Allergy and Environment: Biodiversity, Climate change and airway diseases

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The Effects of Climate Change

- Global average temperature has increased by more than 0.7°C over the past 100 years.
- The Intergovernmental Panel on Climate Change (IPCC) projects that the average global surface air temp. in the years 2090–2099 are likely to be between 1.8 and 4.0°C warmer than those in 1980–1999.

Air temperature plays a key role, together with other factors, such as day-length, water, nutrients, and soil type on pollination.

Environmental changes also involve plants producing allergenic pollen, with expected consequences on atopic population.

Duration of the pollen season is also extended, especially in summer and in late-flowering species. There is evidence of significantly stronger allergenicity in pollen from trees grown at increased temperatures.
Climate change involves several environmental variables, including various greenhouse gases, temperature, water vapor, plant, and animal.
The impact of climate change on pollen

Beggs PJ. Clin Exp Allergy 2004;34:1507-13
# Potential Effects of Climate Change on the Prevalence of Allergic Disease

<table>
<thead>
<tr>
<th>Climate Change Event</th>
<th>Potential Environmental Impact</th>
<th>Effect on Allergic Disease Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in temperature</td>
<td>Migration of stinging and biting insects into new environments and increased population of existing insect species&lt;br&gt;Change to crop patterns, with the potential to introduce new allergenic pollens into the atmosphere and new food proteins into the local diet&lt;br&gt;Earlier and longer pollination seasons&lt;br&gt;Increases in humidity associated with higher temperatures will lead to increased numbers of cockroaches, house dust mites, and moulds and thus allergen load</td>
<td>Sensitizations to new stinging and biting insect species and to foods, with potential increase in cases of IgE-mediated anaphylaxis</td>
</tr>
<tr>
<td>Increase in precipitation and drought, leading to lower crop yields, damaged crops, food shortages, and lack of work</td>
<td>New pollen and mould sensitizations leading to increased prevalence and attacks of allergic rhinoconjunctivitis and asthma; longer pollen seasons leading to increased duration of symptoms</td>
<td></td>
</tr>
<tr>
<td>Increase in thunderstorms in spring and summer months</td>
<td>Population migration</td>
<td>Development of sensitization to new allergens, leading to development of allergic respiratory and skin conditions</td>
</tr>
<tr>
<td></td>
<td>Thunderstorms cause pollen grains to rupture, increasing the levels of respirable allergens and also lead to an increase in ozone levels</td>
<td>Increased hospital admissions due to asthma</td>
</tr>
</tbody>
</table>

Sources: State of World Allergy Report 2008\(^{19}\) and D’Amato et al.\(^{29}\)

# Correlation between air temperature and allergenic pollen in various countries

<table>
<thead>
<tr>
<th>Common name</th>
<th>Latin name</th>
<th>Phenology</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japanese cedar</td>
<td><em>Cryptomeria japonica</em></td>
<td>Increased concentration</td>
<td>Japan</td>
</tr>
<tr>
<td>Birch</td>
<td><em>Betula</em></td>
<td>Increased concentration</td>
<td>Northwestern Poland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Earlier flowering</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Grass</td>
<td><em>Artemisia spp</em></td>
<td>Increased concentration</td>
<td>Australia</td>
</tr>
<tr>
<td>Mugwort</td>
<td></td>
<td>Increased concentration</td>
<td>Central Croatia</td>
</tr>
<tr>
<td>Alder</td>
<td><em>Alnus</em></td>
<td>Increased concentration</td>
<td>Northwestern Spain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased duration</td>
<td>Worcester, UK; Poznań, Poland</td>
</tr>
<tr>
<td>Cedar</td>
<td><em>Cupressaceae</em></td>
<td>Increased concentration</td>
<td>Southern Spain</td>
</tr>
<tr>
<td>Ragweed</td>
<td><em>Ambrosia</em></td>
<td>Increased duration</td>
<td>A transect that ran from Texas to Canada</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased concentration</td>
<td>Korea</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased duration</td>
<td>Central Croatia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased concentration</td>
<td>Northeastern Croatia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased concentration</td>
<td>France</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased concentration</td>
<td>Italy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased concentration</td>
<td>Poland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased concentration</td>
<td>Slovakia</td>
</tr>
</tbody>
</table>
Weed pollen concentration has increased in Korea

