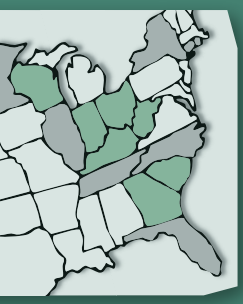
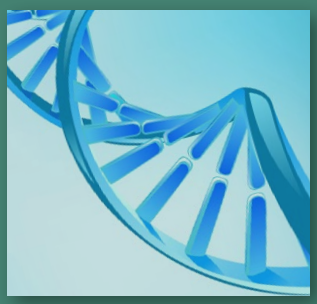
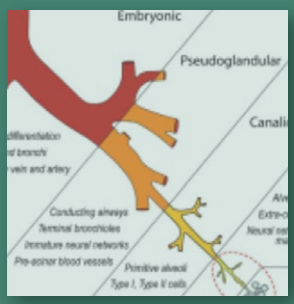
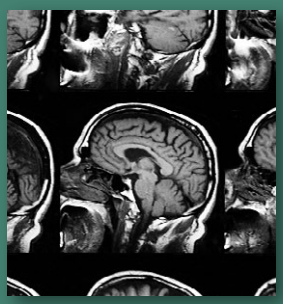
A Story of Health

Asthma: Brett's Story









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Any errors or misrepresentations that remain are entirely the responsibility of the authors.

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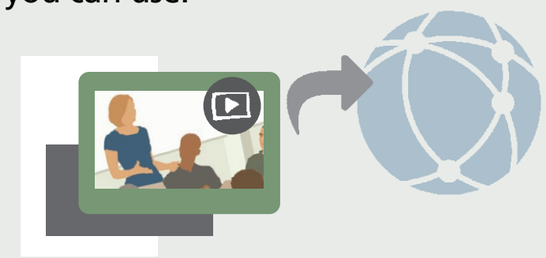
HELP PAGE How to Navigate Our eBook

THE INDIVIDUAL STORIES OF HEALTH in this eBook are written to address many audiences. For example, some sections are more technical than others – you can skip sections if you wish.

(Note: underlined words or phrases link to online information that will open in a browser window, prompt downloads or navigate to a related page within the ebook.)

Each of the eBook stories is embedded with a wide range of resources. These help further explain possible environmental and/or genetic "risk factors" – (contributors to the development of a disease, or factors that might make a disease worse) – and how these factors interact.

We also provide links for additional resources, including actions you can take to prevent disease, and "tools you can use."



RESOURCES INCLUDE videos, slides with audio commentary, tables, charts, and graphics. Some 'pop-up' in the story, and some connect online. Through these links, you can choose to dig deeper and learn more. Refer to icons at right for guidance.

REFERENCES AND CITATIONS: Certain references are cited in the text where we believe they are most warranted. Full references by topic can be found at the end of each story.

For CME Credit, enroll through this link: https://www.train.org/cdctrain/course/1118282/details

Getting Started

Our eBook Navigation: Click on selections in the page headers to navigate back to this **Help Page**, find out about **Continuing Education** opportunities and access further information in **References**.

If you lose your place, use the **Go Back** selection in the navigation bar to return to your previous screen.

Adobe Acrobat Tools

This interactive pdf document is best viewed on a laptop or desktop, downloaded and opened in a current version of Adobe Acrobat Reader. Refer to the top Adobe menu bar for features including:

Magnify - If you want to enlarge a diagram or some text, click (+) button.

Move through pages - You can use the up and down arrows to move through pages.

You can also move through pages using the scroll up and down feature to the right of your screen.

Note: Navigation features may not work properly using other pdf reader platforms.

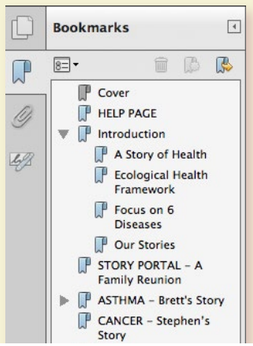


Table of Contents

Use the sidebar Bookmark Tools as a table of contents to skip to a section of interest, find your place, or return to this Help page.

Icons

Click on icons that may appear throughout the stories for pop-ups, videos, and links to more information as described.

key concept

watch a video

additional resources, tools

technical details for health professionals

definition

INTRODUCTION

This is one of a series of collected stories about health.

It is a story of how our own health is intimately connected with the health of our families, friends and communities.

It is a story about how human health is interdependent with our surroundings.

The collected stories include a number of fictional people and highlight the many ways our health is influenced by the complex environments where we live, eat, work, play, volunteer, gather and socialize.

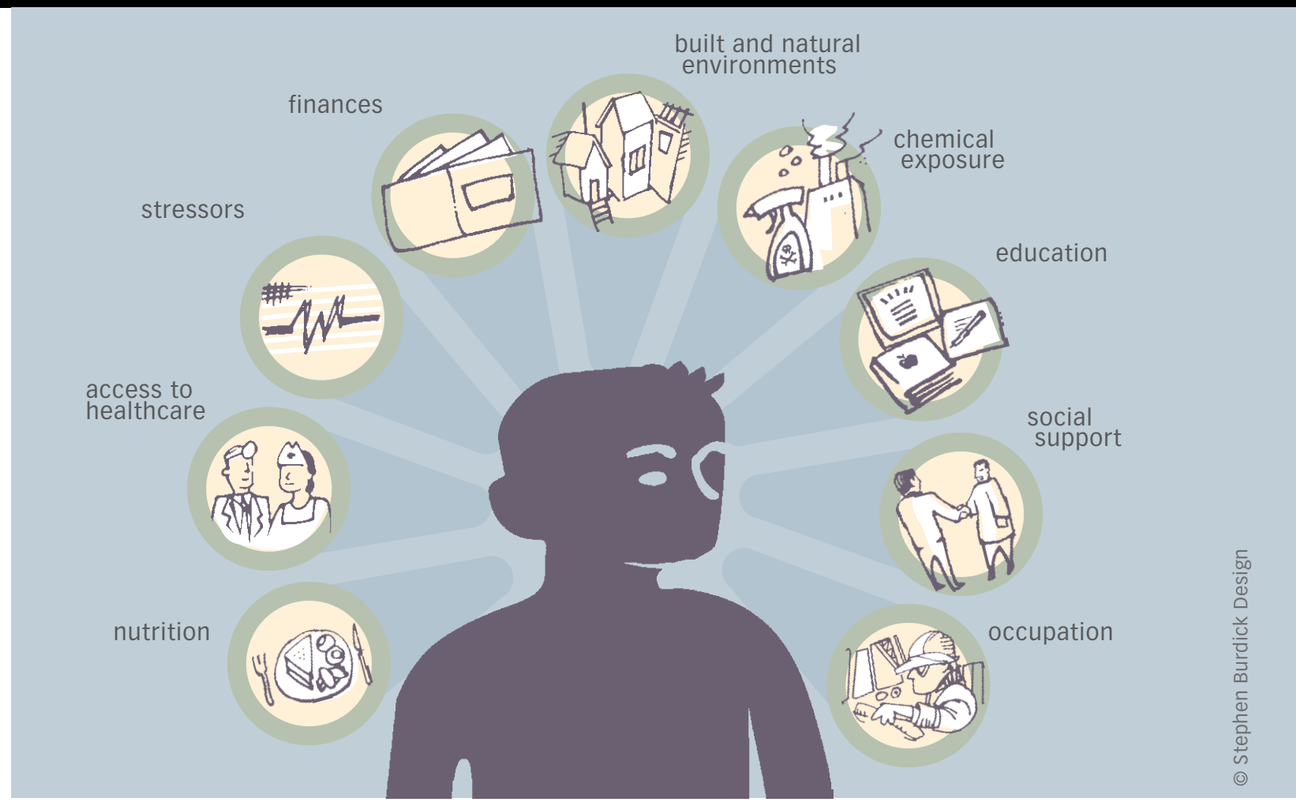
INTRODUCTION

Our stories explore how many aspects of our lives, and what we are exposed to in our environments, influence health across the lifespan—from the beginning of fetal development to elder years—and how they can promote health and resilience, or disease and disability.

Important determinants of health come from the natural, built, chemical, food, economic, and social environments.

These environments are further expressed through such things as education, housing, nutrition, access to health care, social supports and more.

Many of them interact to create the conditions for health and wellness, or vulnerability to disease.



Complex interactions occur among many variables and across individual, community, and societal levels.

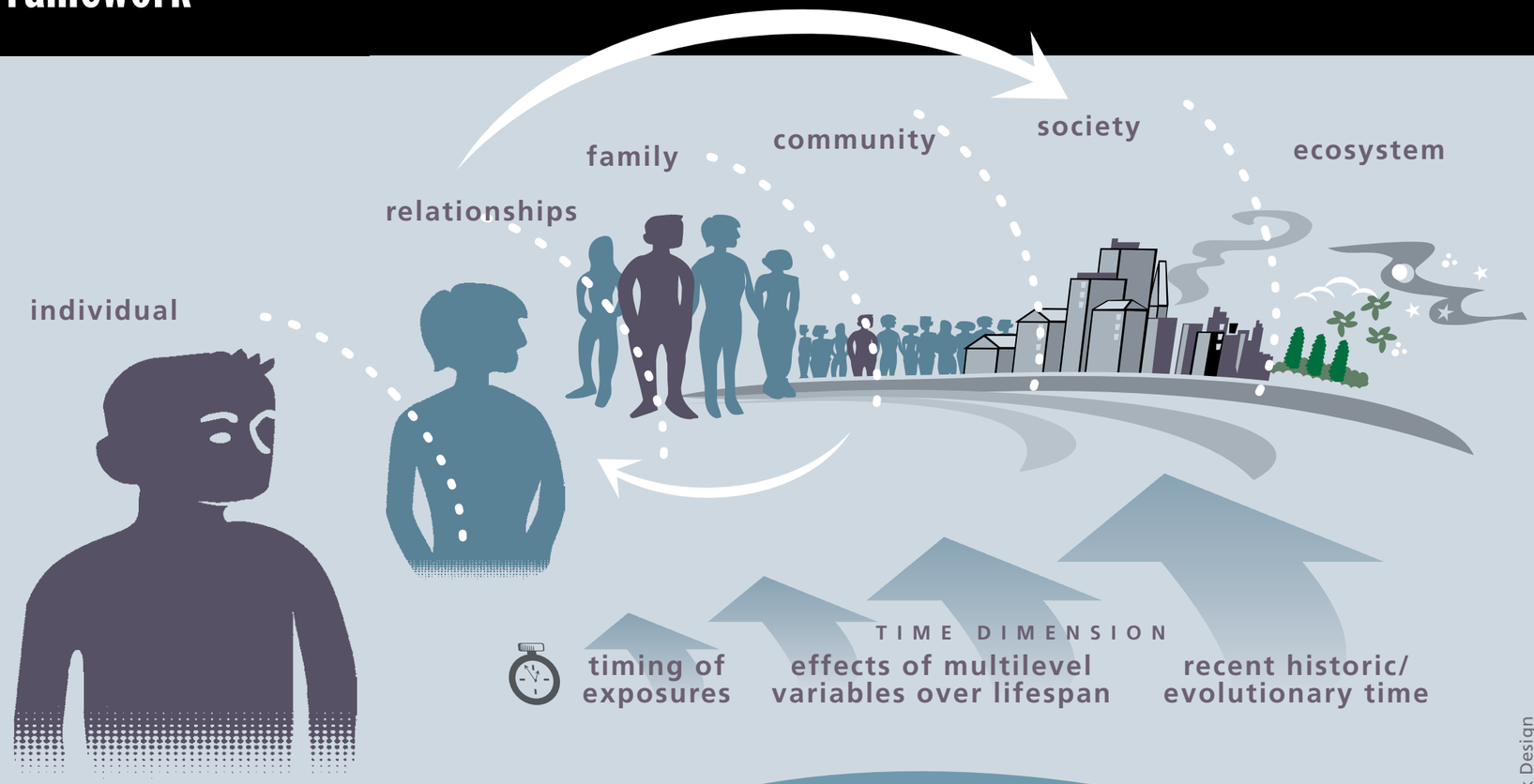
Rarely is one particular thing responsible for health or disease, so we refer to this as a multifactorial (or ecological) approach, the best way to promote health and prevent disease.

