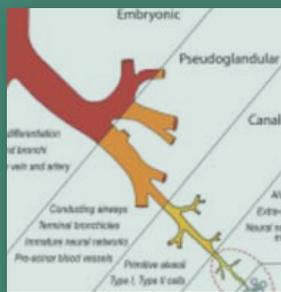
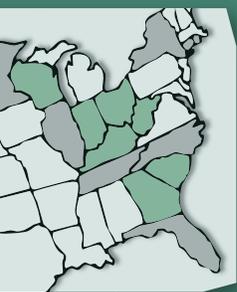


# A Story of Health



# ASTHMA: Brett's Story (a fictional case)

Brett is a nine year old boy who lives with his mom, Karen in an urban area in southern California. They live in an apartment near a busy street, and Brett takes the bus to public school. He plays several sports including baseball, soccer, and basketball, and likes to go out with his friends. Unfortunately, today, many kids like Brett also have asthma.



Basic information:  
Click [here](#) to find our more about asthma.



Health professionals:  
Click [here](#) to read more about asthma.



Asthma resources and more information from the CDC .

## Asthma Information for Health Professionals

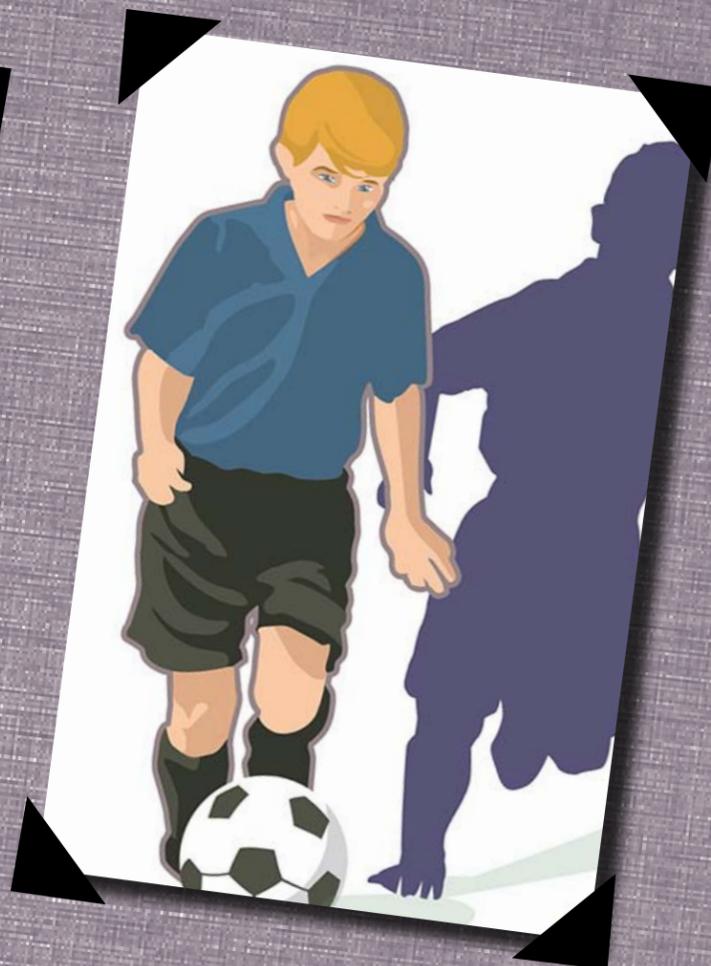
“By definition, all asthmatics share common physiologic abnormalities of airflow limitation such as obstruction on spirometry, airway hyper-responsiveness to methacholine challenge, and symptoms that can include shortness of breath, chest tightness, wheezing, and coughing. Despite these shared features, clinicians have long recognized the great heterogeneity in the severity of airway obstruction and symptoms, degree of reversibility, and the amount of improvement in response to medications.”  
(Bhakta, 2011; Holgate, 2010)

From more information check out these online links:

[CDC's health care guidelines](#)

[ATSDR's CASE study, Environmental Triggers of Asthma](#)

[National Environmental Education Foundation – Environmental Management of Pediatric Asthma: Guidelines for Health Care Providers.](#)



# ASTHMA: A Multifactorial Disease

Brett's mother sometimes wonders what caused Brett's asthma, and why so many of his friends have it.

The causes of asthma in Brett may differ considerably from the causes of asthma in another person, or the prevalent causes of asthma in a population.

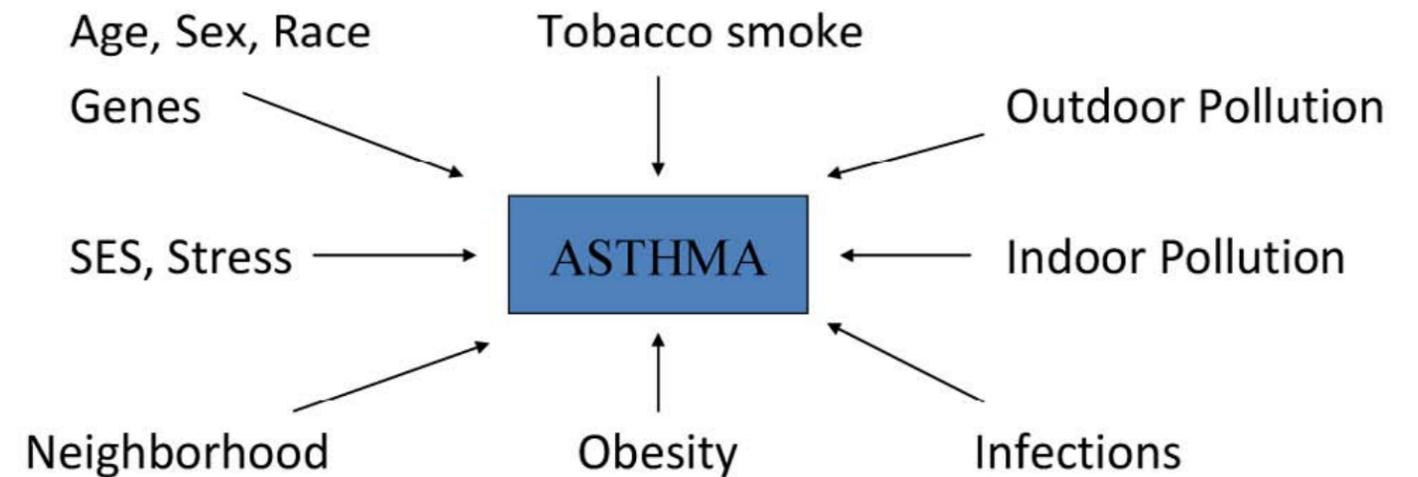
 **Key Concept:** Addressing disease risks in individuals and populations

In general, asthma is a multifactorial disease although in some individuals, a single factor may be predominantly responsible for its onset. For example, an exposure to a chemical airway sensitizer like formaldehyde, or exposure to secondhand smoke.

