

# Planetary health and climate change: the effect on children with respiratory diseases around the world

PATS-ERS Webinar March 20, 2023

## Conflict of interest



• I declare no conflict of interest related to this talk

## Facts about climate change



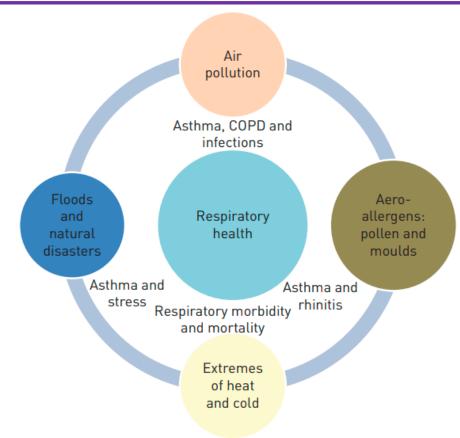
- Climate change refers to long-term shifts in temperatures and weather patterns
- 7 million premature deaths every year due to the combined effects of outdoor and household air pollution
- By 2030 onward, CC is expected to cause 250 000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress.
- The direct damage costs to health: US\$ 2-4 billion per year by 2030

## Important environmental exposures



- Aeroallergens
- Air pollution
- Natural disasters

European Respiratory Review Jun 2014, 23 (132) 161-169



## Impact of CC in Africa region: WHO Africa

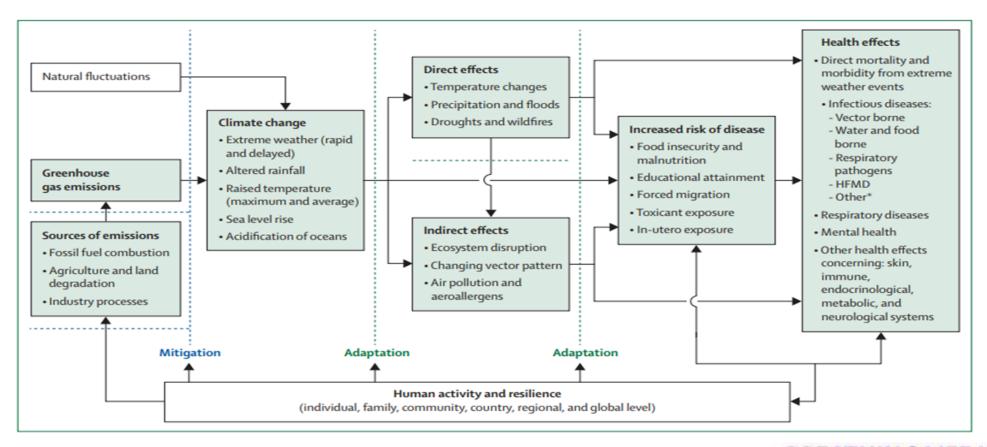


- In the last 20 years , out of 2021 public health events recorded 56% were climate-related
- 28% of health emergencies were vector born
- Floods were the most frequent event (33%)
   of all the reported natural disasters
- An additional 78 million people in Africa face chronic hunger by 2050



#### Climate change and child health: Lancet Planet Health 2021





## Pathophysiology



In utero: ?placental inflammation ,developmental and epigenetic changes Inflammation: increased inflammatory cell, epithelial barriers damage, increased susceptibility Oxidative stress: gene activation, reactive species production Cell death

## Why are children more susceptible?



- Immature physiology and metabolism
- Incomplete development
- Higher exposure to air, food, and water per unit body weight
- Unique behavior patterns
- Dependence on caregivers

Environ Health Perspect. 2011;119(3):291–298

## What are the respiratory impacts?



#### Asthma

- ✓ Increased exacerbation of asthma
- ✓ Declining lung function
- ✓ Increased ER visits

Biomed J. 2022 Feb;45(1):88-94

## .....Cont



- Respiratory infections and acute respiratory symptoms
  - √ 1.8-fold increase in the risk of pneumonia in children aged under 5
    years
  - ✓ Cough , wheezing frequently encountered
  - ✓ Increased carriage of pathogens
- Abnormal lung function

Int. J. Environ. Res. Public Health 2020, 17, 6178

## ...Cont



#### Ambient temperature change

- Rise in allergic rhinitis
- Increased hospitalization for respiratory infections
- Increased mortality and morbidity of asthma



European Respiratory Review Jun 2014, 23 (132) 161-169

## Challenges for Africa



- Limited diagnostic capacity
- High burden in mortality and morbidity
- Lack of cost-effective and quality assured medications
- Poor primary health care capacity
- Lack of organized health promotion programs

J Pan Afr Thorac Soc 2022;3:105-20.