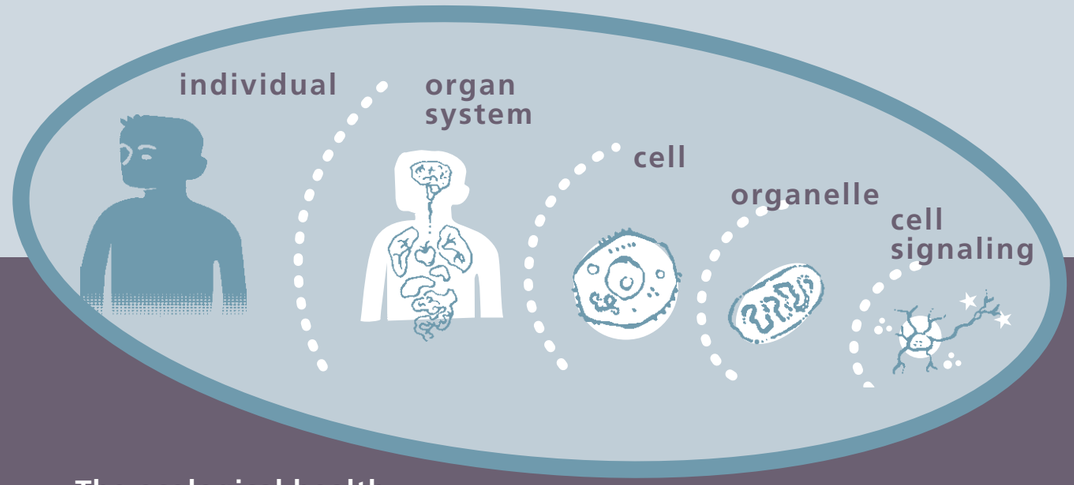
INTRODUCTION Ecological Health Framework

The ecological framework can include multiple levels from sub-cellular to societal.

It is not hierarchical in the sense that one level is more important than another, but rather in the sense that individual biology is progressively nested within the person, family, community, society and ecosystem.

The interactions and feedback loops within, across, and among these levels are complex and variable. They exert their influences on health across time.





The ecological health framework also extends to the sub-cellular level.

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INTRODUCTION Six Different Stories

Following is a story of people like you and me, our partners, families and friends, our mothers and fathers, sisters and brothers, children, grandparents, cousins and aunts and uncles.

The personal health stories explored in this series include some of the most common and troubling diseases and exposures of our time. They include:

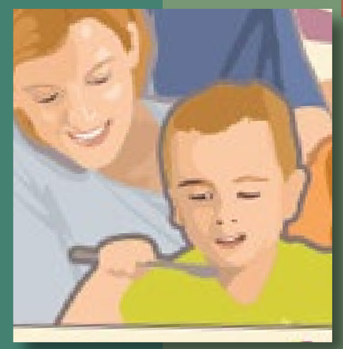
- Asthma (this chapter)
- Childhood cancer
- Wildfire health impacts
- Infertility
- Learning and developmental disabilities
- Cognitive decline

Download other *Story of Health* chapters here.

Asthma

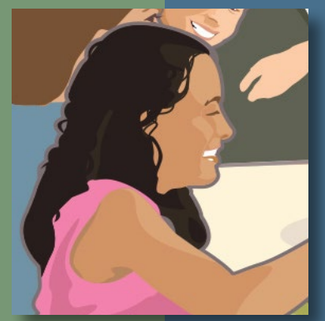
Wildfire health impacts

Childhood cancer



Cognitive decline

Infertility



Learning and developmental disabilities

INTRODUCTION Free Continuing Education

Information on free Continuing Education offered from the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry

This fictional *Story of Health* chapter offers free Continuing Education (CE).

Visit the CDC/ATSDR CE page where you can register and take the test for CE for this and other chapters from the complete work, at the link below.

Please review the learning objectives at right. These will help you focus as you read each story, and prepare you for each CE test.

Download other Story of Health chapters here.

Register for free CE here.

Free Continuing Education available by specialty:

- **Continuing Medical Education (CME) for Physicians**
- **Continuing Nursing Education (CNE) for Nurses**
- **Continuing Education Units (CEU) for other professionals**
- **Continuing Education Contact Hours (CECH) for Certified Health Education Specialists (CHES)**

LEARNING OBJECTIVES

Brett's Story (Asthma):

1. Discuss clinical symptoms associated with asthma.
2. Describe the latest science on environmental, gene-environment risk factors for asthma.
3. Describe how to counsel patients to avoid risk factors that may contribute to asthma.
4. Describe how to improve collaborative practice across the healthcare team regarding the prevention of asthma.

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 out more about asthma.

Health professionals: Click here to read more about asthma.

Asthma resources and more information from the CDC .

For more information check out these online links:

CDC's Health Care Resources

ATSDR's CASE study: Environmental Triggers of Asthma

National Environmental Education Foundation: Asthma management resources including 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 most common 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.

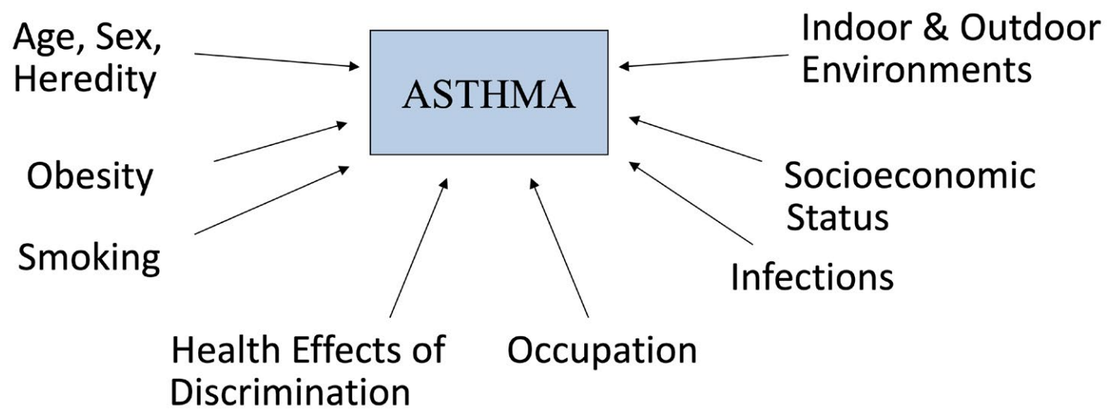
After asthma develops, various exposures can trigger or exacerbate an asthmatic episode.

Key Concept: Causation and Association

When Brett's asthma started, the nurse at his pediatrician's office took an environmental history so his doctor could assess what the influencing factors might have been.

Resources – For Clinicians:
Pediatric Environmental History Forms, National Environmental Education Foundation

Risk Factors for Asthma



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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 Emeritus, Division of Occupational, Environmental and Climate Medicine at University of California; San Francisco

[i] Rose G. Sick individuals and sick populations. Int J Epidemiol. 1985; 14(1):32-38.

[ii] Puska P. From Framingham to North Karelia: from descriptive epidemiology to public health action. Prog Cardiovasc Dis. 2010; 53(1):15-20.

[iii] Editorial: Shot-gun prevention? Int J Epidemiol. 1973; 2(3):219-220.

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), isocyanates found in paints, glues, and foams, 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.

Causes vs. Triggers of Asthma

More details: Asthma in the workplace and elsewhere

Resources – Home Checklists:

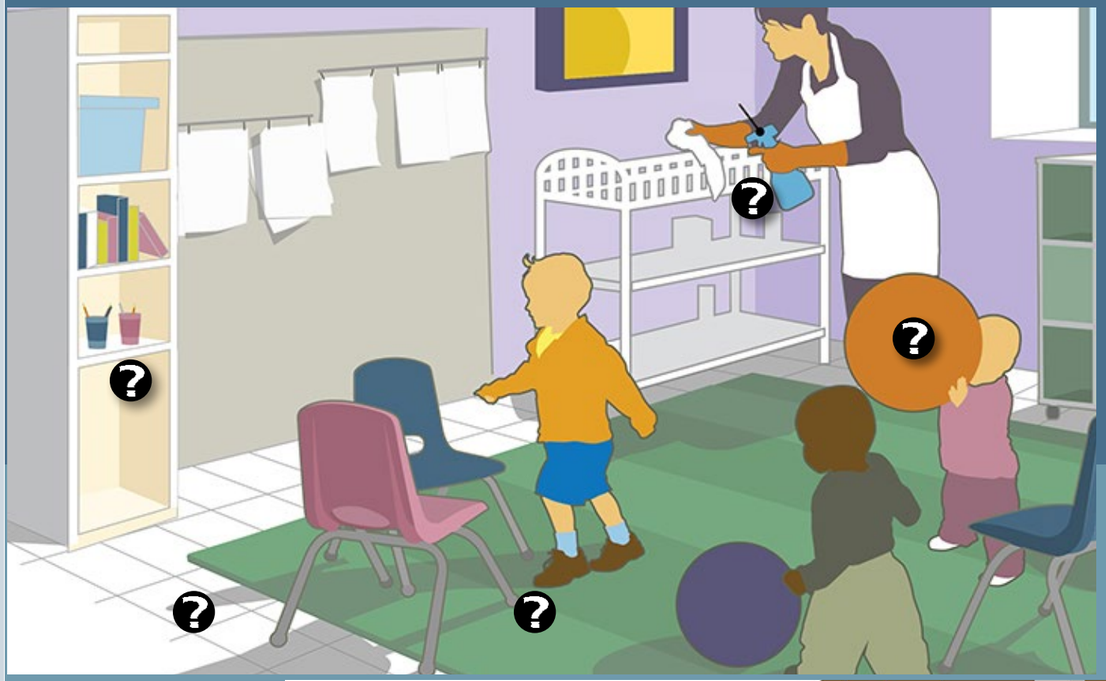
EPA's Asthma *Home Environment Checklist*

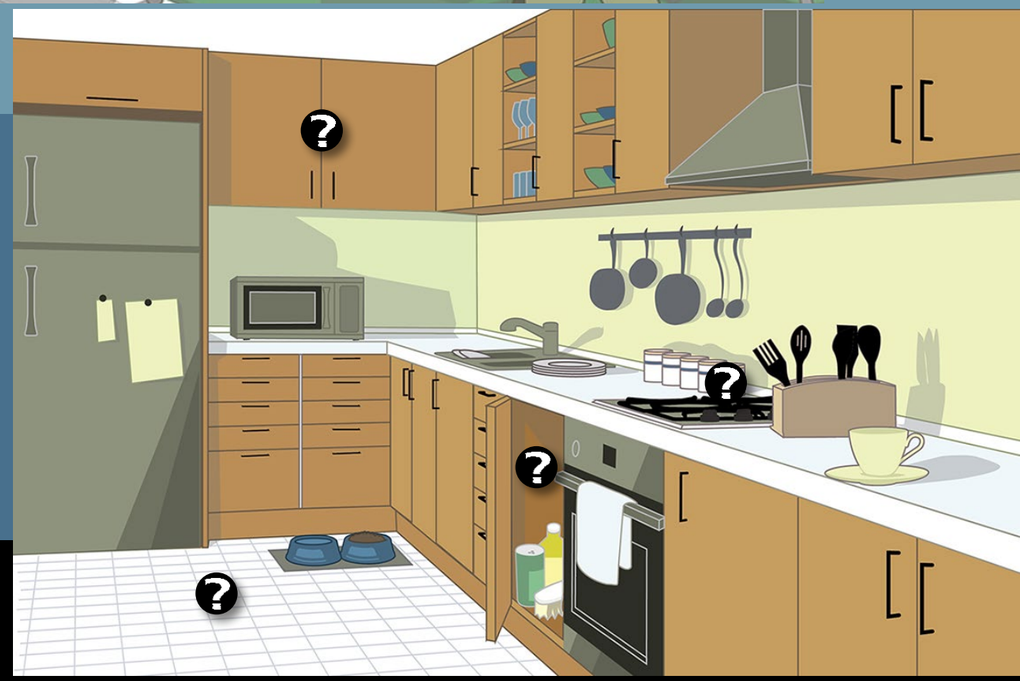
For Clinicians:

Regional Asthma Management and Prevention (RAMP)

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.)