After asthma develops, various exposures can trigger or exacerbate an asthmatic episode.

 **Key Concept:** Causation and Association

## Risk Factors for Asthma



Graphic reproduced with permission.

**Watch** this short informative video by Dr. John Balmes that explains the many risk factors for developing asthma. (1.5 min.)

John Balmes MD, Professor and Division Chief of Occupational and Environmental Medicine at San Francisco General Hospital, University of California, San Francisco

# ASTHMAGENS: Risk factors for the development of asthma

There are hundreds of substances known or suspected to cause asthma (“asthmagens”). Some are encountered in the workplace as well as at home, school, and elsewhere – such as formaldehyde (in certain furnishings and building materials like cabinets), vinyl flooring, carpeting, phthalates (in plastic toys and other plastic products), bleach, natural gas combustion products, cleaning solutions and other products. Brett has likely been exposed to many asthmagens in his life.

Our main character Brett is not yet in the workforce but occupational causes of asthma should be considered when treating adults and children.

Though many chemicals shown to cause asthma in workers may not have been studied in children, it is likely that they are capable of causing asthma in the general population including children. And, working parents can bring exposures home to kids on clothing and in other ways, so pediatricians and parents of kids with asthma should also consider occupational exposures of parents.



## **More details: Asthma in the workplace and elsewhere**



### **Prevention Strategies – Home Checklists:**

*[Better Home Visits for Asthma, Lessons Learned from the Seattle–King County Asthma Program \(pdf\)](#)*

*[Do-it-yourself Home Environmental Assessment List \(HEAL\)\(pdf\)](#)*

*[EPA’s Asthma Home Environment Checklist](#)*

### **For Clinicians:**

*[Pediatric Environmental History Forms, National Environmental Education Foundation](#)*



### **View a database list of asthmagens**

*[The Association of Occupational and Environmental Clinics \(AOEC\). Includes those encountered in the workplace, home, school, etc. \(Click ‘display all asthmagens’ on site page.\)](#)*

## Asthma in the Workplace and Elsewhere

Epidemiologic studies have found that children face increased risks of developing asthma after early life exposure to chemicals that have also been found to cause asthma in workers like, for example, formaldehyde.

In a study of > 4,000 children in Southern California, exposure during the first year of life to 1) wood or fossil fuel smoke, soot, or exhaust 2) herbicides 3) pesticides or 4) cockroaches was associated with 74%, 450%, 230% and 200% respectively increased risk for being diagnosed with asthma by 5 years of age. Risks noted for asthma after exposure to some pollutants were similar or greater than that of another well established causal risk factor, cockroaches. (Salam et al., 2004)

From the American College of Chest Physicians 2008 consensus statement on the **Diagnosis and Management of Work-Related Asthma:**

Work-related asthma has two categories. They are often clinically indistinguishable, but the distinction can impact treatment strategies and medico-legal decisions.

**Occupational asthma.** This diagnosis is appropriate when a worker develops new respiratory symptoms and obstructive airway physiology consistent with asthma and an exposure in the workplace is likely to have contributed to its onset. Occupational asthma is often sub-classified as:

- **Sensitizer-induced** (90% of cases)
- **Irritant induced asthma** (10% of cases), including reactive airway dysfunction syndrome (RADS).

Some cases are mixed or unclassifiable.

**Work-exacerbated asthma.** This occurs when a worker’s previously diagnosed asthma is worsened, but not caused, by agents in the workplace.

### **At risk occupations include:**

- bakers
- building custodians
- detergent manufacturers
- drug manufacturers
- farmers
- grain elevator workers
- hair stylists
- laboratory workers
- nurses
- metal workers
- millers
- plastics and other chemical workers
- woodworkers

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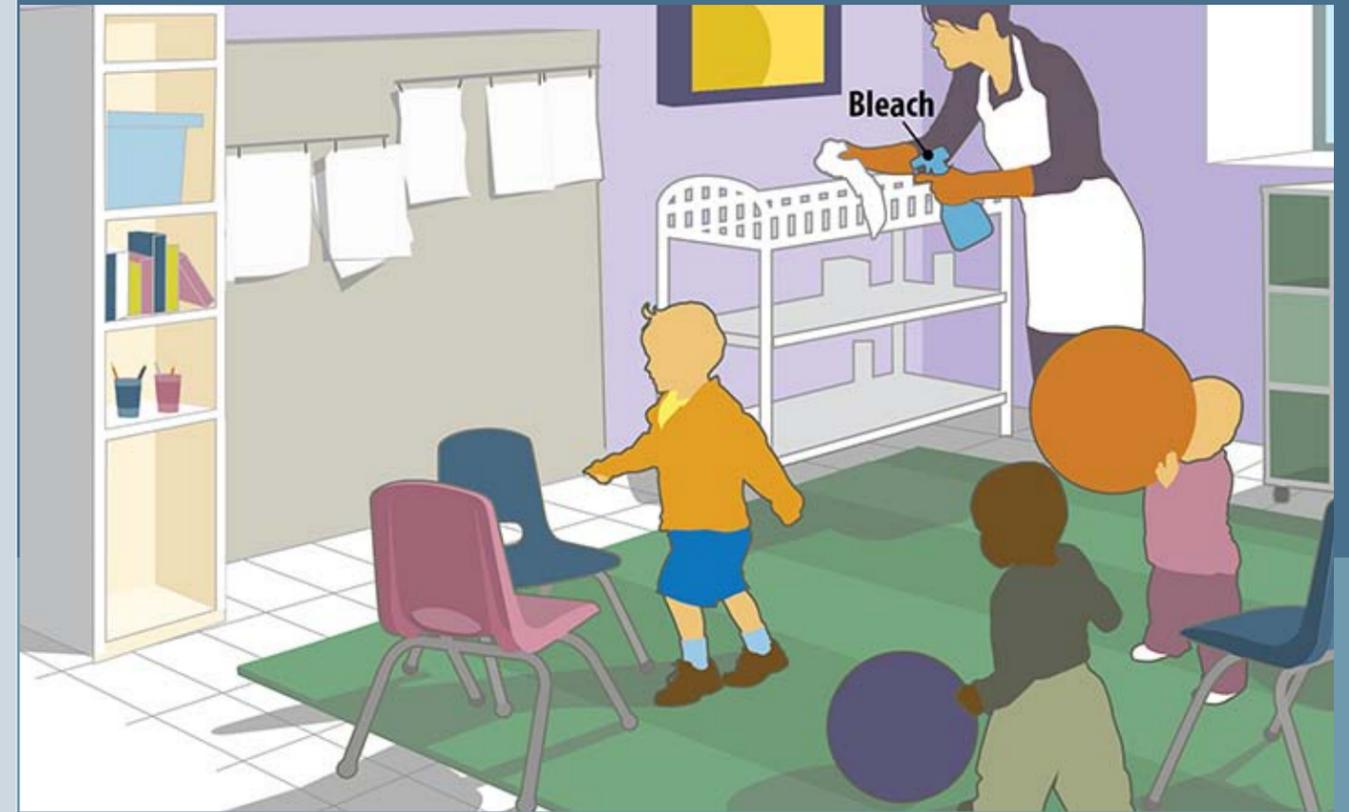
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**View a database list of asthmagens**