## What are Hydrofluorocarbons?



- Hydrofluorocarbons are
  - greenhouse gases
  - short-lived climate pollutants
  - more potent global warming gas

## Kigali Amendement



- The **Kigali Amendment** is an international agreement to gradually reduce the consumption and production of HFCs.
- High income countries: are committed to reducing the use of HFCs by 45% by 2024 and by 85% by 2036,
- LMIC: are committed to reducing its consumption by 80% by 2045

## What is the impact for respiratory medicines?



- 2/3 of all doses prescribed use pMDI using HFC
- In 2019, 480M packs prescribed, equating to 2400 doses taken every second
- In 2014, HFC emissions from MDIs represented only 0.03% of annual global greenhouse gas emissions

Drug Des Devel Ther. 2020 Jul 29;14:3043-3055

## Implementation challenge



- High price
- Difficult to coordinate the actuation of the spray with inhalation

Drug Des Devel Ther. 2020 Jul 29;14:3043-3055



## ....Cont



- A systematic review published in Lancet Global health:
- Only 10 % met the 80% availability target for short-acting beta-agonists (SABAs), 6% for the inhaled corticosteroids, and very few for the combination
- SABA inhalers typically cost around 1–4 days' wages, ICSs 2–7 days, and ICS–LABAs at least 6 days.

The Lancet Global Health, Volume 10, Issue 10, e1423 - e1442

#### ...cont





Can Africa afford the switch of HFC to new formulations using propellants with lower GWP?

### Conclusion



- CC impact on respiratory disease is a global public health.
- Asthma, COPD, respiratory infections, allergic rhinitis are the main diseases
- Access and affordability of inhaled drugs in LMIC are challenges for LMIC
- Emphasis have to be made to enhance access of new formulations using propellants to LMIC .



## Planetary health and climate change: the effect on children with respiratory diseases around the world

A European perspective

ERS- PATS seminar, March 20<sup>th</sup> 2023

Erik Melén, MD, PhD
Professor, senior consultant pediatric allergy
Member, ERS Environmental Health Committee

#### Conflict of interest disclosure



- ☐ I have no real or perceived conflicts of interest that relate to this presentation.
- **■** I have the following real or perceived conflicts of interest that relate to this presentation:

**Affiliation / Financial interest** 

**Commercial company** 

**Grants/research support:** 

Honoraria or consultation fees:

Advisory board reimbursement and/or speaker's fee from ALK, AstraZeneca, Chiesi, Novartis and Sanofi.

Participation in a company sponsored bureau:

Stock shareholder:

Spouse / partner:

Other support / potential conflict of interest:

#### Outline



- 1. Air pollution and climate change
- 2. Children's exposure
- 3. Across the life-course
- 4. Beyond air pollution exposure; allergen levels and meat allergy
- 5. Mitigation and what health-care professional can do
- 6. Conclusions

#### **AIR POLLUTION - THE SILENT KILLER**



are due to exposure from both outdoor and household air pollution.

#### Air pollution is a major environmental risk to health.

By reducing air pollution levels, countries can reduce:



Stroke



disease



Lung cancer, chronic obstructive pulmonary disease, pneumonia and asthma



WHO Air Quality Guidelines set goals to protect millions of lives from air pollution.

**CLEAN AIR FOR HEALTH** 

#AirPollution



in the Region of the Americas



#### More than 90% of the world's children breathe toxic air every day

29 October 2018 | News Release | Geneva

















**Media Contacts** 



**New WHO Global Air Quality** Guidelines aim to save millions of lives from air pollution

Air pollution is one of the biggest environmental threats to human health, alongside climate change.