ASTHMAGENS: Stress and Other Risk Factors for Asthma

Some early life environmental risk factors have been identified.

For example, prenatal and early life exposure to social stressors, such as violence, can increase the risk of asthma as well as increase the impacts on respiratory health from allergens, air pollution, and tobacco smoke.

Secondhand smoke alone is a risk factor for new cases of asthma in preschool-aged children.

Karen was surprised to learn that some doctors are even concerned about acetaminophen and its relationship to asthma.

Brett has experienced many of these risk factors in his short life. More details about these can be found as you read his story.

More information on acetaminophen

Stress, ACEs and Asthma

Download the CA Surgeon General's "Roadmap for Resilience" report here.

Stress affects our health. Watch this video by Dr. Rosalind Wright to see how social stressors, along with environmental factors, can be linked to asthma. (5 min.)

Rosalind J. Wright, MD, MPH, Horace W. Goldsmith Professor of Pediatrics, Dean of Translational Biomedical Sciences, Department of Pediatrics, Icahn School of Medicine at Mount Sinai

McBride JT. The Association of Acetaminophen and Asthma Prevalence and Severity. Pediatrics;doi: 10.1542/peds.2011-1106.

Martinez-Gimeno A, García-Marcos L. The association between acetaminophen and asthma: should its pediatric use be banned? Expert Rev Respir Med. 2013 Apr;7(2): 113-22. doi: 10.1586/ers.13.8.

Sheehan W, Mauger D, Paul I, Moy J, et al. Acetaminophen versus ibuprofen in young children with mild persistent asthma. New Engl J Med. 2016; 375(7):619-630. https://www.ncbi.nlm.nih.gov/pubmed/27532828.

ASTHMA: Prenatal and Early Life Exposures

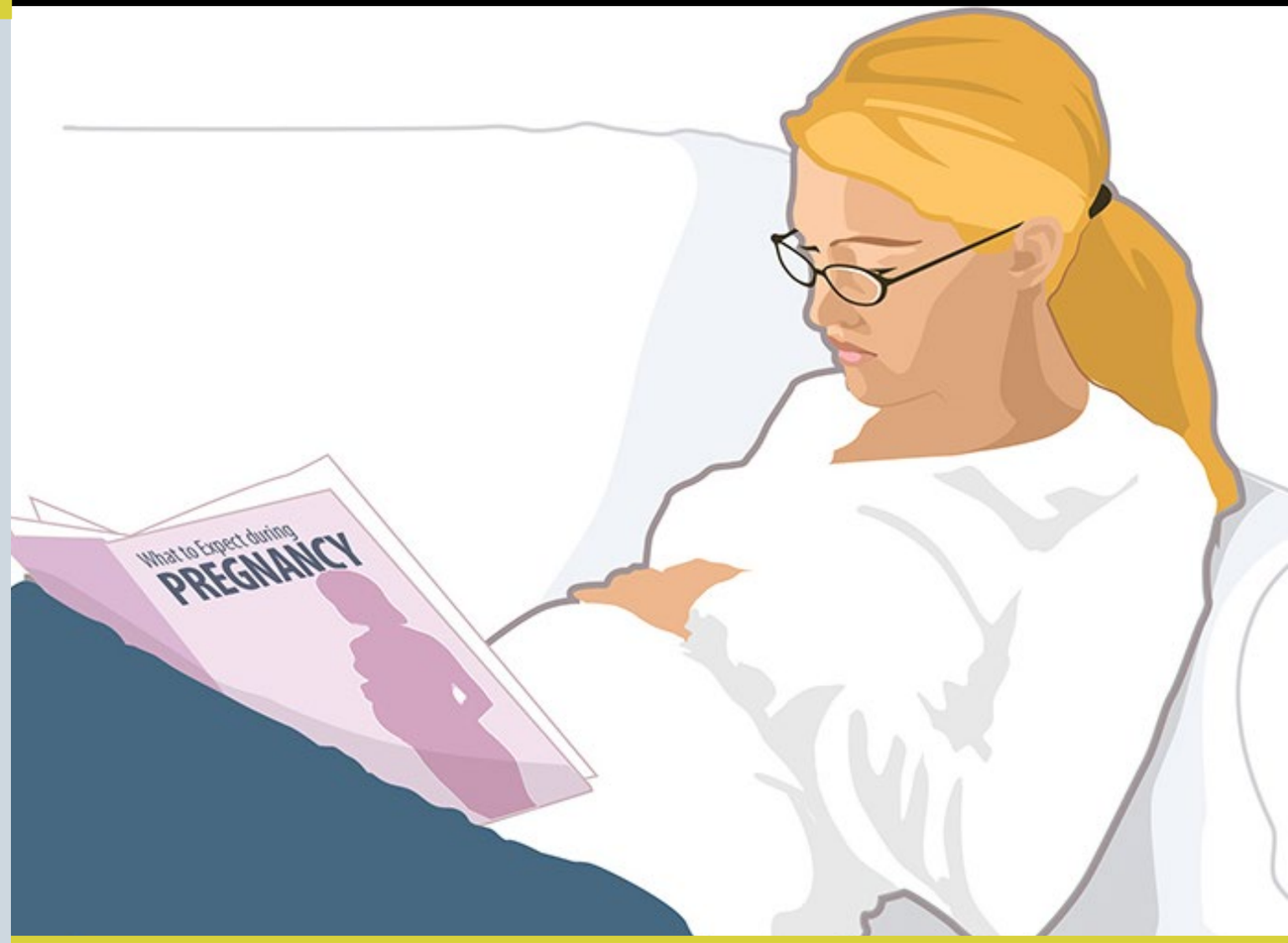
Karen also thinks about what her doctors told her when she was pregnant about exposure to tobacco smoke, and how she tried to get her husband to quit which was another source of fighting between them.

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

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

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.



ACOG Reference:

ACOG Committee on Obstetric Practice. ACOG Committee Opinion No. 495: Vitamin D: screening and supplementation during pregnancy. Obstet Gynecol. 2011;118 (1):197-198.

CDC Reference:

Perrine C, Sharma A, Jeffers M, Serdula M, Scanlon K. Adherence to vitamin D recommendations among US infants. Pediatrics. 2010; 125(4):627-632.

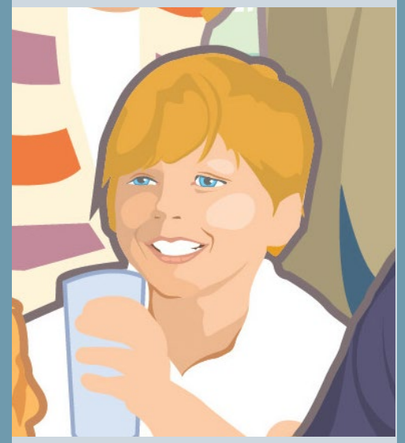
ASTHMA: Triggers

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:

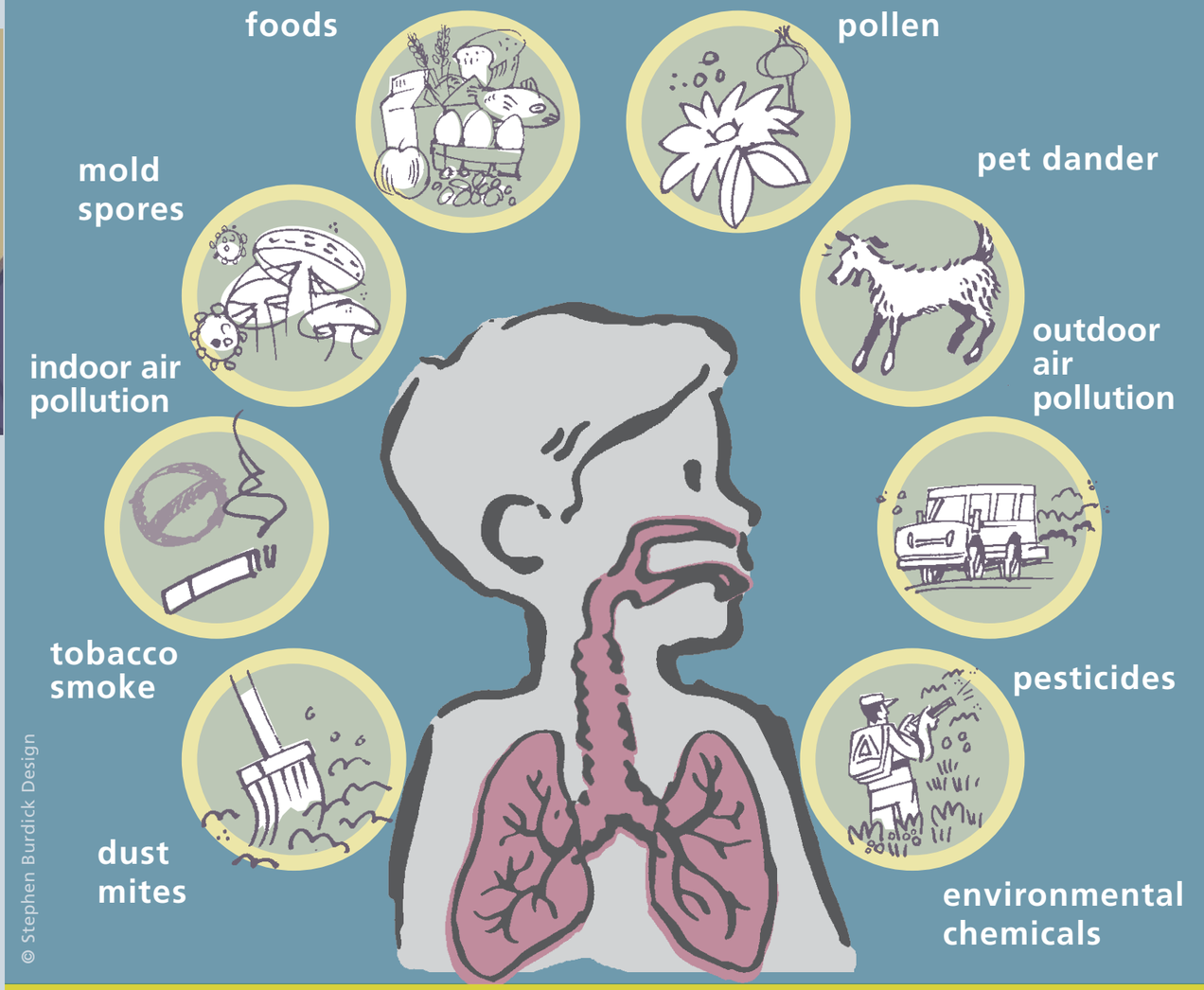
- indoor air pollutants such as tobacco smoke, outdoor air pollution;
- other environmental chemicals including pesticides, and;
- allergens including mold, pollen, cockroach droppings and pet dander.