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# ASTHMA: Prenatal and Early Life Exposures

Karen also thinks about what her doctors told her when she was pregnant about exposure to tobacco smoke, and how she tried to get her husband to quit which was another source of fighting between them.

In her discussions with her OB/GYN she also learned about keeping her weight down and the importance of Vitamin D.

## [+ Additional Information: About Vitamin D](#)

Some prenatal variables are well-established as risk factors for asthma, alone or in combination with postnatal exposures. For example, maternal obesity during pregnancy is associated with increased risk of asthma in offspring.



**Watch:** Dr. John Balmes presents powerful evidence on the detrimental effects of air pollution and smoking on prenatal and early childhood development. (5 min.)



# ASTHMA and Lung Development

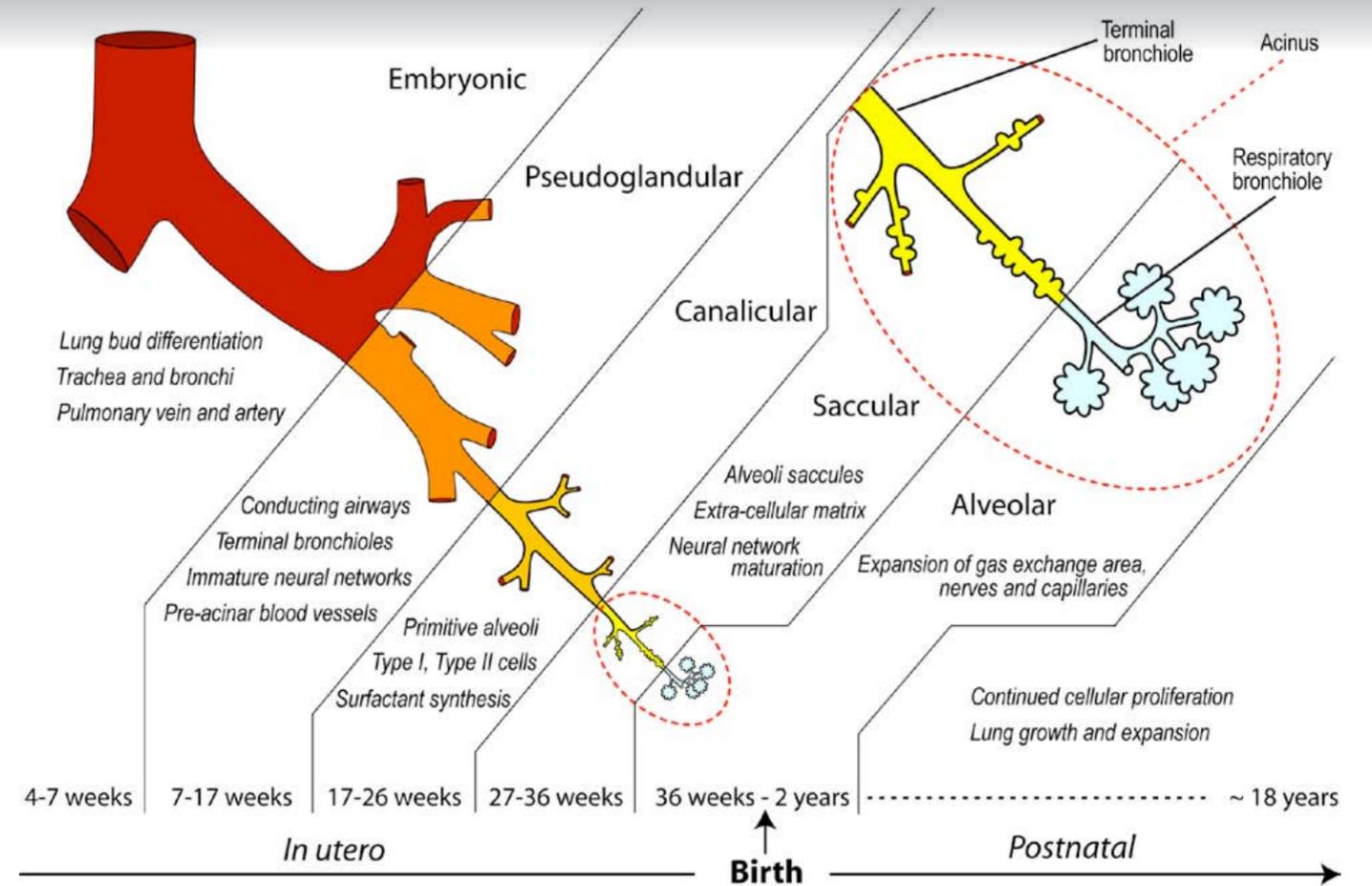
## THE LUNG IS SUSCEPTIBLE TO MANY INFLUENCES DURING EARLY DEVELOPMENT.

Though the lung develops into a functioning organ during the fetal period, important stages in lung growth and development continue during early childhood and may be altered by environmental exposures.

 [Click here for more details.](#)

 [You may skip this section and go to "Growing Problem of Asthma"](#)

## Stages of Lung Development



Reference: Kajekar R. Environmental factors and developmental outcomes in the lung. *Pharmacol Therap.* 2007;114:129-145. Graphic used with permission.