Weed pollen (grain/m³)

date

Humulus
Artemisia
Ambrosia

Comparison of the pollen concentration changes among common weeds annually in Korea

Humulus

Artemisia

Ambrosia
Sensitization rates to weed and tree pollen are increased yearly in Korean childhood.

![Graph showing sensitization rates to weed and tree pollen over years.](chart.png)
Sensitization rates to allergic pollens* are increased in early childhood

* Allergic pollen: birch, alder, oak, grass mix, ragweed, mugwort, sagebrush
Allergic Rhinitis

- Coincident with climate changes during the past 30 years is the finding that allergic rhinitis in the US population has increased from 10% in 1970 to 30% in 2000.

- In case of the change of prevalence of allergic rhinitis in Korean school children in ISAAC from 9.1% - 16.8% in 1995 to 13.5% - 22.0% in 2000.

Allergic Rhinitis and Weather Change

- Increased humidity has been associated with 8- to 15-fold increases in eosinophil influx and eosinophil cationic protein levels during the late-phase allergic responses of the nasal mucosa, and with the regional predictions of climate change of increased temperatures and humidity.  
  

- Cold air–induced rhinitis may also be seen to increase in those individuals with chronic allergic or non-allergic rhinitis in regions affected by colder climate changes. Nasal mast cell activation, sensory nerve stimulation, and subsequent triggering of a cholinergic reflex can then lead to rhinorrhea.

Asthma

- possible negative effects on reversible airway disease include earlier start, increase of length and intensity of pollen season, increase of pollutant levels, and increase of heavy precipitation events.
- Warmer winter temperature could reduce susceptibility of asthmatic adults to upper respiratory tract infections that play a key role in exacerbations of asthma but in its place may increase exposure to allergenic pollen.
- Lower minimum (cold) temperature or a decrease in temperature was associated with asthma prevalence and exacerbation in adults.
Data on increasing trends in prevalence of asthma

<table>
<thead>
<tr>
<th>First author, year, Country</th>
<th>Population (aged) n</th>
<th>Years</th>
<th>Trend</th>
<th>Method(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5,850</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1,309, 652</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Children</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8,266</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>30,838</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7,632</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Downs, 2001, Australia</td>
<td>Schoolchildren (8–11 yrs)</td>
<td>1982–1997</td>
<td>Increasing</td>
<td>Questionnaires</td>
</tr>
<tr>
<td></td>
<td>2,635</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8,496</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwong, 2001, UK</td>
<td>Schoolchildren (8–9 yrs)</td>
<td>1991–1999</td>
<td>Increasing</td>
<td>Questionnaire (ISAAC)</td>
</tr>
<tr>
<td></td>
<td>9,591</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Correlation between concentration of CO\textsubscript{2} and ragweed allergen (Amb a 1) in chamber

![Box plot showing correlation between CO\textsubscript{2} concentration and ragweed allergen levels in chamber.](image)

- **p < 0.05**

- **Open top CO\textsubscript{2} Growth chamber**

- **CO\textsubscript{2} Growth chamber**
Comparison of pollen from Common Weeds Between Urban and Rural area in Korea

<table>
<thead>
<tr>
<th></th>
<th>Dates of Collection</th>
<th>Peak Amount</th>
<th>Date on which peak was collected</th>
<th>Pollen sum</th>
<th>Pollen Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Guri</td>
<td>Aug 23–Sep 30</td>
<td>434</td>
<td>Sep 10</td>
<td>5288</td>
<td>136.0</td>
</tr>
<tr>
<td>Urban Seoul Downtown</td>
<td>Aug 23–Sep 30</td>
<td>726</td>
<td>Sep 11</td>
<td>5360</td>
<td>137.4</td>
</tr>
</tbody>
</table>