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 has asthma because of allergies to materials such as pollen or cat dander.



Potential Asthma Triggers



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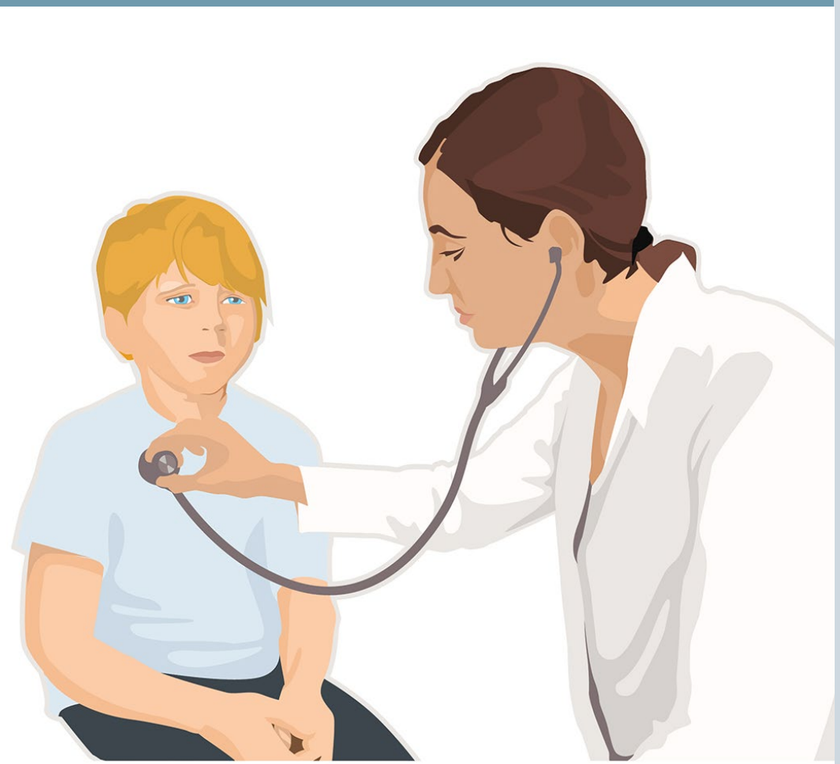
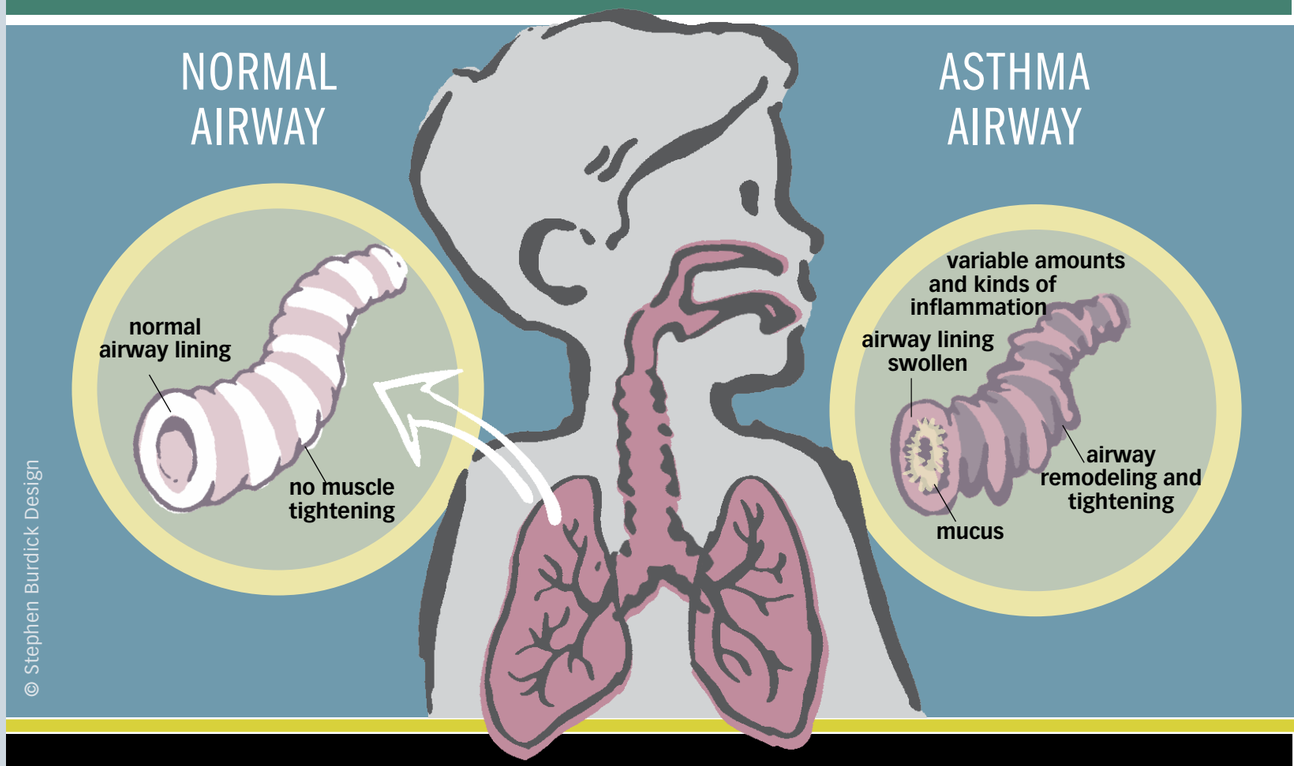
ASTHMA: Effects on the Lungs and Immune System

Brett's doctor told him that the reason he wheezes sometimes is because of inflammation and narrowing of the airways in his lungs.

Watch: **Dr. John Balmes discusses the many factors that influence lung development and the severity of asthma. (Technical/ academic - 6 min.)**





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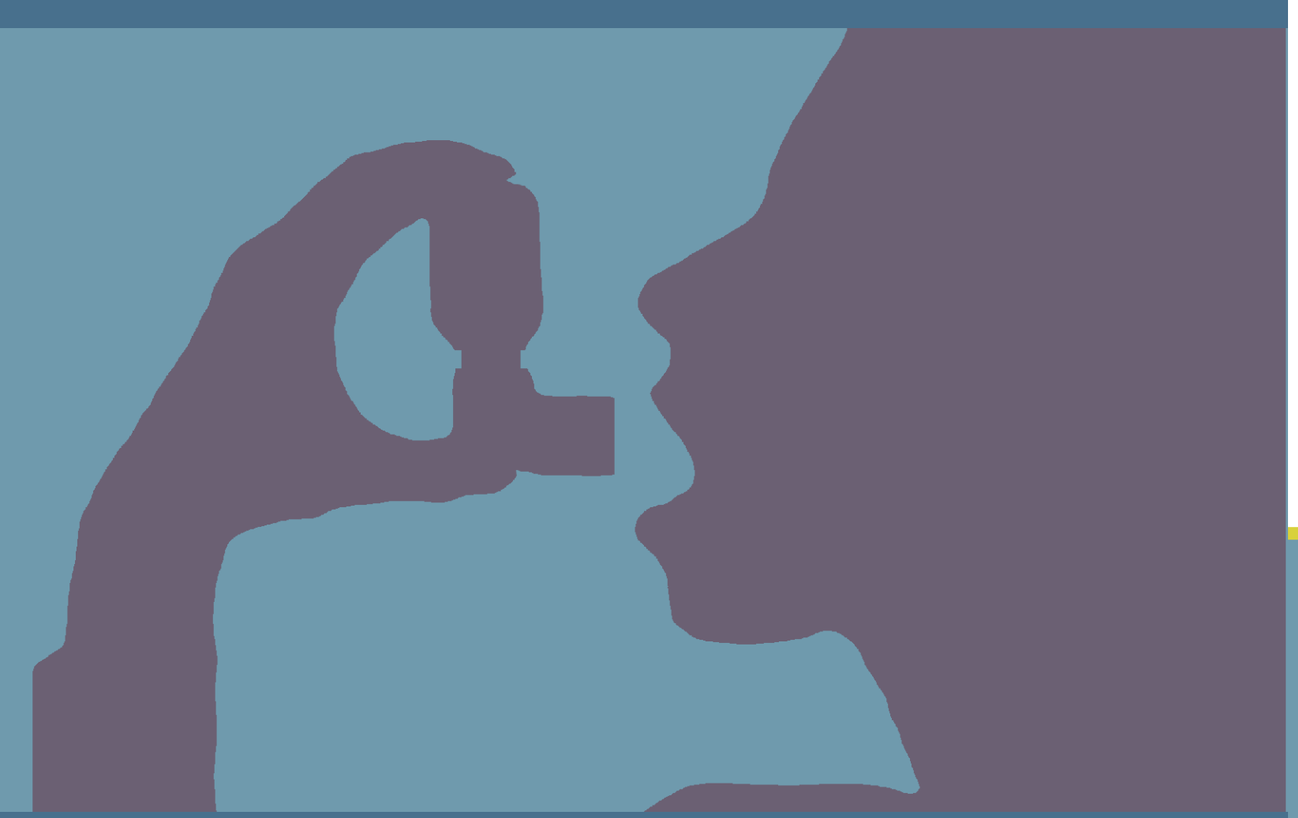
ASTHMA and Lung Development

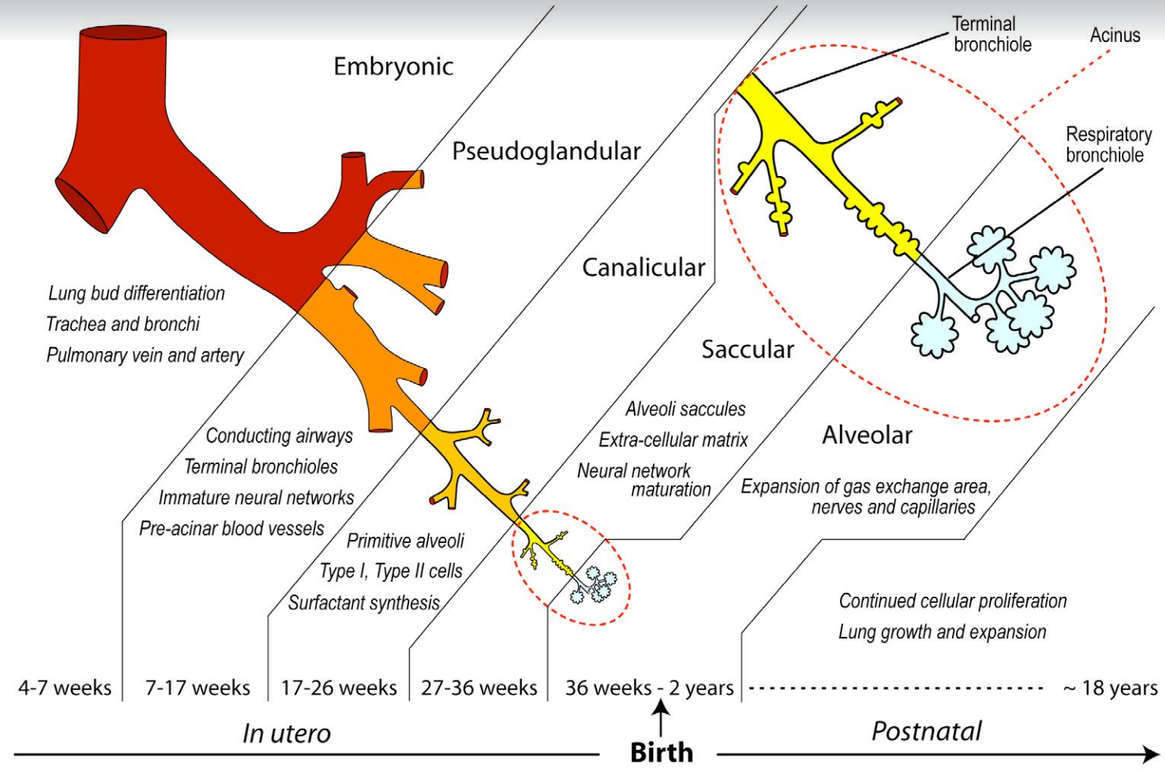
THE LUNG IS SUSCEPTIBLE TO MANY INFLUENCES DURING EARLY DEVELOPMENT.