# ASTHMA: Triggers

In someone like Brett who already has asthma, an asthma attack can be triggered or set off by a wide range of many of the same environmental agents including exposure to:

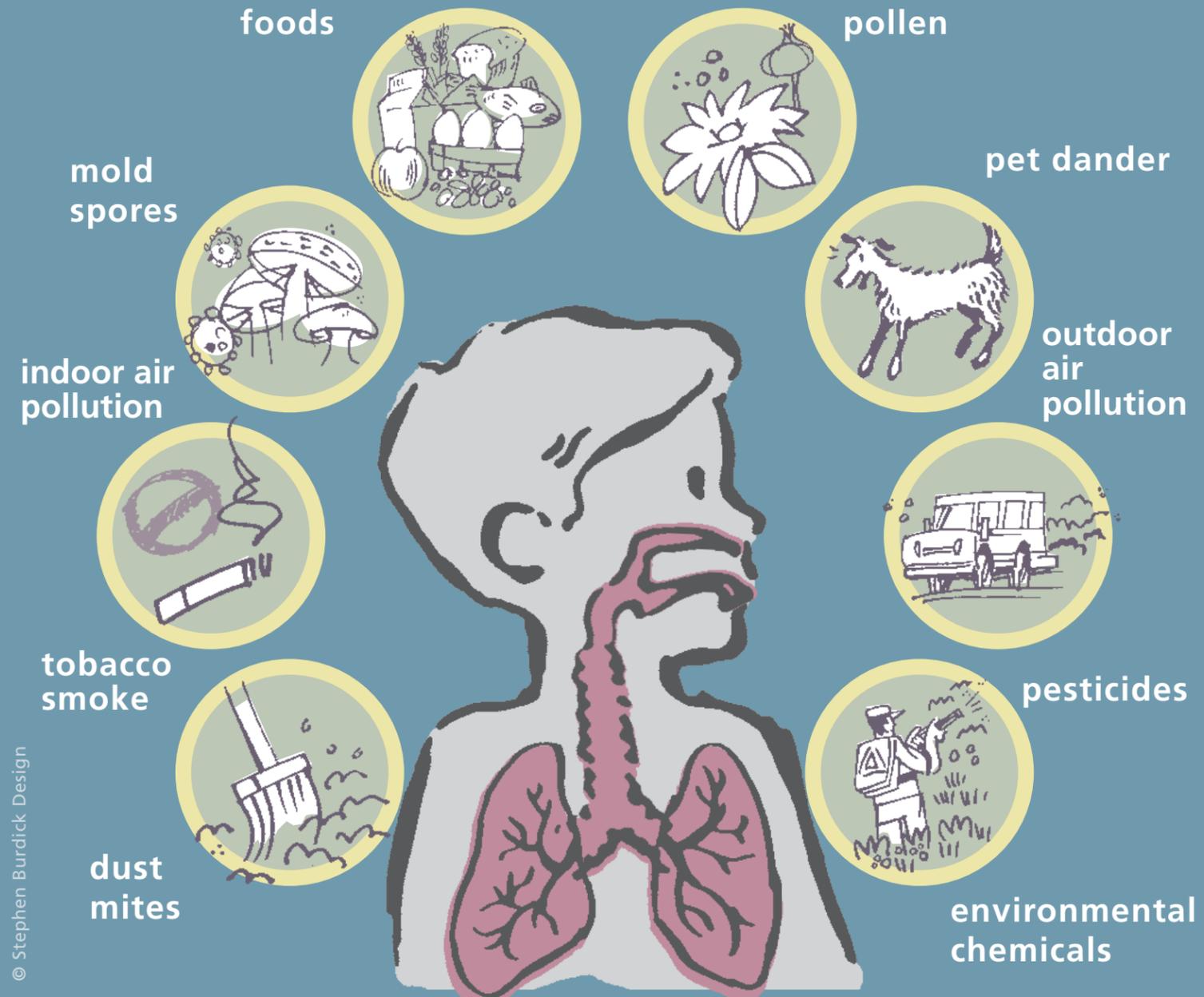
- indoor air pollutants such as tobacco smoke, outdoor air pollution;
- other environmental chemicals including pesticides, and;
- allergens including mold, pollen, cockroach droppings and pet dander.

Exercise and cold weather can also be triggers. These triggers vary from one person to another.

It is sometimes called “allergic asthma” when an individual wheezes in response to exposure to an allergen such as pollen or cat dander.



## Potential Asthma Triggers



# ASTHMA: Family and Community Stressors

Karen sometimes wonders whether the constant fights with her ex-husband while she was pregnant and after Brett was born may have had an effect on Brett's asthma.

She may be right.

Family stressors such as money problems, exposure to violence, illnesses and deaths, and divorce can make kids more susceptible to many health problems, including asthma.

Stress can add to and even magnify the impacts of exposure to other environmental conditions that foster the onset or increase the severity of asthma.

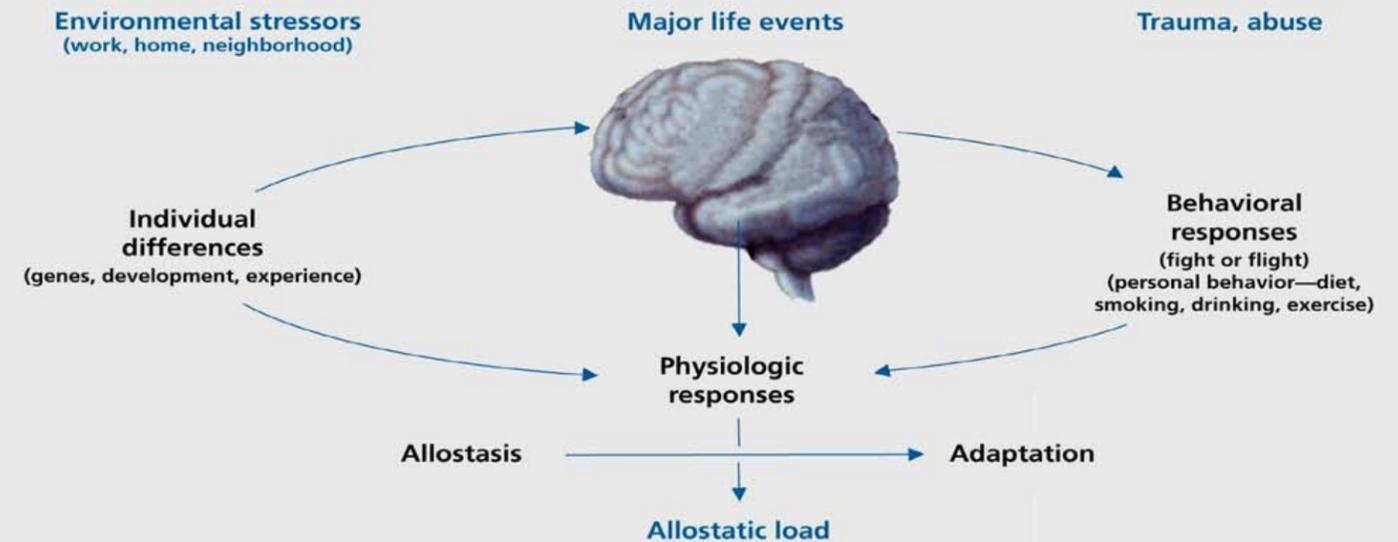


 **Key Concept:**  
Allostatic Load

 **Key Concept:**  
Effect Modifiers



**Watch:** Dr. John Balmes discusses how multiple factors can interact to increase the risk of developing asthma (effect modification). (3 min.)



