Impacts of our Changing Climate on Allergic Respiratory Disease

Katherine Gundling, MD
Clinical Professor
UC San Francisco
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What are allergies and allergic respiratory conditions?
Is the warming of our planet affecting allergic respiratory disease?
  • Pollens
  • Beyond pollens

Special considerations
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Common use:
The term *allergies* refers to strong or excessive reactions that occur upon exposure to substances in the environment.

Medical definition:
An *allergic reaction* is a hypersensitivity response by the *immune system* to a substance that generally poses no threat.

We distinguish *allergic* reactions, such as eye itching/watering due to grass pollen exposure, from *irritant* reactions, such as sneezing upon exposure to airborne pepper.
Global population:
10-30%, allergic rhinitis
300 million, asthma

Peak atmospheric grass pollen levels = ER visits for asthma and wheeze

Anemophilous (wind) Pollination
Entomophilous (insect) Pollination

Pawankar, et al., 2011
WHO
Darrow, et al., 2012

Photos by Gundling
Examples of respiratory allergens:

- Pollens from trees, weeds, grasses
- Dust mites
- Molds
- Furry animals
- Cockroaches
January to December:

- Cedar/Cypress/Juniper
- Oak/Birch
- Rye grass
- Ragweed
- Dust mites, Cat, Dog, Rodents, Cockroaches, Molds
**Mechanism of the Allergic Reaction**

Mast Cell

- Sensitization Exposure (Allergen - Dog)
- Repeat Exposure

- Cough
- Nasal drainage
- Wheeze
- Itching
- Hives
- Swelling

- Histamine
- Tryptase
- Prostaglandins
- Leukotrienes
- Etc.
Examples of Allergic Conditions

**Allergic rhinitis** ("hay fever") – facial allergy symptoms
nasal congestion, drainage, itching, throat clearing

**Sinusitis** – drainage, facial pain, headache, recurrent sinus infections,

**Conjunctivitis** – itching, drainage, sometimes swelling of the eyes

**Asthma** – wheezing, cough, shortness of breath, mucus production

**Food allergy** – hives, abdominal pain, nausea/vomiting

**Stinging insects** – hives, swelling, shortness of breath
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People with allergies know that daily weather determines symptoms

Whether it is...
- Raining
- Snowing
- Warm
- Dry
- Humid
- Windy

And symptoms vary by season, depending on our specific allergies, our geographic location, whether we are indoors or outdoors, and what is pollinating
...so how can we determine if global warming is causing changes in how we experience allergic respiratory disease?
Can we measure pollen levels?

Can we compare pollen levels over time?

Can we use measurements of temperature, humidity, frost days, etc., over time or possibly as proxies for predicting changes to pollen exposure?
Burkard Pollen and Mold Spore Counter

Estelle Levetin, PhD
AAAAI.org
Pollen counting stations in the western US

AAAAl.org
Saskatoon, Canada has seen ragweed season increase from 44 to 71 days over 15 years, with delayed frost.

Poole, et al. 2019
European studies indicate: *Earlier start dates* to birch and oak pollen seasons *Rising pollen concentrations* associated with increasing temperature:

- Switzerland
- Finland
- Denmark
- Germany
- Spain
- Turkey

(Garcia-Mozo et al. 2006; Frei, Gassner 2008; Erkan 2010; Yli-Panula et al. 2009; Rasmussen 2002; Estrella et al. 2006)
This makes intuitive sense:

Increasing temperatures:
➡ fewer cold nights, warmer days
➡ earlier spring, later fall
➡ longer pollen season
➡ more pollen exposure
➡ more allergies and asthma

But does it hold up elsewhere?
US pollen trends more variable

Over time, comparing 1994-2000 to 2001-2011, at different pollen counting stations,

**Birch** and **oak** pollen *seasons* starting earlier in most locations
*Birch* and **oak** pollen *levels* trending higher in most locations

**Season lengths** are different for birch and oak pollen across the different pollen counting stations

Zhang Y et al. 2014
Significant regional variations of climate change

The Intergovernmental Panel on Climate Change (IPCC):

*Land surface warming likely to be higher in regions with high latitudes and altitudes*
Oak Pollen Season Length Projection (Zhang, 2014)
As with much of science and nature, there are complicating circumstances

Precipitation
Humidity
Migration
New or changing varieties of trees, weeds and grasses
Does atmospheric CO2 affect pollen levels?

By one estimate (conducted in experimental conditions), airborne *Timothy grass pollen* is estimated to increase by 200% with projected increases of CO2.

Albertine J et al., PLoS One 2014
Higher atmospheric CO$_2$ levels equate with higher **ragweed** pollen levels
More observations

Air pollution augments allergic (immunologic) reactions

Higher ambient temperatures may create more allergenic (more potent) pollen due to modified IgE binding

“Thunderstorm asthma” is increasing in conjunction with more severe and frequent weather systems.

Summary regarding *pollens* and allergic respiratory disease on our heating planet

Many locations are experiencing higher pollen counts and longer pollen seasons.

The effect may be larger in higher latitudes.

Increasing atmospheric CO2 is associated with higher pollen levels.

Increasing temperature may cause pollen to be more potent.

There is significant variability from one location to the next, depending on many factors.
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Mold allergens can cause severe asthma and respiratory symptoms, such as those seen with rising sea levels, after hurricanes, or with increasing humidity.

Aspergillus
Alternaria
Cladosporium
Penicillium

Mold can also serve as an *irritant*, or produce *mycotoxins*.

Changing weather patterns can alter *exposure* to indoor allergens such as dust mites, cockroaches and mice.

Pacheco S, Pediatr Res. 2018
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Children under 5 years of age are particularly vulnerable:

Lung growth and development
Higher metabolic demands
Immature immune systems
Higher respiratory rates
Greater time outdoors, increasing exposures to heat, pollution, insects
Many are economically disadvantaged
People with pre-existing respiratory conditions
Workers with increased exposures due to their occupations
Homeless people
Patients who cannot afford air conditioning, appropriate medications, the ability to move out of polluted zones or poor housing situations
Older adults (decreased ability to compensate for physical stresses)

Good news: Solutions to climate change are also solutions to improve health disparities and allergic respiratory disease
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