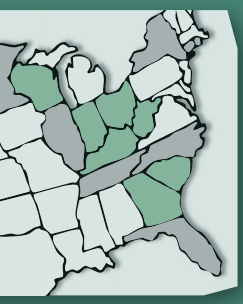
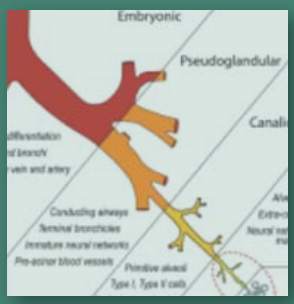
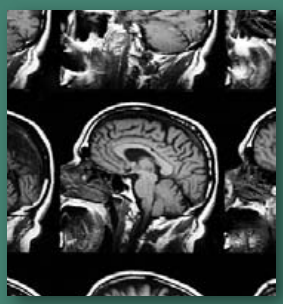
A Story of Health







ACKNOWLEDGEMENTS

Primary Development Organizations

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For more information:
Brian Tencza: bht1@cdc.gov
Maria Valenti: mvalenti@igc.org

Primary Authors/Development Team

Mark Miller MD MPH, Director, UCSF Pediatric Environmental Health Specialty Unit

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

Ted Schettler MD MPH, Science Director, Science and Environmental Health Network

Science Director, Collaborative on Health and the Environment

Brian Tencza MEd, Team Lead Education Services, Agency for Toxic Substances and Disease Registry (ATSDR)

Maria Valenti, National Coordinator, Healthy Aging and the Environment Initiative, Collaborative on Health and the Environment

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Dedication:

This eBook is dedicated to our designer Stephen Burdick for his extraordinary talent and vision.
- The authors.

CONTRIBUTING AUTHORS

Christine Zachek, Victoria Leonard, UCSF Pediatric Environmental Health Specialty Unit

ART TEAM

Illustrations and eBook design, production

Stephen Burdick, Stephen Burdick Design

Illustrations

Dan Higgins, Visual Information Specialist, Centers for Disease Control and Prevention

OTHER CONTRIBUTORS

Agency for Toxic Substances and Disease Registry:

Online course development and video editing: Amanda Cadore

Copyright and Editing: Diana Cronin

Geographic Information Services Team: Charlton Coles; Stephanie Foster; Melissa M. Smith; Shannon Graham, Julia Bryant

University of California, Berkeley:

Berkeley/Stanford Children's Environmental Health Center

Center for Integrative Research for Childhood Leukemia and the Environment >

Educational Technology Services – Jon Schainker and Scott Vento

University of California, Davis:

Brenda M. Giddings, California Cancer Registry, Institute for Population Health Improvement, U.C. Davis Health System

Videos – Speakers:

John Balmes; Patricia Buffler; Gary Dahl; Mark Miller; Catherine Metayer; Lawrence Rosen; Joseph Wiemels; Thomas Whitehead; Rosalind Wright

REVIEWERS

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Introduction and Asthma (Brett's Story): Polly Hoppin; Catherine Karr; Brian Linde; Maria Mirabelli; Madeleine Scammell; Rebecca Wolf

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The UCSF PEHSU

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2. The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the organizations listed (above) as funders.

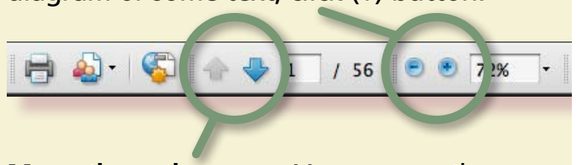
3. The ATSDR, US EPA, and Cal EPA/OEHHA do not endorse the purchase of any commercial products or services mentioned in this publication.

HELP PAGE How to Navigate Our eBook

Adobe Acrobat Tools

This interactive pdf document is best viewed on a laptop or desktop, down-loaded 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.

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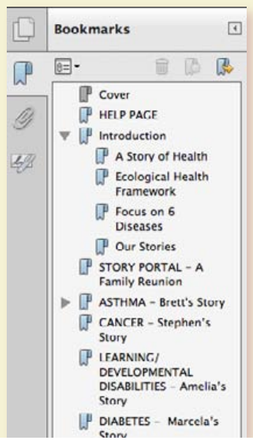


Table of Contents

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.

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, prompt down-loads or navigate to a related page.)

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."

Our eBook Navigation: Click on selections in the bar at the top of each page to move between stories, navigate back to this 'Help Page', and to find out more in the References section.