## KEY CONCEPT: Allostatic Load

Homeostasis is the body's ability or tendency to maintain its normal equilibrium by regularly adjusting the processes that influence blood pressure, temperature, blood sugar, and other functions. **Allostasis** is the body's ability to change vital homeostatic functions in response to environmental changes. Like homeostasis, allostasis is complex, and involves responses from the brain and other parts of the nervous system as well as the immune and cardiovascular systems. **Allostatic load** is the cumulative "wear and tear" on the body due to these systems actively maintaining balance in response to stressors.

Real or perceived threats activate stress hormones and can lead to the following:

- Constricted capillaries in the skin
- Dilated bronchial tubes
- A release of sugar and fatty acids (for energy)
- Conversion of muscle protein to fat
- Blocked insulin action
- Release of minerals from bones
- Changes to white blood cells

These actions (and others that are part of the stress response) help the body meet an immediate threat. Long-term functions

such as building muscle, bone, and brain cells are temporarily sacrificed to provide energy to respond to a threat or escape ("fight or flight response").

Because we can experience stress from current events and ideas (remembering past stressful events and anticipating stressful circumstances), our allostasis mechanisms may go into overdrive on a long-term basis. Exposures to various kinds of stress (psychosocial, chemical, nutritional, etc.) during our early life can reprogram the body's mechanisms, resulting in chronic increased responses to stressors that affect our health negatively throughout our life.

# ASTHMA: Family and Community Stressors

The impact of asthma on the family can be substantial, from emotional to economic.

Children suffer from days lost at school and can be excluded from certain activities.

Parents who need to work must take time off or find adequate care for their children when they need to stay home.

When a child has an acute attack, it can be very stressful and frightening for parents.



**Watch:** Dr. Rosalind Wright discusses how caregiver stress, early childhood stress and community violence all have an impact on the development of asthma. (5 min.)



**More information:** Link to resources on comprehensive family asthma management programs – CDC and medical legal

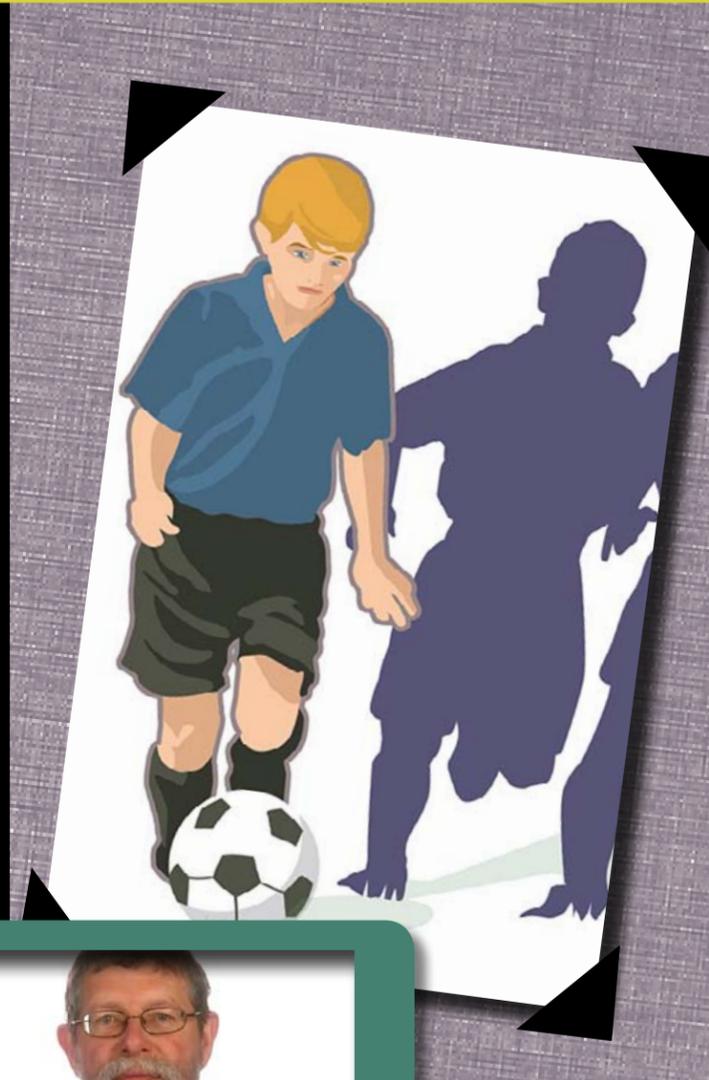


# ASTHMA, Exercise and Air Pollution

Brett's asthma is sometimes triggered by exercising or playing the sports he loves, which is very frustrating for him.

Some research shows that playing multiple sports along with higher exposures to air pollution (ozone) can actually cause the onset of asthma.

(McConnell et al., 2002)



**Watch:** Dr. John Balmes presents compelling scientific evidence that clearly illustrates the relationship between air pollution and incidence of asthma. (6 min.)



**For clinicians,** link to Dr. Jim Gauderman slide show on Children's Health and Traffic Exposures.

# ASTHMA and Air Pollution

## INDUSTRIAL AND TRAFFIC AIR POLLUTION MAKE ASTHMA WORSE

### Adverse Effects of Regional and Traffic-Related Air Pollutants on Children with Asthma

#### Pollutants

- Ozone
- Nitrogen Oxide
- Respirable particulate matter (PM - <10 and <2.5 μm)
- Vehicle exhaust (trucks, cars, trains, ships, etc.)