⊕ **3 € 9 €** 



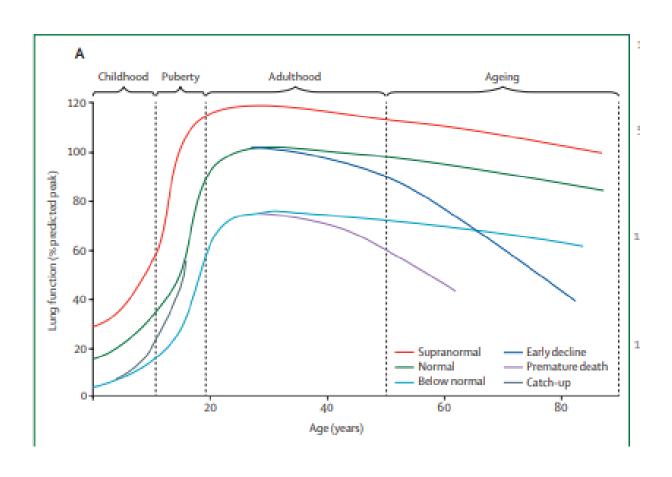


## Air pollution and climate change intertwined



## A life-course perspective





Melén, Koppelman et al. Lancet Child & Adolescent Health 2022

Agusti, Melén et al. Lancet Resp Med 2022





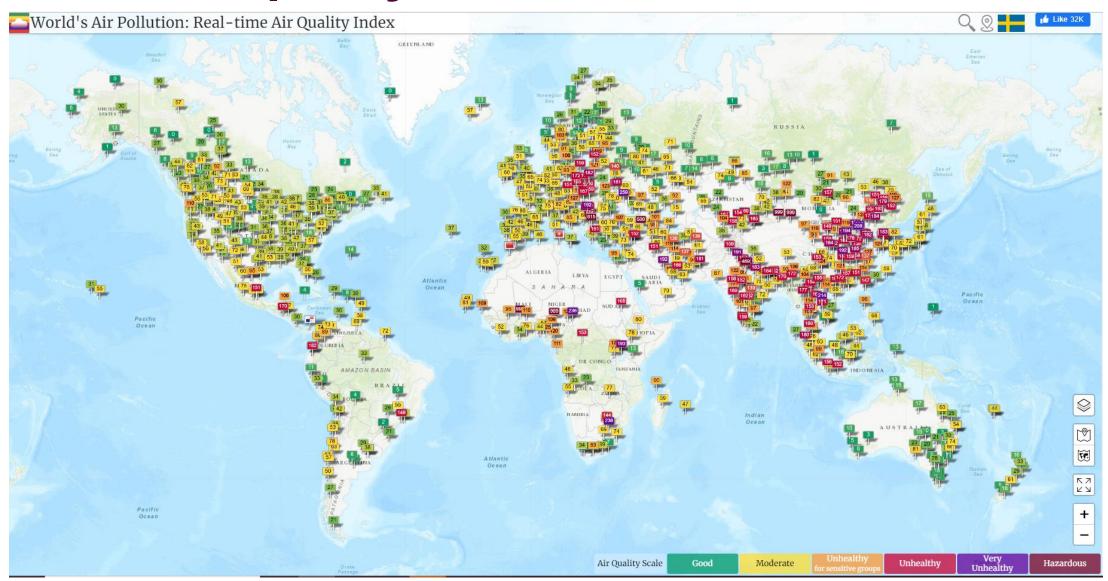
https://www.dnaindia.com/



## Children are particularly vulnerable to environmental hazards:

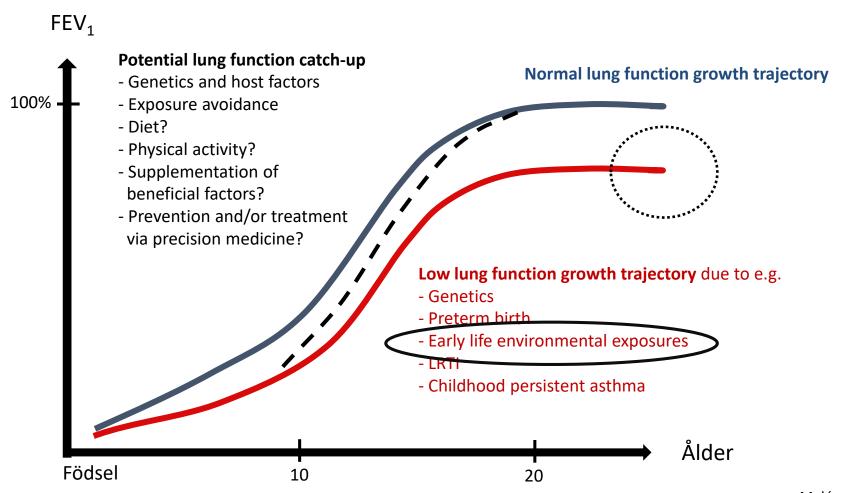
- More time outside, physically active
- Higher rates of breathing and ventilation rates relative to body size
- Narrower airways
- Ineffective airway particle filtering
- Underdeveloped detoxification systems
- Typically don't choose lifestyle and environment