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.



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.

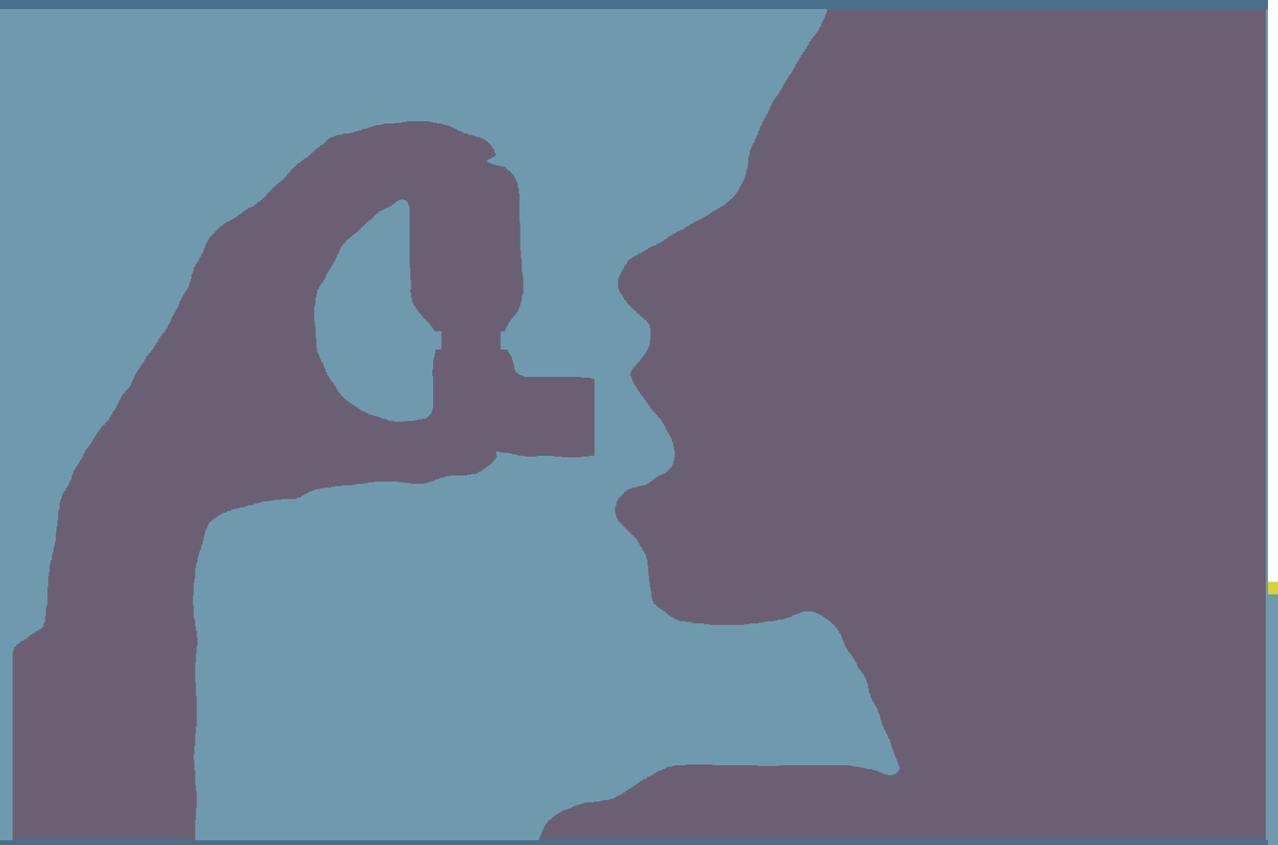
More Information: "Cellular, structural, and functional impacts on lung development of xenobiotics"

ASTHMA and Lung Development

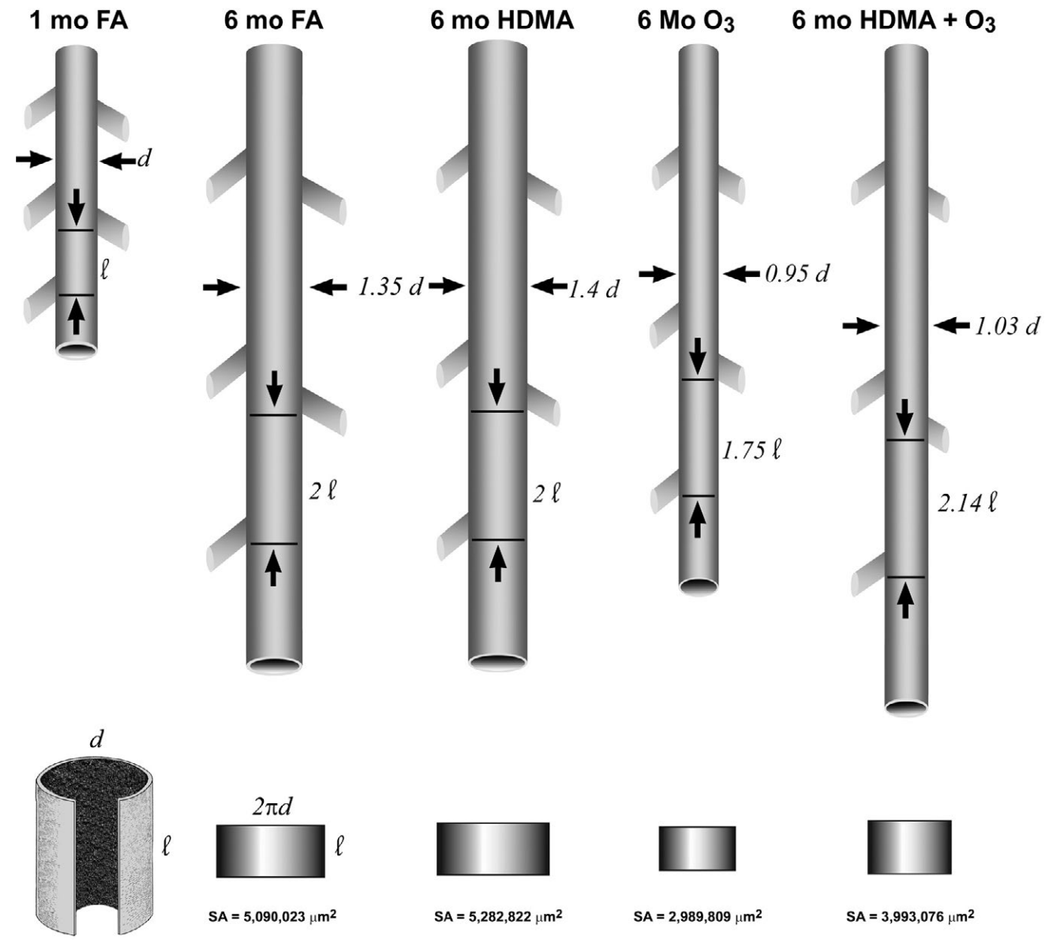
THE LUNG IS SUSCEPTIBLE TO MANY INFLUENCES DURING EARLY DEVELOPMENT.

Environmental exposures during susceptible developmental periods may produce lifelong structural and functional alterations. Monkeys exposed to ozone and house dust mite postnatally develop longer, narrower, and fewer branches of bronchioles along with other changes consistent with increased risk for asthma development.

Click here for more details.



Environmental exposures at critical developmental periods may permanently alter structure of airways



Diagrammatic comparison of differences in the size of one generation of distal bronchiole in the left cranial lobe of infant rhesus monkeys (180 days of age) following 11 cycles of exposure to filtered air (FA), house dust mite allergen (HDMA), ozone (O3) or both (HDMA+O3).

Reference: Plopper CG, Smiley-Jewell SM, Miller LA, Fanucchi MV, Evans MJ, Buckpitt AR, et al., 2007. Asthma/allergic airways disease: does postnatal exposure to environmental toxicants promote airway pathobiology? (link) Graphic used with permission.

ASTHMA: Still a Major Health Problem

When Brett gets an attack, he has a difficult time breathing and sometimes feels as if he is going to pass out.

He is careful to carry an inhaler with him at all times. Lots of kids have them, there are different types of inhalers that can be used to prevent or treat an asthma attack. The number of children with asthma continues to be substantial.

The proportion of children ages 0 to 17 years reported to currently have asthma increased from 8.7% in 2001 to 9.4% in 2010, and then decreased to 7.0% in 2019. In 2016–2019, 7.8% of all children ages 0 to 17 years were reported to currently have asthma.

According to the CDC, 1 in 12 children has asthma.