#### Health effects in children with asthma

- Respiratory symptoms
- Wheezing (acute)
- Bronchitis (chronic)
- Increased rescue medication use
- Decreased lung function
- Emergency department visits
- Hospitalizations
- School absences

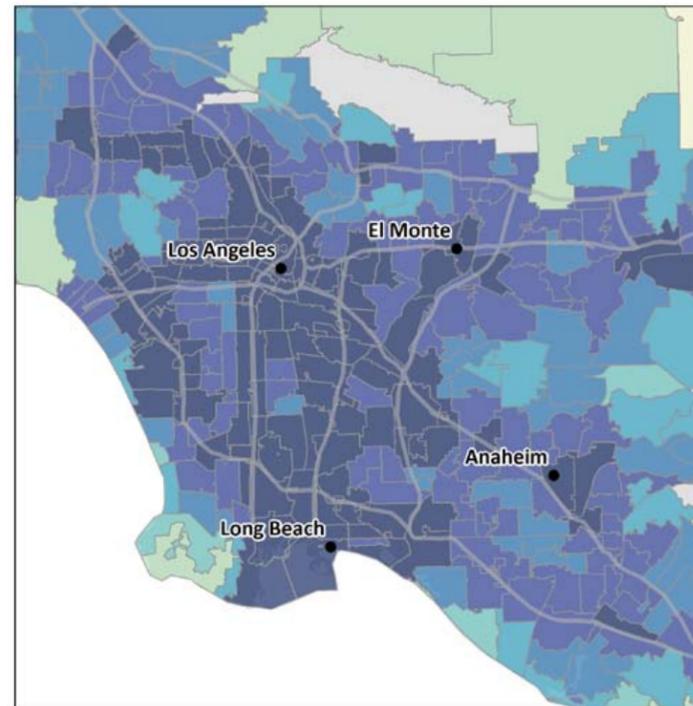
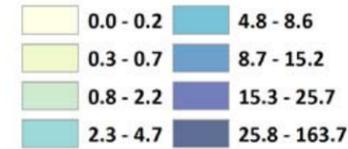
+ Diesel emissions and asthma demographics in southern California

+ Asthma and near roadway exposure to air pollution

## Diesel Emissions and Asthma Demographics in Southern California

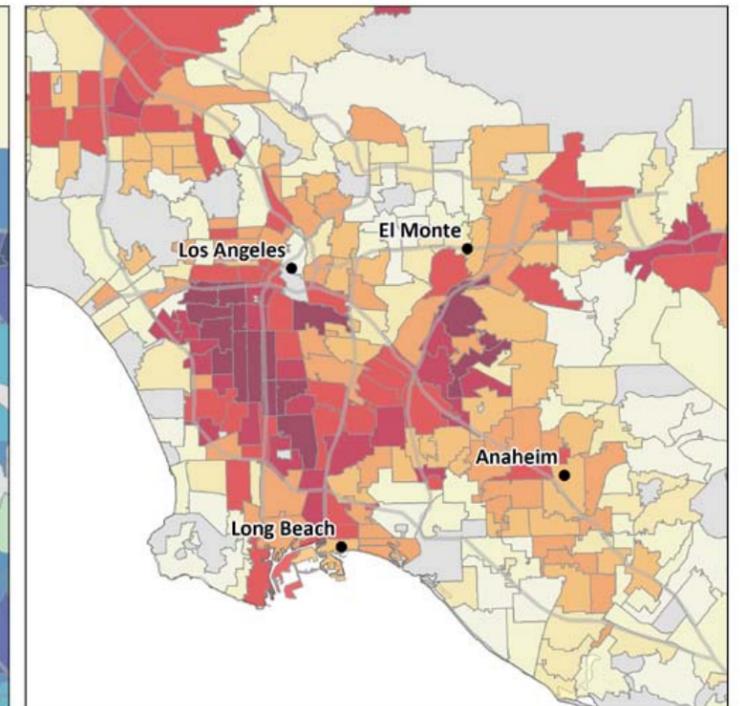
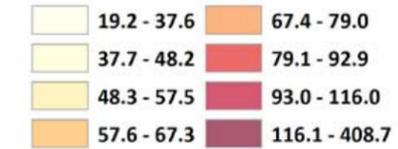
### Diesel PM

Diesel PM emissions from on-road and non-road sources for a 2010 July day (kg/day)



### Children's Asthma

2009 childhood ED visits for asthma (age-adjusted rate per 10,000 by ZIP code)



+ **Credit:** CalEnviroScreen, Office of Environmental Health Hazard Assessment, California EPA

Graphic used with permission.

+ **Link:** California Environmental Health Tracking Program Web Portal

# ASTHMA and Air Pollution

## EFFECT MODIFIERS — AIR POLLUTION, STRESS AND SOCIOECONOMICS

Brett lives in a low-income neighborhood close to Los Angeles and near a major roadway. Children in relatively low-income families and exposed to traffic-related air pollution, such as in Brett's case, are at greater risk of frequent asthma symptoms. Importantly, they are at greater risk than children in the same neighborhood whose families are financially better off.

(Meng et al., 2008, Shankardass et al., 2009, Clougherty et al., 2007)

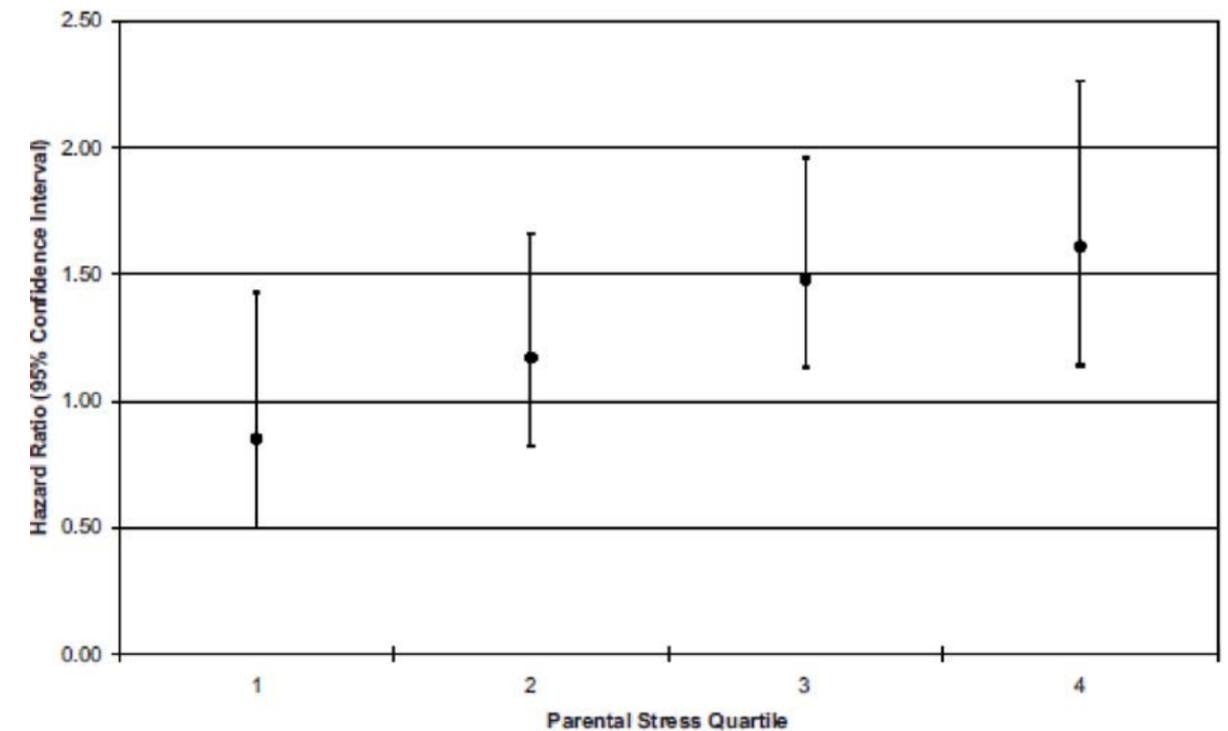
And, those with a lower income and people of color are much more likely to go to a school that has a heavily trafficked roadway next to it.