## Air quality index, March 19th 2023





#### Lung development from childhood to adulthood



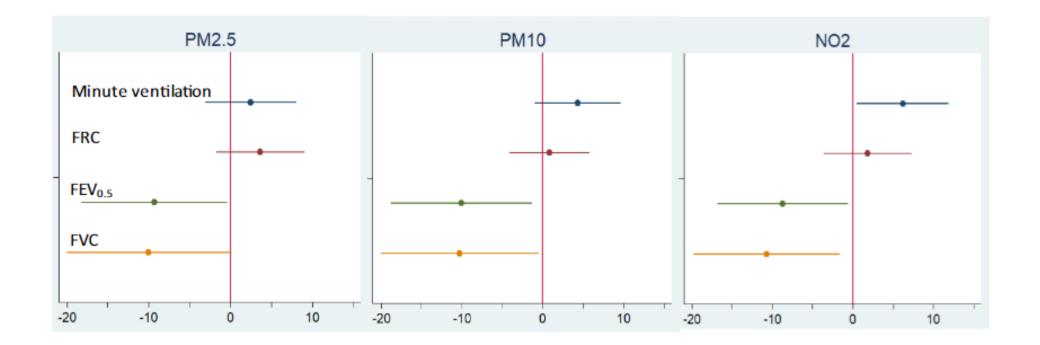
#### ORIGINAL ARTICLE



#### Air pollution exposure impairs lung function in infants

Björn Lundberg<sup>1,2</sup> | Olena Gruzieva<sup>3,4</sup> | Kristina Eneroth<sup>5</sup> | Erik Melén<sup>1,2</sup> | Åsa Persson<sup>3</sup> | Jenny Hallberg<sup>1,2</sup> | Göran Pershagen<sup>3,4</sup>







#### Early-life events linked to lung health in young adulthood (age 21-24 y)

- Chronic bronchitis 5,5%
- Irreversible airflow limitation according to COPD-criteria 2%
- Cough, phlegm, recurrent airway infections and respiratory symptoms
- Air pollution exposure 0-1 y strongly associated (OR 2-3)
- RSV bronchiolitis / pneumonia 0-1 y
   OR 3.6 for airflow limitation
- Active smoking OR 3.8 for bronchitis
- Breastfeeding OR 0.66 for bronchitis

Wang et al, Eur Resp J 2021; Thorax 2021

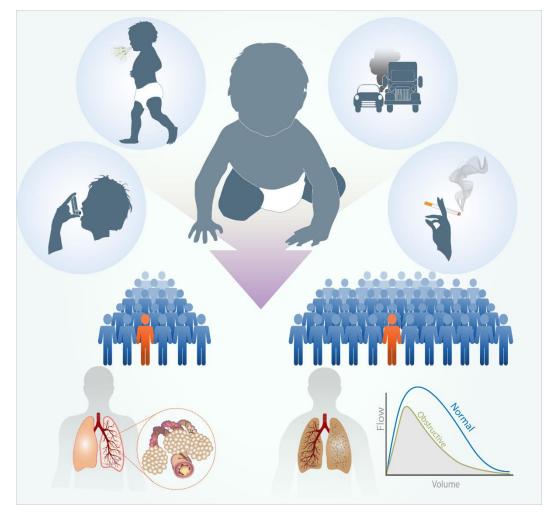


Illustration: Fuad Bahram

https://news.ki.se/early-life-events-linked-to-lung-health-in-young-adulthood

#### Air pollution not only associated with lung function....

Articles

Lancet Reg Health Europe 2023





Original Investigation | Public Health

Association of Short-term Air Pollution Exposure With SARS-CoV-2 Infection Among Young Adults in Sweden