Asthma costs about $50 billion each year in healthcare costs. (CDC Fastfacts)

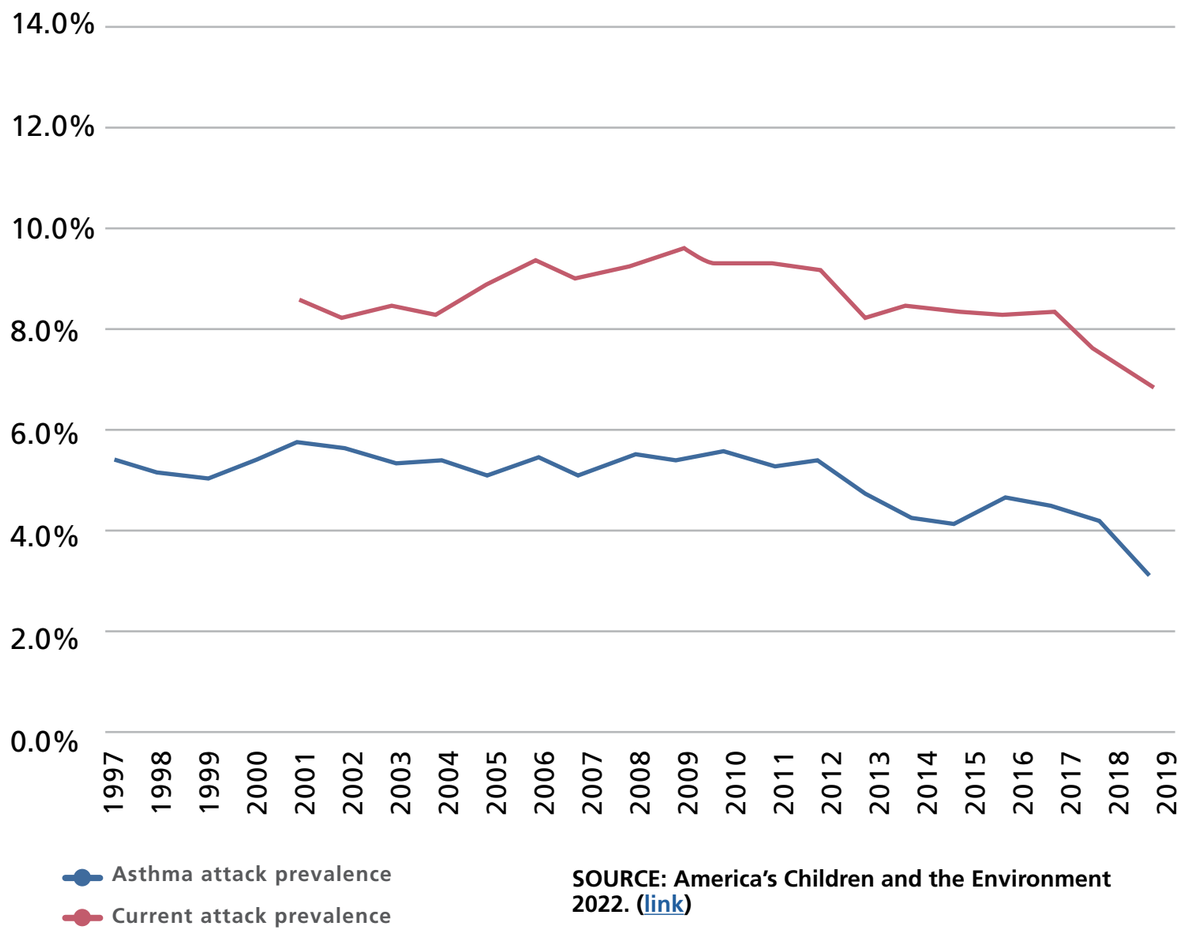
(CDC and America's Children and the Environment 2022.)

More information:

CDC FastFacts

Americas Children and the Environment

Percentage of children ages 0-17 years with asthma, 1997-2019



SOURCE: America's Children and the Environment 2022. (link)

ASTHMA: Racial and Socioeconomic Disparities

Many of Brett's friends who live in the city also have asthma.

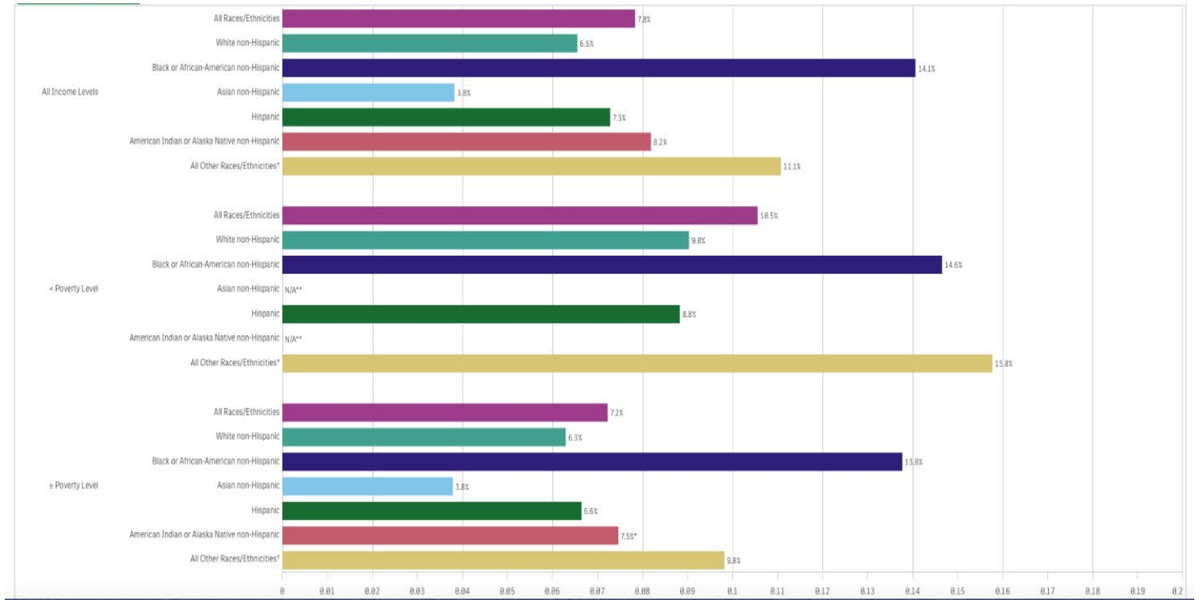
From 2016-2019, 7.8% of all children at all income levels were reported to currently have asthma. Among those living below the poverty level, this rose to 10.5%.

Differences by race/ethnicity are also significant in children even at all income levels. For example, 14.1% of black or African American, non-Hispanic children were reported to have asthma while that rose to 14.6% below the poverty level. And, among Hispanic children, 13.6% of Puerto Rican children were reported to currently have asthma.

Disparities may be explained by higher exposures to risk factors for asthma and lack of comprehensive asthma management, among other things.

Source: America's Children and the Environment: Respiratory Diseases

Percentage of children ages 0-17 years reported to have current asthma by race/ethnicity and family income, 2016-2019



SOURCE: America's Children and the Environment 2022. (link)

Graphic reproduced with permission.

enlarge image

ASTHMA: Family and Community Stressors

“Hi Mom,” says Brett. Brett’s mother, Karen, comes over and gives him a hug.

Although Karen doesn‘t make a lot of money, they have a stable home life now, but it wasn’t that way when Brett was younger.

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.

Karen's pediatrician suggested she might want to consult with Brett's school counselor to help Brett through this difficult period.

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.)

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

ASTHMA: Family and Community Stressors

Because of all the prior family problems, Karen pays a lot of attention to Brett and tries to show him how much she loves him in a lot of ways, including making sure they eat dinner together every night.

They have formed a close bond and Karen is happy about that, although like many boys his age Brett usually acts like he doesn't know her when they are in public.

Key Concept: Windows of Vulnerability and Opportunity

Example: Stress and Asthma Development of Lung Function is Affected by the Home Environment

Watch: Dr. Mark Miller discusses early origins of adult disease.

Mark Miller MD MPH, Director Emeritus, Western States Pediatric Environmental Health Specialty Unit at UCSF;

Director, Children's Environmental Health Center, Office of Environmental Health Hazard Assessment, California EPA

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 Ambient 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

Link to EPA's Near Roadway Exposure Resources

Ozone and Particles Make Asthma Worse:

- More symptoms
- More medications used
- More respiratory illnesses
- More clinic visits
- More emergency room visits
- More hospitalizations

(Sarnat JA, Holquin F. Asthma and air quality Curr Opin Pulm Med. 2007; 13: 63-6.)

Map graphic used with permission.

Tracking California, Public Health Institute. Asthma Related Emergency Department & Hospitalization data

Office of Environmental Health Hazard Assessment. CalEnviroScreen 4.0 Diesel Particulate Matter

ASTHMA and Indoor Air Pollution

Though Brett does a good job being active in his sports, he still spends a lot of time indoors, both at home and at school. This means that minimizing pollutants inside his home and school can be really important in improving his asthma control.

Ways to decrease air pollutants indoors:

- using ventilation every time you cook
- using filters rated MERV-13 or higher in heating/air conditioning systems
- using portable HEPA filters (mechanical, not electronic), as electronic ones can actually produce pollutants
- minimizing the use of anything that burns indoors (fireplaces, candles, incense, smoking, etc.)
- changing gas to electric (cleaner) appliances when possible
- using unscented and low-VOC products (e.g. paints, cleaning supplies).

Cooking-related pollution and asthma

Resources:

Safer cleaning and disinfection supplies can be found using the EPA's Safer Choice program.

Good information from the EPA on indoor air in schools.

Watch: Clean Air While You Cook:

This video from the Western States PEHSU discusses the importance of decreasing air pollution from cooking and strategies for doing so. (4 min)

ASTHMA and Air Pollution Effect Modifiers

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

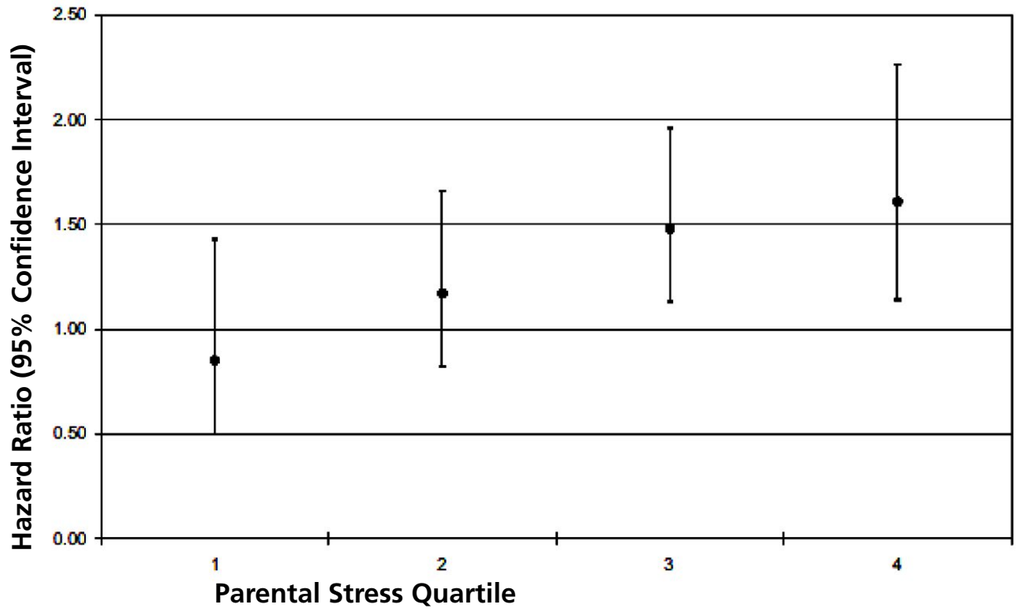
Slides reference: Green et al., EHP 2004

Example: Asthma and Poverty Rates in Fresno County, CA

Source: CalEnviroScreen 4.0

Link: National Environmental Health Tracking Program

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 development of asthma.

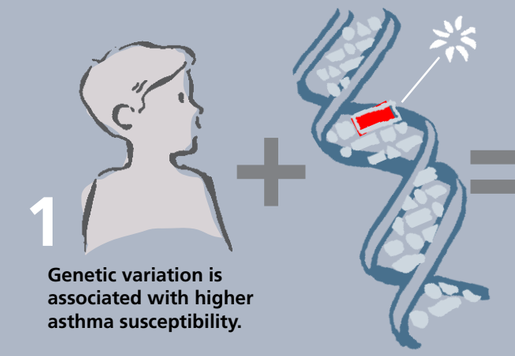
Key Concept: Inflammation and Oxidative Stress

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.

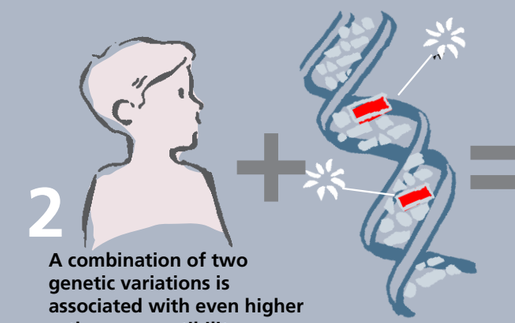
Salam et al., Thorax 2007; 62:1050-1057

Genetics Increase Susceptibility to Air Pollution



1) Variation in one gene, epoxide hydrolase (EPHX1) is associated with 50% increase in asthma risk.