+ [Examples: Air pollution and socioeconomics](#)

+ [Link: National Environmental Health Tracking Program](#)

+ [Asthma in California](#)

## Effect of traffic-related pollution on incident asthma across parental stress quartiles



Over a period of 3 years of follow up in a prospective cohort study of 2,497 children aged 5-9 years with no previous history of asthma, the risk of new onset asthma attributable to traffic related air pollution (TRP) was significantly higher for children whose parents were subject to higher amounts of stress.

Stress was estimated using the Perceived Stress Scale (PSS), which is a widely used measure of the degree to which respondents believed their lives were unpredictable, uncontrollable, or overwhelming. Stress was also associated with larger effects of in utero tobacco smoke exposure.

A similar pattern of increased risk of asthma was observed among children from low SES families who also were exposed to either TRP or in utero tobacco smoke. (Shankardass 2009)

Graphic used with permission.

# ASTHMA Genetics and Air Pollution

Exposure to oxidants in ambient air contributes to inflammation in the lungs. Oxidants include oxygen, ozone, particulate matter, polycyclic aromatic hydrocarbons (PAHs - a group of chemicals that occur primarily from burning fuel), nitrogen oxides, and cigarette smoke.

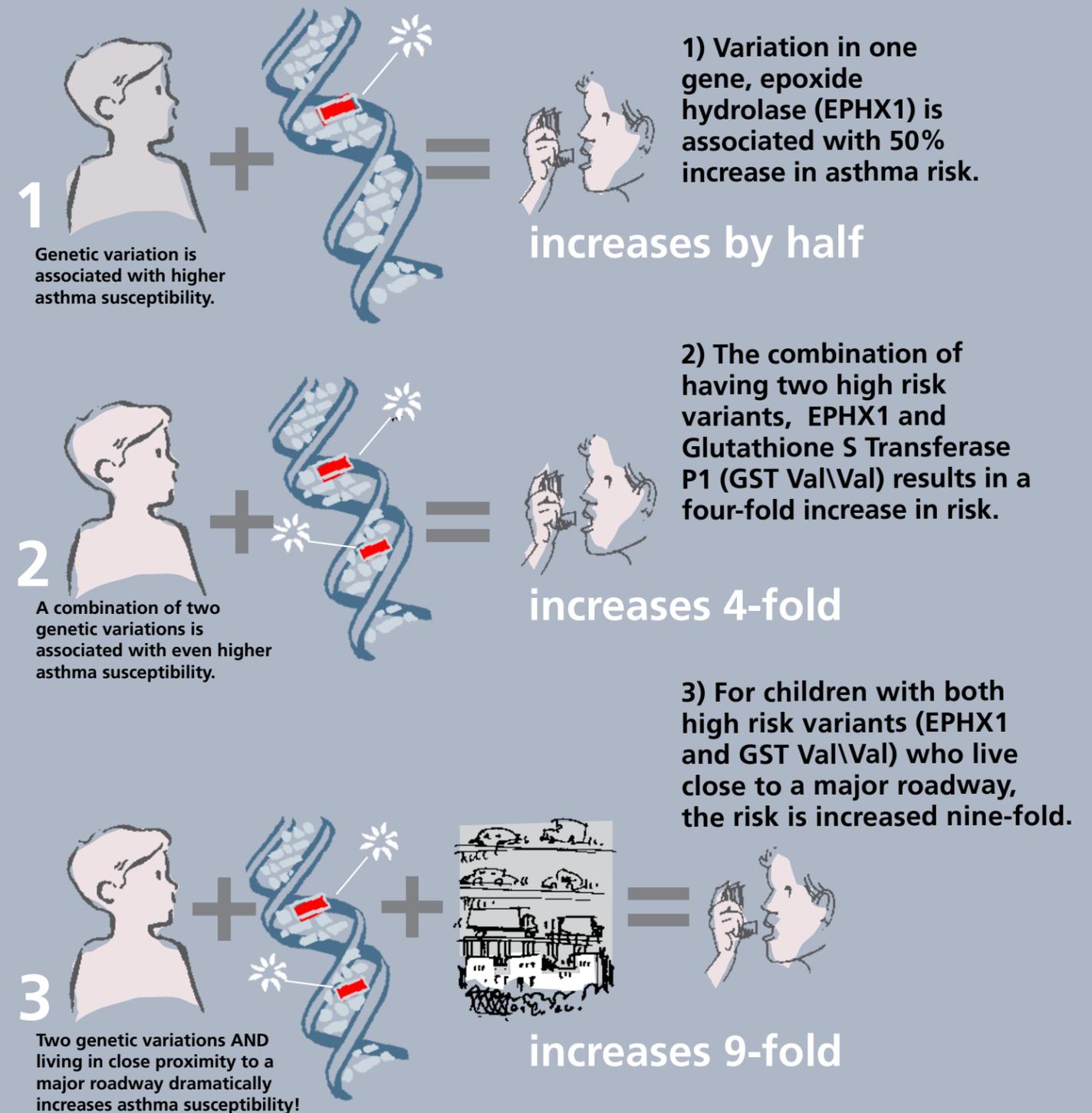
The genes glutathione (GST) and epoxide hydrolase (EPHX1) are important for detoxification and elimination of contributors to oxidative stress associated with asthma. Oxidative stress and inflammation are fundamental to the origination and development of asthma.

## **Key Concept: Inflammation and Oxidative Stress**

Certain genetic variants in GST and EPHX1 each are individually associated with increased risk of developing asthma, as is living in close proximity to a major roadway. Salam et al., found that being in the high risk group for all three resulted in nearly a nine-fold increase in risk for lifetime asthma. Ultrafine particulate matter has strong oxidant properties and generates inflammatory responses (Li et al., 2003).

Genes metabolizing PAHs have polymorphisms (many forms) that affect how well they mediate tissue damage via development of reactive oxygen species.