Zhebin Yu, PhD; Tom Bellander, PhD; Anna Bergström, PhD; Joakim Dillner, MD, PhD; Kristina Eneroth, PhD; Magnuz Engardt, PhD; Antonios Georgelis, PhD; Inger Kull, PhD; Petter Ljungman, MD, PhD; Göran Pershagen, MD, PhD; Massimo Stafoggia, PhD; Erik Melén, MD, PhD; Olena Gruzieva, MD, PhD; and the BAMSE COVID-19 Study Group

#### The Washington Post

## Growing evidence links air pollution exposure and covid-19 risks





Ambient air pollution exposure linked to long COVID among young adults: a nested survey in a population-based cohort in Sweden

Zhebin Yu,<sup>a</sup> Sandra Ekström,<sup>a,b</sup> Tom Bellander,<sup>a,b</sup> Petter Ljungman,<sup>a,c</sup> Göran Pershagen,<sup>a,b</sup> Kristina Eneroth,<sup>a,d</sup> Inger Kull,<sup>e,f</sup> Anna Bergström,<sup>a,b</sup> Antonios Georgelis,<sup>a,b</sup> Massimo Stafoggia,<sup>a,g</sup> Olena Gruzieva,<sup>a,b,h</sup> and Erik Melén,<sup>e,f,h,\*</sup> the BAMSE COVID-19 Study Group



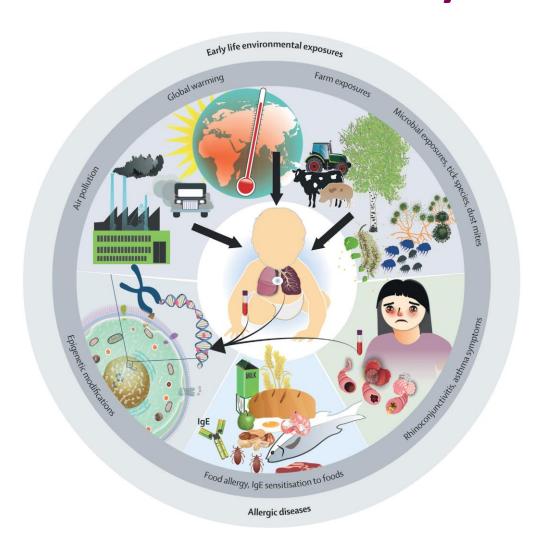


Long COVID linked to air pollution exposure in young adults – new study

Published: March 7, 2023 6.01pm CET



### **Beyond air pollution**



Melén, Koppelman et al. Lancet Child & Adolescent Health 2022

#### Key messages

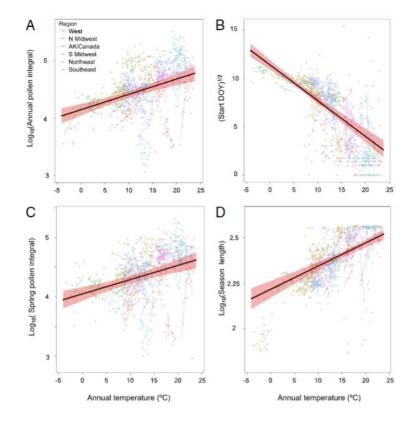
- Allergic diseases affect millions of children and adolescents worldwide; in many regions between 5% and 30% of adolescents report rhinoconjunctivitis symptoms and up to 10% report food allergy
- Links between climate change and allergic diseases are of increasing concern; these links include extended and altered pollen seasons, spread of allergens to new areas, along with changing and warmer climate, air pollution exposures changes, increasing exposure to heat events, and altered biodiversity
- These new climate change aspects of allergic diseases have clinical implications for prevention, diagnostics, and treatment
- Epigenetic changes, exemplified by DNA methylation, are associated with both environmental exposures and allergic diseases, although causality needs to be explored further
- Use of epigenetic signatures and omics profiles has the potential to detect and monitor aspects of environmental exposures of relevance for health and disease in children and adolescents