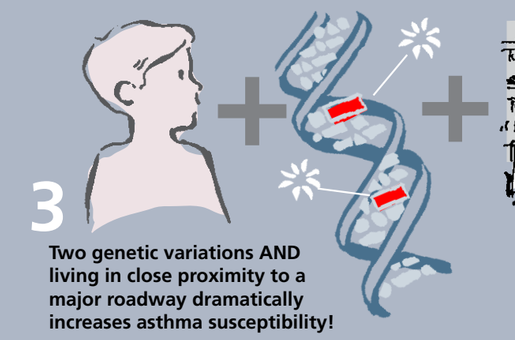
increases by half



2) The combination of having two high risk variants, EPHX1 and Glutathione S Transferase P1 (GST Val\Val) results in a four-fold increase in risk.

increases 4-fold

3) For children with both high risk variants (EPHX1 and GST Val\Val) who live close to a major roadway, the risk is increased nine-fold.



increases 9-fold

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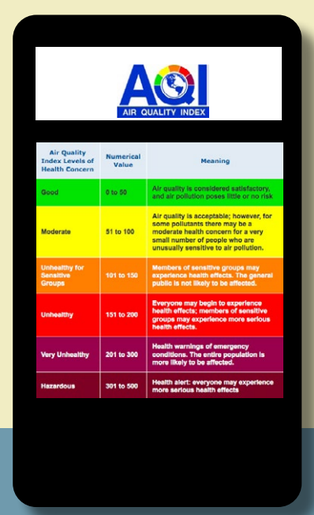
ASTHMA and Climate Change

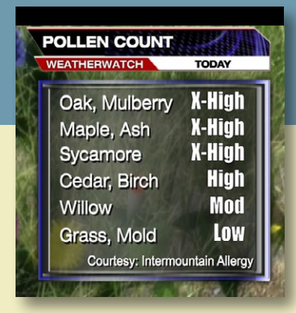
Brett's generation has heard a lot about climate change. Climate change is expected to increase ground level ozone through increases in temperature and wind patterns, smoke from more frequent forest fires, airborne particles from more frequent and intense dust storms, and dampness/mold resulting from more frequent severe weather and flooding events. As CO2 levels rise and temperatures increase, airborne pollen levels are also increasing.

The combination of higher levels of asthma-related air pollutants associated with changes in atmospheric conditions are expected to continue to increase the frequency of asthma attacks in people with asthma, and may also increase the prevalence of asthma in populations.

Watch: In this short video Dr. John Balmes clearly outlines how climate changes will increase the incidence of asthma. (2 min.)

It is easy to check the air quality in your area on the weather channel on television, in the newspaper, on the internet, or via your smartphone. The EPA's Air Quality Index is a good resource.





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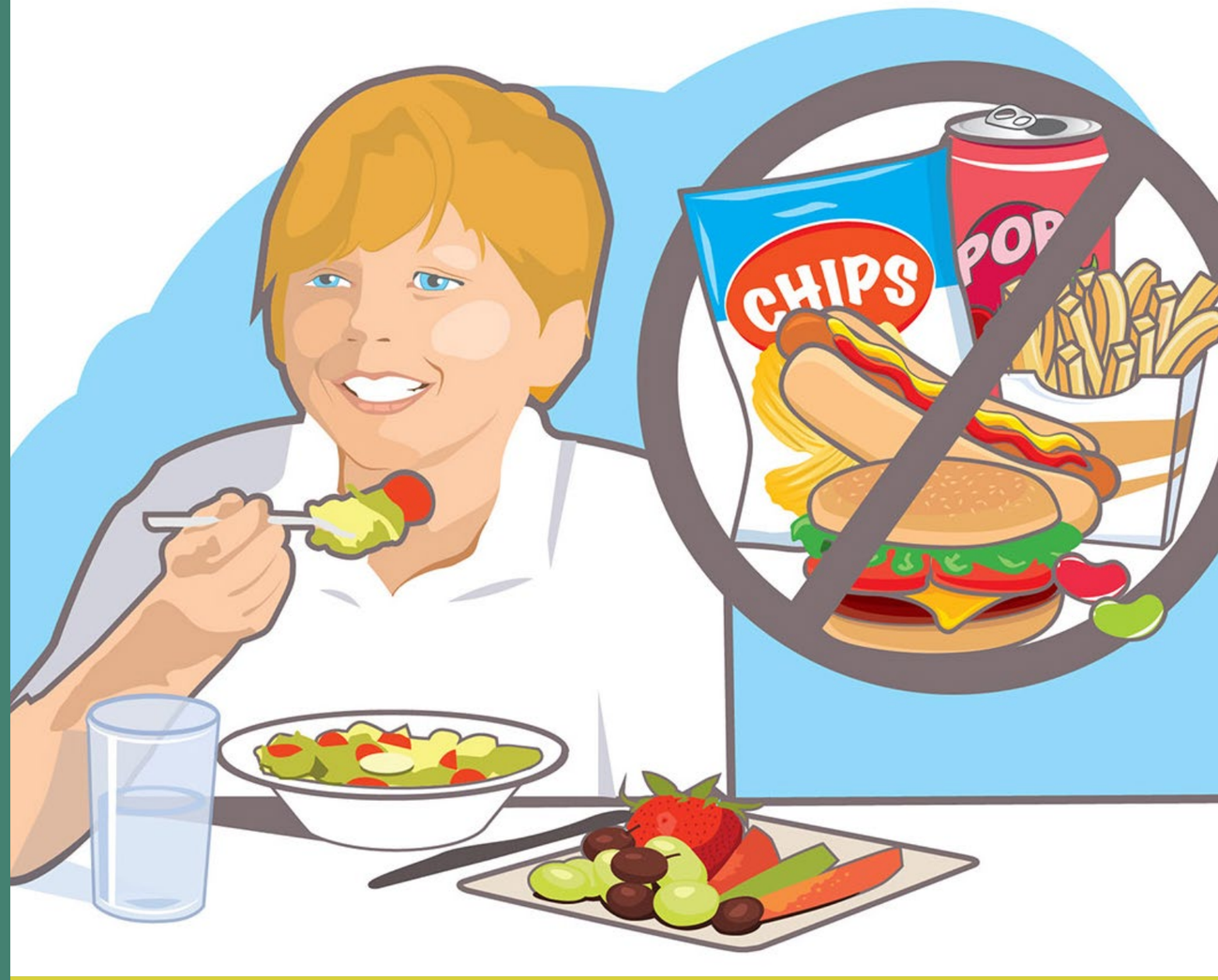
Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.

AQI AIR QUALITY INDEX

*pollutants measured: PM 2.5, ozone

ASTHMA: Healthy Eating Habits



At the family reunion it is time to eat. Brett grabs a sandwich off the buffet table. Karen is glad that Brett has chosen a sandwich on healthier whole wheat bread, rather than processed white bread.

Because of his asthma, Karen wants Brett to stay as healthy as possible, and also not to become overweight as it could worsen his asthma. (Obesity can also increase risk of developing asthma.)

His pediatrician regularly emphasizes the importance of eating nutritious foods high in antioxidants such as colorful fruits and vegetables, and other healthy foods including fish that have omega-3 fatty acids.

He has also measured Brett's vitamin D status and recommended a supplement because, like many children, Brett's levels were suboptimal and supplementation may help reduce asthma exacerbations.

(Riverin et al., 2015; Hollams et al., 2017)

ASTHMA

Hey, there comes Max, his cousin's dog, running right at him!

"Hey Max," Brett says as he pets him and holds him close, forgetting for a minute that dogs can also cause him to have an asthma attack, something about their hair. (Hastert et al., 2007, Popplewell et al., 2000)

Brett doesn't care, Max is so friendly.

But Brett never goes into his grandmother's house. She has cats and they make his asthma really bad.

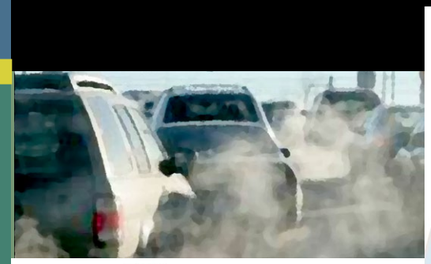
ASTHMA: Brett's Story

We have seen throughout the pages of Brett's story that a wide range of factors, and their interactions across his lifespan, are risk factors for both the onset of asthma, as well as triggering it. These include environmental chemicals and other contaminants, family and community social stressors, diet and nutrition, economics, and how these might interact with each other and with genetics.

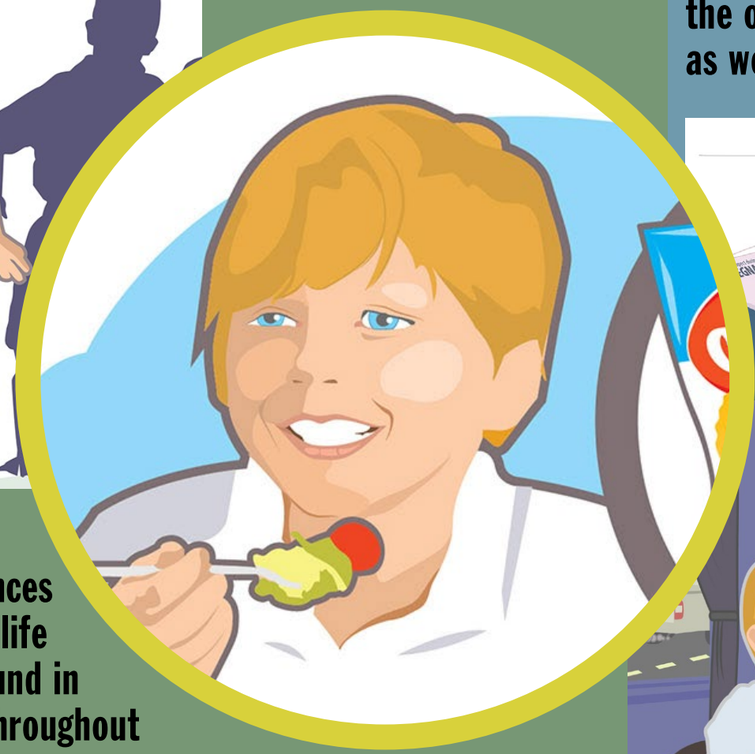
Although Brett's story is fictional, and it is difficult to determine what risk factors might be most important to him, the circumstances of his life can be found in children throughout our country.

It is therefore critical that we consider multiple environmental influences on asthma when we design prevention strategies and treatment.

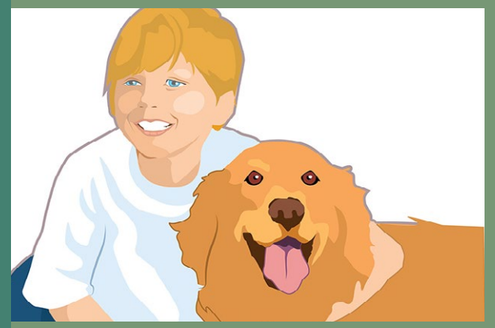
Continue on to the next page to learn more about preventive strategies.



A wide range of factors, and their interactions across Brett's lifespan, are risk factors for both the onset of asthma, as well as triggering it.