## Genetics Increase Susceptibility to Air Pollution



# ASTHMA: Management and Prevention Strategies

## Children with asthma should:

- Not be exposed to secondhand smoke (SHS) and other types of combustion smoke,
- Not exercise outdoors on bad air quality days, but outdoor exercise should otherwise be encouraged, and,
- Avoid allergens to which they are sensitized.

## Other protective factors include the following, if possible:

- Choosing homes and walking routes away from major roadways with heavy traffic,
- Improved access to health care, healthy foods, and green space for disadvantaged children with asthma,
- Dietary antioxidants, including vegetables,
- Avoidance of water-damaged environments,
- Improved ventilation in buildings to discourage mold growth,
- Using household chemicals and pesticides sparingly if at all, and with care, and,
- Replacing or retrofitting older diesel vehicles.

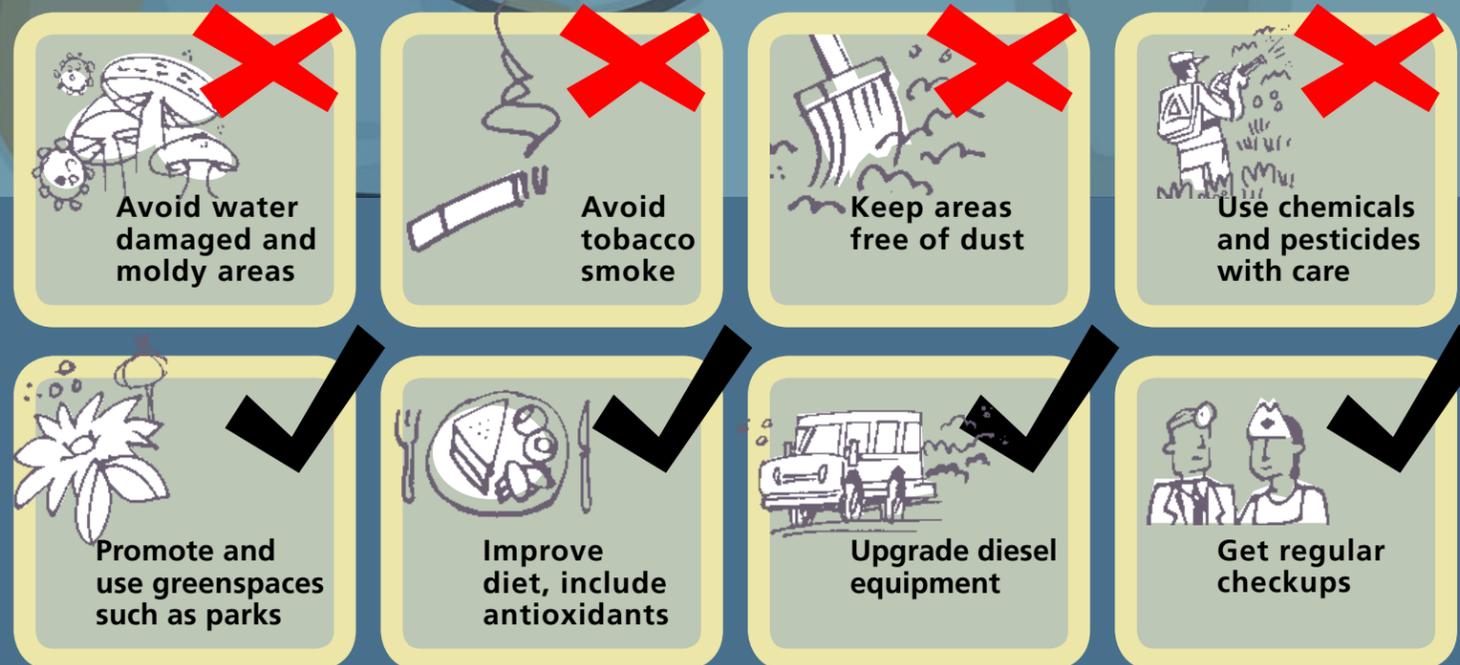


For clinicians - more information on asthma management:

[Guidelines](#) from the National Environmental Education Foundation

[Guidelines](#) from the National Heart, Lung and Blood Institute

## Asthma Management Strategies



# SOME FINAL THOUGHTS

## COMMON THEMES

Although the fictional narratives in *A Story of Health* describe the lives of people with different diseases, common themes resonate. They include:

- Important environmental influences come from the natural, chemical, food, built, and social environments.
- Although there are exceptions, most diseases as well as good health are the result of complex interactions among multiple environmental influences and genetics.
- Early-life experiences, particularly during critical windows of development, can have profound beneficial or detrimental lifelong effects, even into elder years.
- Preventing disease and promoting health require actions and commitments from the individual, family, community and society, as they are all interconnected.



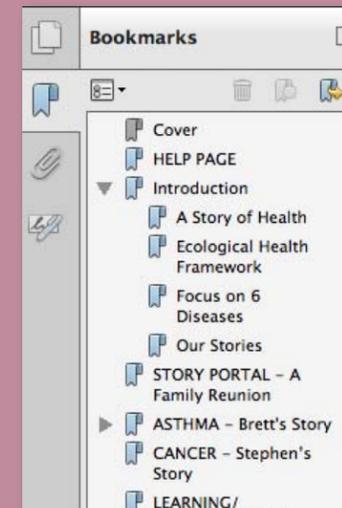
- Common themes in stories
- Additional Resources
- Register for Continuing Education Credits



We'd love to hear from you. Give us your feedback on *A Story of Health*. [Click here!](#)

## Resources

We have linked to many useful resources in each story relevant to a wide range of audiences, including clinicians. To quickly access resources on specific topics in each story, use the **Bookmarks** toolbar on the left (which you can open or close), or return to the [Help page](#) for more details on other eBook features.



Additional resources to help prevent disease and promote health:

**Portal to Science Resources:** Hundreds of additional resources on environmental health including organizations, publications, videos and more.

**Pediatric Environmental Health Toolkit:** Materials for health care providers and patients in English and Spanish.

**Out of Harm's Way: Preventing Toxic Threats to Child Development:** Fact Sheets in English and Spanish.

**Approaches to Healthy Living:** A 4-page guide on how to avoid toxicants, eat healthier, reduce stress.

**Healthy Aging: The Way Forward:** An ecological approach to policy level interventions for healthy aging across the lifespan.

## Continuing Education

Register for Continuing Education (CE) credits for *A Story of Health* for a variety of health professions. Free credits are offered by the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry [at this link](#).



Another free CE course on environmental health offered by the CDC/ATSDR is the **Pediatric Environmental Health Toolkit** online course.