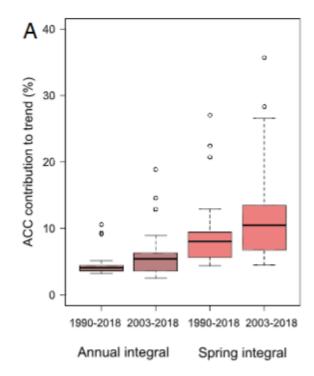


## Anthropogenic climate change is worsening North American pollen seasons

William R. L. Anderegg<sup>a,1</sup>, John T. Abatzoglou<sup>b</sup>, Leander D. L. Anderegg<sup>c,d</sup>, Leonard Bielory<sup>e,f,g</sup>, Patrick L. Kinney<sup>b</sup>, and Lewis Ziska<sup>i</sup>

aSchool of Biological Sciences, University of Utah, Salt Lake City, UT 84112; bManagement of Complex Systems Department, University of California, Merced, CA 95343; 'Department of Integrative Biology, University of California, Berkeley, CA 94720; dDepartment of Evology, Evolution, and Marine Biology, University of California, Santa Barbara, CA 93106; Center for Environmental Prediction, Rutgers University, New Brunswick, NJ 08854; Department of Medicine, Allergy and Immunology and Ophthalmology, Hackensack Meridian School of Medicine, Nutley, NJ 07110; PNew Jersey Center for Science, Technology and Mathematics, Kean University, Union, NJ 07083; School of Public Health, Boston University, Boston, MA 02118; and Mailman School of Public Health, Columbia University, New York, NY 10032









#### Changes to Airborne Pollen Counts across Europe

Chiara Ziello<sup>1\*</sup>, Tim H. Sparks<sup>1,2,3</sup>, Nicole Estrella<sup>1,2</sup>, Jordina Belmonte<sup>4</sup>, Karl C. Bergmann<sup>5</sup>, Edith Bucher<sup>6</sup>, Maria Antonia Brighetti<sup>7</sup>, Athanasios Damialis<sup>8</sup>, Monique Detandt<sup>9</sup>, Carmen Galán<sup>10</sup>, Regula Gehrig<sup>11</sup>, Lukasz Grewling<sup>12</sup>, Adela M. Gutiérrez Bustillo<sup>13</sup>, Margrét Hallsdóttir<sup>14</sup>, Marie-Claire Kockhans-Bieda<sup>15</sup>, Concepción De Linares<sup>4</sup>, Dorota Myszkowska<sup>16</sup>, Anna Pàldy<sup>17</sup>, Adriana Sánchez<sup>1</sup>, Matthew Smith<sup>18</sup>, Michel Thibaudon<sup>19</sup>, Alessandro Travaglini<sup>7</sup>, Agnieszka Uruska<sup>20</sup>, Rosa M. Valencia-Barrera<sup>21</sup>, Despoina Vokou<sup>8</sup>, Reinhard Wachter<sup>22</sup>, Letty A. de Weger<sup>23</sup>, Annette Menzel<sup>1,2</sup>

Received: 25 May 2020

Revised: 10 September 2020

Accepted: 11 September 2020

DOI: 10.1111/all.14618

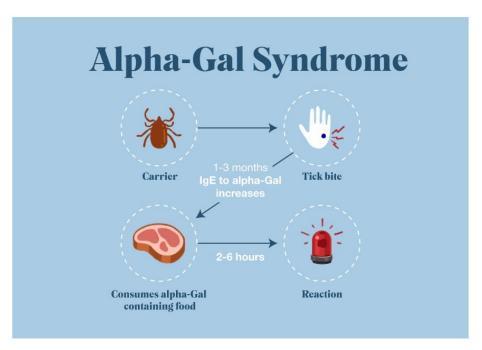
#### ORIGINAL ARTICLE

Basic and Translational Allergy Immunology



## Ragweed plants grown under elevated CO<sub>2</sub> levels produce pollen which elicit stronger allergic lung inflammation

```
Denise Rauer<sup>1</sup> | Stefanie Gilles<sup>1</sup> | Maria Wimmer<sup>2,3</sup> | Ulrike Frank<sup>4</sup> |
Constanze Mueller<sup>5</sup> | Stephanie Musiol<sup>2,3</sup> | Behnam Vafadari<sup>1</sup> | Lorenz Aglas<sup>6</sup> |
Fatima Ferreira<sup>6</sup> | Philippe Schmitt-Kopplin<sup>5</sup> | Jörg Durner<sup>4</sup> | Jana Barbro Winkler<sup>7</sup> |
Dieter Ernst<sup>4</sup> | Heidrun Behrendt<sup>2</sup> | Carsten B. Schmidt-Weber<sup>2,3</sup> | |
Claudia Traidl-Hoffmann<sup>1,8,9</sup> | Francesca Alessandrini<sup>2,3</sup> |
```