The circumstances of Brett's life can be found in children throughout our country



It is critical that we consider multiple environmental influences on asthma when we design prevention strategies and treatment.

ASTHMA: Management and Prevention Strategies

Children with asthma should:

- Live in homes where ventilation is *always* used during cooking. And if possible gas stoves should be replaced with electric.
- Use MERV-13 filters in their home HVAC and/or mechanical portable air cleaners (*not* electronic ones),
- Have an asthma action plan, which includes plans for wildfire smoke events. Including AQI on the asthma action plan improved asthma control test scores!
- Not be exposed to secondhand smoke (SHS) and other types of combustion smoke,
- Exercise outdoors frequently (but not exercise outdoors on bad air quality days), and,
- Avoid allergens to which they are sensitized.

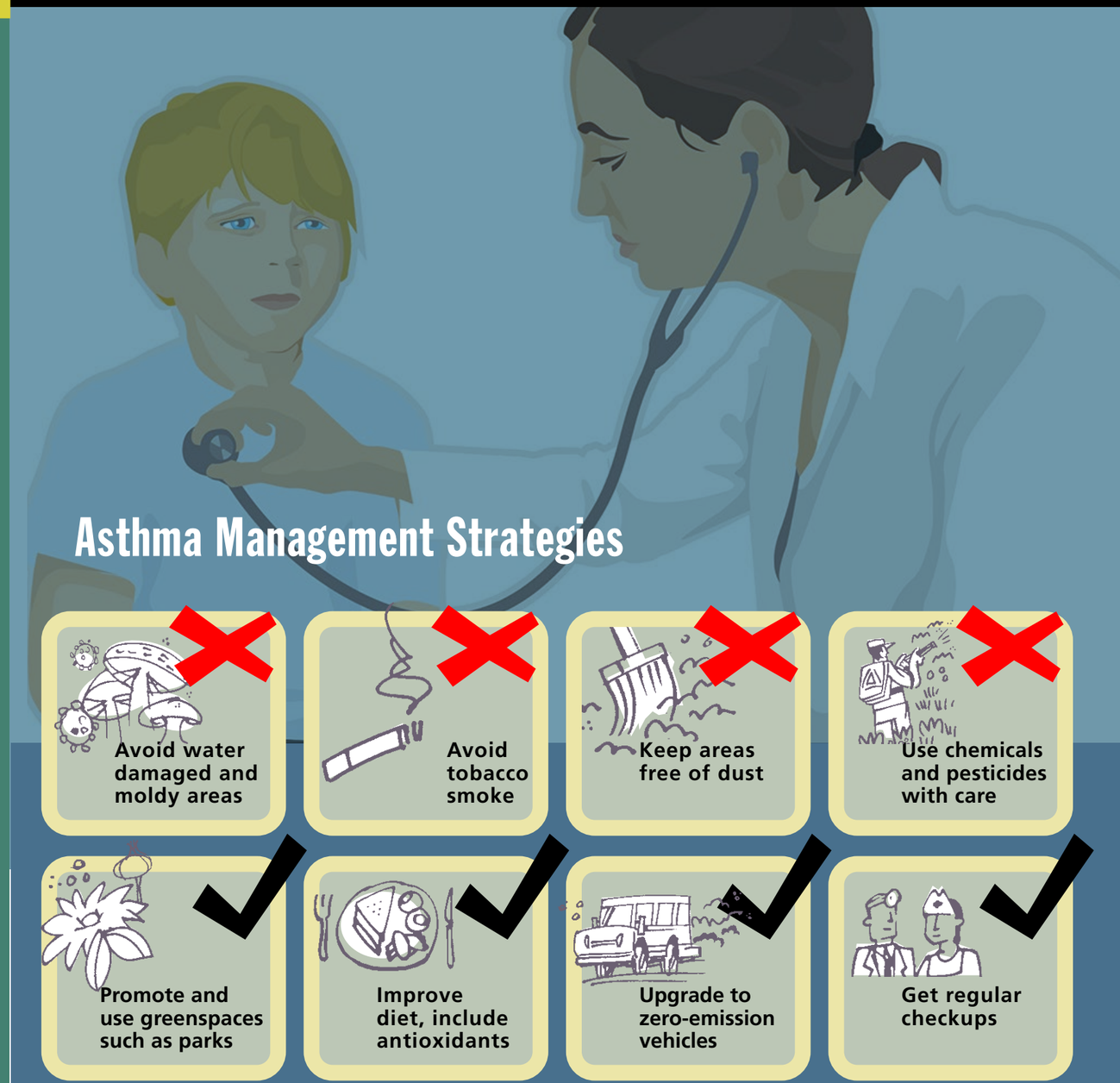
Other protective factors include the following, if possible:

- 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 gas or diesel motor vehicles with zero-emission 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: Policy Initiatives to Protect Health

Policy initiatives to protect health include:

- Increased green space,
- Zero-emission vehicles,
- Improved forest management to decrease catastrophic wildfires,
- Improved city and highway planning,
- Improved public transportation, bicycle friendly streets, accessible sidewalks,
- Changes in zoning laws, where appropriate, to allow mixed use neighborhoods resulting in less driving,
- Healthy building practices for schools and public buildings, including improved ventilation, reducing use of toxic chemicals in building materials and maintenance, incentives for green buildings,
- Increased use of renewable and less polluting energy, e.g. solar,
- Chemical policy reform,
- Smoking ordinances,
- Asthma home visiting programs for asthma education on trigger control and disease management,
- School sitings should be >500 meters from highways, and,
- Regulations to limit wood burning and outdoor wood boilers.

Watch: Public polices can help improve health. Dr. John Balmes offers specific recommendations to reduce air pollution. (7 min.)

More on policies to prevent asthma:

CDC Asthma

EPA Indoor Air Pollution

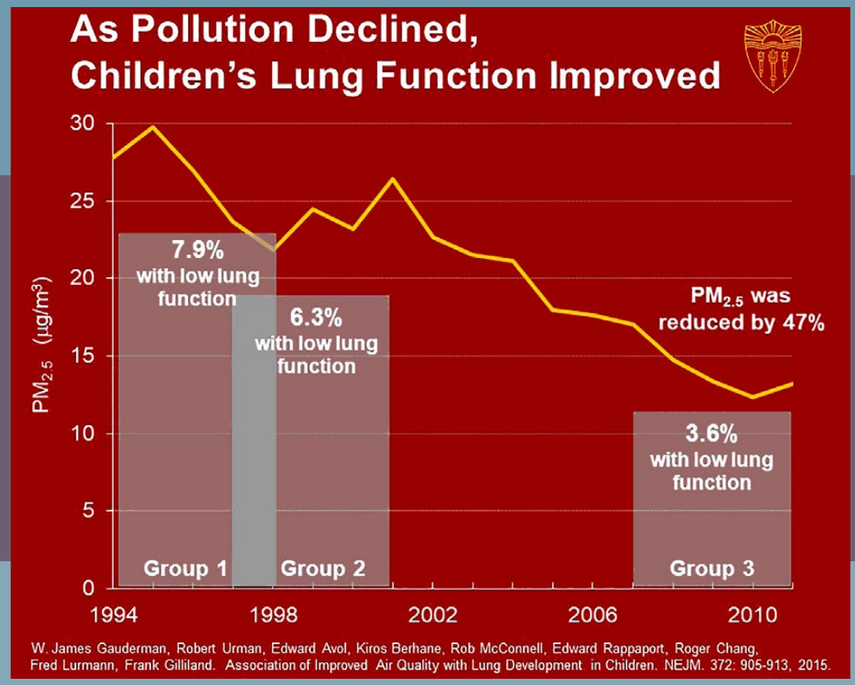
Asthma Community Network

EPA's new diesel school bus program

Policy Initiatives for Cleaner Air in California

California has instituted a number of policy initiatives to improve air quality which other states and communities could replicate.

- Replacing diesel vehicles with zero-emission
- Decreasing diesel emissions in surface goods movement efforts (ports and rail yards)
- No-burn rules to limit wood smoke emissions
- Housing near public transit ("smart growth") to limit emissions
- By 2035, all new cars will be zero-emission
- By 2045, most new trucks will be zero-emission



Slide 1: $PM_{2.5}$ reduction

Slide 2: NO_2 reduction

As air pollution from ozone and particulates (PM 10) have gone down in the California South Coast air basin, children's lung function has improved.

Graphics used with permission.

Gauderman WJ, et al. Association of Improved Air Quality with Lung Development in Children. N Engl J Med 2015; 372:905-913

Prospective cohort studies of children from 11 to 15 years of age were conducted in five communities in the Los Angeles basin during three distinct time periods from 1994 through 2011. The authors found an improvement in lung-function development in adolescence that occurred in concert with improvements in air quality. **Overall NO2 and particulate matter levels (markers of ambient air pollution) declined dramatically during these years**.

These long-term improvements in air quality were associated with statistically and clinically significant positive effects on lung-function growth in children. The number of children with less than 80% of predicted lung function decreased by half from the early to later years. This demonstrates the real world benefits of public policy to reduce exposure to air pollutants..

Graphics: Wendy Gutschow, USC, used with permission.

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Note: there are many topic overlaps

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General Resources

EPA: Science Notebook on Asthma

CDC: Asthma

CDC: Triggers

CDC: Workplace Asthma

ATSDR's CASE study "Environmental Triggers of Asthma"

List of asthmagens from Association of Occupational and Environmental Clinics

Association of Occupational and Environmental Clinics Exposure Code Lookup

Collaborative on Health and the Environment (CHE): Toxicant Database

ALA's "State of the Air" search page

(most relevant for CE course):

EPA/NIEHS Children's Centers 2012 Webinar Series
In particular:

- Embracing Complexity: Animal Models of Environmental Exposure Health Effects - *Richard Auten, Duke University*
- Effects of Prenatal Environmental Exposures on Child Health and Development *-Frederica Perera, Columbia University*

CalEnviroScreen, Office of Environmental Health Hazard Assessment, California EPA

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U.S. EPA. America's children and the environment

Asthma Management, Treatment

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CDC: Health Care Resources

National Environmental Education Foundation: Pediatric Environmental History forms

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EPA's Asthma Home Environment Checklist

EPA Air Quality Index

SOME FINAL THOUGHTS

COMMON THEMES

Although the fictional narratives in *A Story of Health* describe the lives of children and adults with different conditions and diseases – infertility, asthma, developmental disabilities, childhood cancer and cognitive decline - 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.
- Healthy people and healthy communities are interdependent. All people do not have equal access to nutritious food, clean air and water, safe workplaces, healthy housing, green spaces, peaceful neighborhoods or quality health care.
- Preventing disease and promoting health require actions and commitments from the individual, family, community and society. Health promoting public policies are necessary to make healthy living available to all people.

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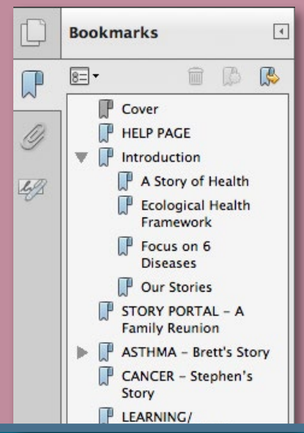
Bookmarks

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

Pediatric Environmental Health Toolkit application for mobile devices

The Toolkit is an easy-to-use reference guide for health providers on preventing exposures to toxic chemicals and other substances that affect infant and child health. The new mobile device-ready online version of the PEHT includes links to many related online resources.

Continuing Education

Use the link at left to register for FREE Continuing Education (CE) 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.