinamento atmosferico ed allergie respiratorie. Interazioni tra allergeni ed inquinanti

a cura di Giampiero D’Amato, Luciano Lionetti, Maria Elena di Nardo, Anna Rindarle, Mauro Arico, Antonio Bonifazi, Maria Luisa Albanese, Consiglio Nazionale delle Ricerche, Istituto di Ricerche Farmacologiche "Mario Negri" Milano.

Tabella 1.2 Razionale relativo alla interazione tra componenti dell’inquinamento atmosferico ed allergeni nell’indurre allergia respiratoria

<table>
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<tr>
<th>Rationale relative alla interazione tra componenti dell’inquinamento atmosferico ed allergeni nell’indurre allergia respiratoria</th>
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<tbody>
<tr>
<td>Le componenti dell’inquinamento atmosferico possono interagire con i granuli pollinici, dando luogo ad antigeni caratterizzati da alergenicità modificata.</td>
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<tr>
<td>Le componenti dell’inquinamento atmosferico possono interagire con particelle di piccole dimensioni che derivano da piante e che crescere allergeni. Queste sono in grado di raggiungere le vie aeree periferiche con l’aria inalata inducendo asma in soggetti sensibilizzati.</td>
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<td>Le componenti dell’inquinamento atmosferico, soprattutto il nero PM e SO2, svolgono un effetto proinflammatorio nelle vie aeree di soggetti suscettibili causando aumento di permeabilità, facilitata penetrazione degli allergeni pollinici nelle mucose delle vie aeree e più facile attivazione con le cellule del sistema immunitario. C’è anche evidenza che i soggetti predisposti presentano un’aumentata reattività delle vie aeree indotta dall’inquinamento atmosferico e da aumentata responsività delle vie aeree verso gli allergeni dei pollini inalati.</td>
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<tr>
<td>Le componenti dell’inquinamento atmosferico, in particolare le radici incombustibili dei monos di ossigeno, hanno un effetto immunologico adiuvante sulla sintesi di IgE in soggetti atopi ci.</td>
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ASMA RINITE E BPCO
Gestione clinica del paziente dal fenotipo alla terapia

Gennaro D’amato
Vi sono prove che, in alcuni pazienti asmatici, l’uso eccessivo dei social network può indurre depressione e stress scatenante ostruzione bronchiale, mentre in altri il loro uso razionale può indurre effetti benefici in termini di gestione della malattia.