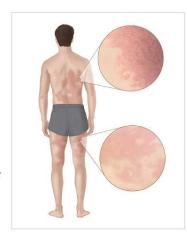
Allergy Healthcare Resources & Education | Allergy & Autoimmune Disease (thermofisher.com)

#### AGS reactions can include:

- · Hives or itchy rash
- Nausea or vomiting
- · Heartburn or indigestion
- · Cough, shortness of breath, or difficulty breathing
- Drop in blood pressure
- Swelling of the lips, throat, tongue, or eye lids
- · Dizziness or faintness
- · Severe stomach pain

Symptoms usually appear 2-6 hours after eating meat or dairy products, or after exposure to products containing alpha-gal (for example, gelatin-coated medications). People may not have an allergic reaction after every alpha-gal exposure.

Alpha-gal Syndrome Factsheet | Ticks | CDC



## Current Opinion in Allergy and Clinical Immunology

Articles & Issues ➤ For Authors ➤ Journal Info ➤

FOOD ALLERGY: EDITED BY ALESSANDRO FIOCCHI AND MOTOHIRO EBISAWA

Cite

#### Red meat allergy in children and adults

Wilson, Jeffrey M.; Platts-Mills, Thomas A.E.

< Share Author Information ⊗

Current Opinion in Allergy and Clinical Immunology 19(3):p 229-235, June 2019. | DOI: 10.1097/ACI.00000000000000523

Enders et al. Journal of Medical Case Reports https://doi.org/10.1186/s13256-022-03718-8

Journal of **Medical Case Reports** 

#### **CASE REPORT**

**Open Access** 

Alpha-gal syndrome initially misdiagnosed as chronic spontaneous urticaria in a pediatric patient: a case report and review of the literature

Felicitas Bellutti Enders<sup>1\*</sup>, Marius Elkuch<sup>1</sup>, Andreas Wörner<sup>2</sup>, Kathrin Scherer Hofmeier<sup>3</sup> and Karin Hartmann<sup>4</sup>

How can we mitigate climate change effects?



Lancet 2023

#### Asthma



Celeste Porsbjerg, Erik Melén, Lauri Lehtimäki, Dominick Shaw

The carbon footprint of inhalers continues to rise as global use increases. A study estimated that in 2018, 800 million hydrofluoroalkane (HFA)-propellant-based metered-dose inhalers were manufactured worldwide, using approximately 11 500 tonnes of hydrofluorocarbons, predominantly HFA-134a. Most of these HFAs are contained in salbutamol metered-dose inhalers. HFAs are strong greenhouse gases and contribute to global warming; every puff of salbutamol is estimated to be approximately equivalent to a mile travelled in a petrol car in terms of global warming. Consequently, the use of dry powder inhalers that do not contain propellants is now encouraged. Three companies have announced programmes to implement propellants with a lower global warming potential using HFA-152a or HFA-1234ze, with the first products potentially available from 2025. Disappointingly, the ability to recycle inhalers is still limited globally and the majority still end up in landfill.

## In clinical practice and research we could.....

- <u>Acknowledge and discuss</u> with patients (also the children!) and colleagues climate change effects on respiratory health
- Improve and provide continued <u>education</u> of healthcare professionals on the impact of climate change
- Focus attention on high-risk and <u>vulnerable populations</u>, in our case children with potentially severe disease
- Promote <u>climate-friendly activities</u> and lifestyle among clinicians and patients that will lead to personal health and planetary co-benefits
- Raise awareness of the impacts of climate change and to boost national/international policy action
- Conduct <u>interdisciplinary research</u> to advance knowledge on climate change health impacts and adaptation mechanisms
- Act as an example in <u>reducing greenhouse gas emissions</u> in clinical practice (e.g. prescribe DPIs instead of pMDIs when possible) and in our daily activities
- <u>DPI</u> from age 5-6 years (depending on the child) and whenever possible
- Strive for <u>optimal asthma control</u> minimize SABA overuse

DPI = dry powder inhalator pMDI = Pressurized metered-dose inhalers



#### Navigate on the page

Children's lung capacity improved in cleaner air

Publication

Published: 23-02-2023 15:59 | Updated: 23-02-2023 20:15

#### Children's lung capacity improved in cleaner air



Photo: Getty Images



#### 

Photograph: Fabrizio Bensch/Reuters

The researchers said the results sent 'a strong message to policymakers and city planners'.