* Common weeds: Ragweed, Japanese hop, Mugwort
Correlation between concentration of CO2 and ragweed allergen (Amb t 5) in Field study

<table>
<thead>
<tr>
<th>Field study</th>
<th>Giant ragweed Pollen Amb t 5 Concentration (ng/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural (CO2: 230ppm)</td>
<td>262.8 (197.4 – 391.2)</td>
</tr>
<tr>
<td>Urban Downtown (CO2: 440ppm)</td>
<td>484.0 (379.2 - 568.6)</td>
</tr>
</tbody>
</table>
DIFERRENCE OF ALLERGENICITY OF POLLEN BETWEEN URBAN AND RURAL AREA

- It can also generate potentially increased sensitization as various pollutants, and will increase allergenicity by acting as immunogenic adjuvants.
- The results of the increased exposure and sensitization will potentially promote the “allergic march” in the pediatric population, whereas in the adult it will lead to persistence of symptoms or the development of new allergies later in life, affecting the geriatric population.
Checking up blooming in Oak

From Kwangneung National park, Korea

Cooperated with Korean Meteorological Agency (KMA)
Checking up blooming in Oak

TLC200 PRO

Cooperated with KMA
Checking up blooming in Oak

<table>
<thead>
<tr>
<th>Date</th>
<th>Plant action</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 8</td>
<td>Start blooming</td>
</tr>
<tr>
<td>April 20</td>
<td>Start flowering</td>
</tr>
<tr>
<td>April 27</td>
<td></td>
</tr>
<tr>
<td>May 4</td>
<td>End blooming</td>
</tr>
<tr>
<td>May 11</td>
<td>End flowering</td>
</tr>
</tbody>
</table>

Cooperated with KMA
Air temperature plays a key role, together with other factors, such as day-length, water and nutrients availability, and soil type.

Duration of the pollen season is also extended, especially in summer and in late-flowering species.

There is evidence of significantly stronger allergenicity in pollen from trees grown at increased temperatures.
Long-term Follow up of Pollen Concentration (1999 – 2010)

Total: Seoul

Trees: Seoul

Pine: Seoul

Weeds: Seoul

Year
number of pollen
0
2000
4000
6000
8000
10000
12000

Monthly Total Sum
Long-term Trend
Regression

2512.9

693.2

6203.6

440.6

Year
Monthly Trees Sum
Long-term Trend
Regression

Year
Monthly Pine Sum
Long-term Trend
Regression

Year
Monthly Weeds Sum
Long-term Trend
Regression
Pollen Collection Center in Korea

KAPARD – Committee for Pollen Allergy
Jae-Won Oh: Hanyang University
Seong-Won Kim: Busan St. Maria Hospital
Im-Joo Kang: Daegu Fatima Hospital
Hai Lee Chung: Daegu Catholic Univ Hospital
Myung-Hee Kook: Kwangju Veteran’s Hospital
Eun-Seok Yang: Kwangju Chosun Univ Hospital
Kang-Seo Park: Jeonju Presbyterian Hospital
Kwang-Woo Kim: Pohang ABC Peds Clinic
Bong-Seong Kim: Kangneung Asan Hospital
Ja-Kyung Kim: Kangwon Univ Hospital

National Institute of Meteorological Research
Applied Meteorology Research Laboratory
Kyu-Rang Kim
Chang-Beom Cho
Mi-Jin Kim
Calendar for allergic pollen in Seoul

Larch
Chestnut
Beech
Gingko
Oriental thuja
Oak
Willow
Maple
Hazelnut
Popular
Elm
Birch
Pine
Alder
Sycamore