#### Not everything is getting worse



EUROPEAN RESPIRATORY JOURNAL ORIGINAL RESEARCH ARTICLE Z. YU ET AL.

### Associations of improved air quality with lung function growth from childhood to adulthood: the BAMSE study

Zhebin Yu<sup>1</sup>, Simon Kebede Merid<sup>2</sup>, Tom Bellander<sup>1,3</sup>, Anna Bergström<sup>1,3</sup>, Kristina Eneroth<sup>4</sup>, Antonios Georgelis<sup>1,3</sup>, Jenny Hallberg<sup>2,5</sup>, Inger Kull<sup>2,5</sup>, Petter Ljungman<sup>1,6</sup>, Susanna Klevebro<sup>2,5</sup>, Massimo Stafoggia <sup>(1)7</sup>, Gang Wang<sup>1,2</sup>, Göran Pershagen<sup>1,3</sup>, Olena Gruzieva <sup>(1)3</sup> and Erik Melén <sup>(2)5</sup>

**TABLE 4** Association between improvement of air quality and differences in lung function growth from age 8 to 24 years

	Unit of improvement in exposure	Raw value		GLI z-score	
		Difference in FEV <sub>1</sub> growth, mL per year (95% CI) <sup>#</sup>	Difference in FVC growth, mL per year (95% CI)#	Difference in FEV <sub>1</sub> growth, so per year (95% CI)	Difference in FVC growth, sp per year (95% CI)
PM <sub>2.5</sub>	2.19 μg·m <sup>−3</sup>	4.63 (1.64-7.61)	9.38 (4.76–14.00)	0.03 (0.02-0.04)	0.04 (0.03-0.05)
$PM_{10}$	$1.00  \mu \text{g} \cdot \text{m}^{-3}$	0.72 (-0.91-2.35)	2.77 (0.19-5.35)	0.01 (0.00-0.02)	0.01 (0.01-0.02)
BC	$0.28  \mu g \cdot m^{-3}$	2.80 (0.66-4.93)	5.59 (2.30-8.87)	0.02 (0.01-0.03)	0.02 (0.01-0.03)
$NO_x$	6.17 μg·m <sup>-3</sup>	1.70 (-0.16-3.57)	3.29 (0.35–6.23)	0.01 (0.01-0.02)	0.01 (0.01-0.02)



#### Conclusions

- Air pollution exposure and climate change is strongly linked
- Effects associated with respiratory health across the life-course
- Children are particularly vulnerable; lung development, asthma, respiratory infections etc
- Climate change → altered biodiversity, pollen levels, exposures
- Time to act!
- Risk mitigate is possible

#### Thanks!





#### Centrum för arbets- och miljömedicin

#### Research Group Melén

Jenny Hallberg, PhD/A.prof
Petra Um-Bergström, MD, PhD, postdoc
Sophia Björkander, PhD, postdoc
Susanna Klevebro, MD, PhD, postdoc
Natalia Hernandez-Pacheco, PhD, postdoc
Gang Wang, MD, PhD, postdoc
Simon Kebede Merid, PhD
Ashish Kumar, statistician
Björn Lundberg, MD, PhD student
Maura Kere, PhD student

Hans-Jacob Koefoed, MD, visiting PhD student









European Research Council
Established by the European Commission

Supporting top researchers from anywhere in the world

#### BAMSE project group

Erik Melén, PI
Inger Kull, Co-PI
Anna Bergström, Co-PI
Antonis Georgellis, Co-PI
Alexandra Ek
André Lauber
Niklas Andersson
Sandra Ekström



#### **BAMSE** clinical team & FoC

Ulrika Hellberg
Anna Castel
Ann-Charlotte Sundqvist
Margareta Eriksson
Carina Wallén
Fuad Bahram
Thomas Olsson
Zekiye Cansu

#### MeDALL collaborators

Gerard Koppelman and PIAMA Stefano Guerra and CRS Jean Bousquet and Josep M. Antó

#### **CADSET** collaborators

Alvar Agusti Rosa Faner et al

#### PERMEABLE / ERA-PERMED

Susanne Vijverberg, PI Anke-Hilse Maitland van der Zee et al

#### Umeå Univ.

Annelie Behndig Jonas Eriksson Ström



Horizon 2020 European Union funding for Research & Innovation



BAMSE workshop, Stockholm archipelago