Sorrel
Chrysanthemum
Plantain
Japanese hop
Pigweed
Mugwort
Ragweed
Grasses
Calendar allergic pollen of Jeju

Larch
Chestnut
Beech
Juniper
Japanese cedar
Oak
Willow
Maple
Hazelnut
Popular
Elm
Birch
Pine
Alder
Sycamore

Sorrel
Chrysanthemum
Plantain
Japanese hop
Pigweed
Mugwort
Ragweed
Grasses

--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
1~5 | 6~10 | 11~20 | 21~40 | 41~80 | 81~160 | 161~320 | 321~640 | 641~1200 | 1201~2400 | --- | ---
Regression model for tree pollen in Spring

<table>
<thead>
<tr>
<th>Year</th>
<th>R</th>
<th>P</th>
<th>Regression model</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002–2004</td>
<td>0.693</td>
<td>0.001</td>
<td>0.494386 + 0.002296×AccumT - 0.009812×PRE - 0.012852×AS + 0.047051×MeanT</td>
</tr>
</tbody>
</table>

This model (2002–2004) presents statistically predicted value when applied to 2005 pollen count.

JW Oh, JKMA 2009
Regression model for Weed in Autumn

<table>
<thead>
<tr>
<th>Year</th>
<th>R</th>
<th>P</th>
<th>Regression model</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2004</td>
<td>0.743</td>
<td>0.00</td>
<td>(5.419920 - 0.001308 \times \text{AccumT} + 0.023948 \times \text{MinT} - 0.044073 \times \text{RT} + 0.008469 \times \text{HUM})</td>
</tr>
</tbody>
</table>

AccumT: accumulated temperature, MinT: daily minimum temperature, RT: continued rainfall hours, HUM: daily relative humidity

This model (2001-2004) presents statistically predicted value when applied to 2005-2006 pollen count.
Korean Meteorological Agency (KMA) pollen forecasting report
Oak pollen

Oak sheds more pollen than any other tree where the trees are abundant. It is very hard to identify the oak tree because of its tendency to hybridization. The drooped male catkins release pollen in the middle of February and the middle of April. Therefore, the oaks can evoke pollinosis early in spring.
Risk Grade of pollen for allergy pollen forecast among each allergic plant

<table>
<thead>
<tr>
<th>Risk Grade</th>
<th>Alder Birch</th>
<th>Cedar</th>
<th>Oak</th>
<th>Pine</th>
<th>Ragweed</th>
<th>Mugwort</th>
<th>Japanese hop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>0-19</td>
<td>0-49</td>
<td>0-49</td>
<td>0-499</td>
<td>0-19</td>
<td>0-19</td>
<td>0-49</td>
</tr>
<tr>
<td>Severe</td>
<td>50-99</td>
<td>100-199</td>
<td>100-199</td>
<td>1000-1499</td>
<td>50-199</td>
<td>50-199</td>
<td>100-299</td>
</tr>
<tr>
<td>dangerous</td>
<td>≥100</td>
<td>≥200</td>
<td>≥200</td>
<td>≥1500</td>
<td>≥200</td>
<td>≥200</td>
<td>≥300</td>
</tr>
</tbody>
</table>
Pollen prediction model
A growing number of people are recently contracting allergic diseases caused by pollen because of climate change in the world.

Recently allergic sensitization rate to pollens have gradually increased since early 2000s in school aged childhood moreover the seasonal and regional variations of pollen have been changed in Korea.

Regression models and risk grade for allergic pollens were developed after following up allergic patients with monitoring pollen concentration.

Calendar of allergic pollens was revised in Korea since 2010.
Climate change and allergic diseases

- This may also have implications for the assessment of potential health effects due to climate change.
- A number of the findings may suggest that climate may affect the prevalence of asthma, allergic rhinitis, conjunctivitis and atopic eczema in children as well as adults.
- A growing number of people are recently contracting allergic diseases caused by pollen because of climate change in the world.
Thank you for your attention