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

Icons

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

Skip this section - If you wish to skip a technical section, choose the "Skip this section" arrow and you will jump to the page after the technical sections ends.

key concept | **watch a video** | **additional resources, tools** | **technical details for health professionals** | **skip this section** | **definition**

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 the icons (above) 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.

You can skip this section and continue to the Story of Health introduction.

INTRODUCTION

This is a story 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.

Our overall story is told through the personal stories of a number of fictional people of various ages attending a family reunion.

These individual stories 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.

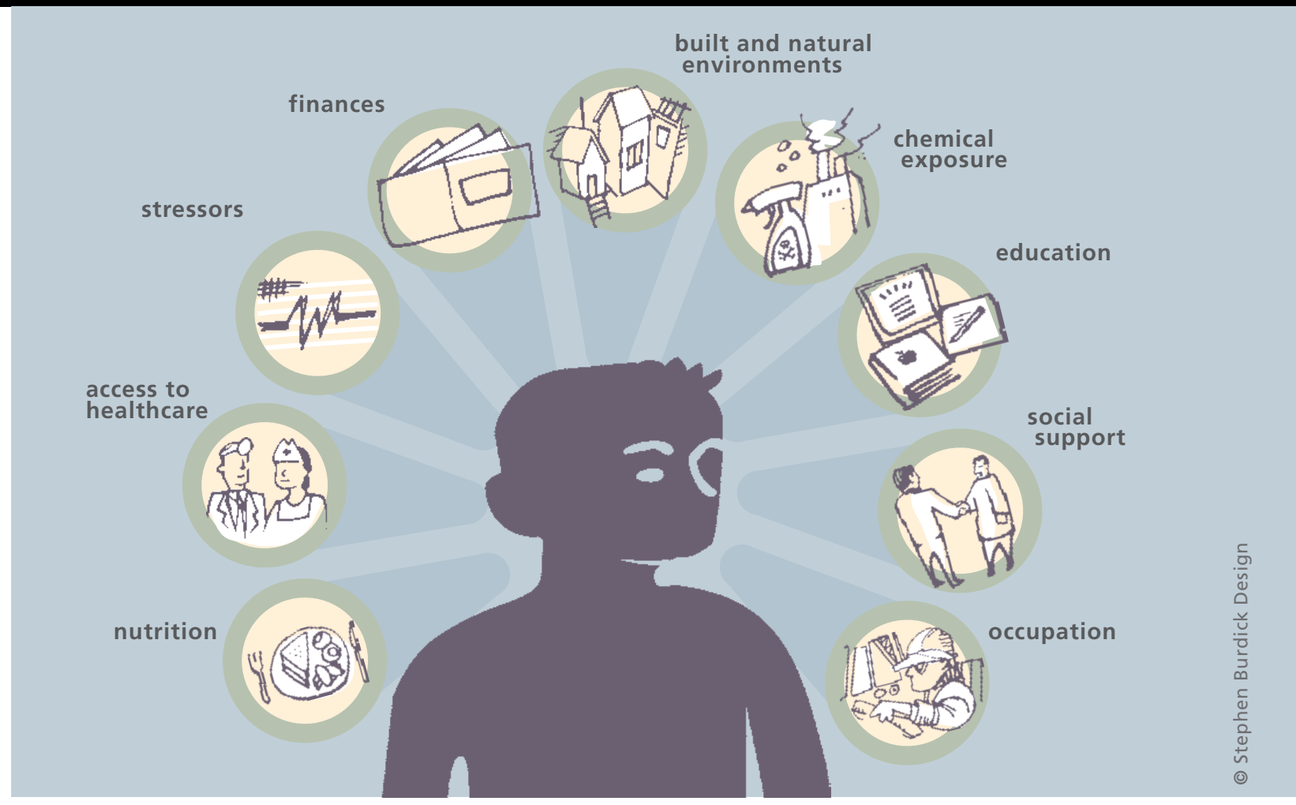
Important determinants of health come from the natural, built, chemical, food, economic, and social environments.

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.

Watch: Pediatrician Larry Rosen addresses the environment and family health. (2 min.)

Lawrence D. Rosen MD is an integrative pediatrician and founder of the Whole Child Center.



Complex interactions occur among many variables and across individual, community, and societal levels. These aspects of our lives are not independent of one and other.

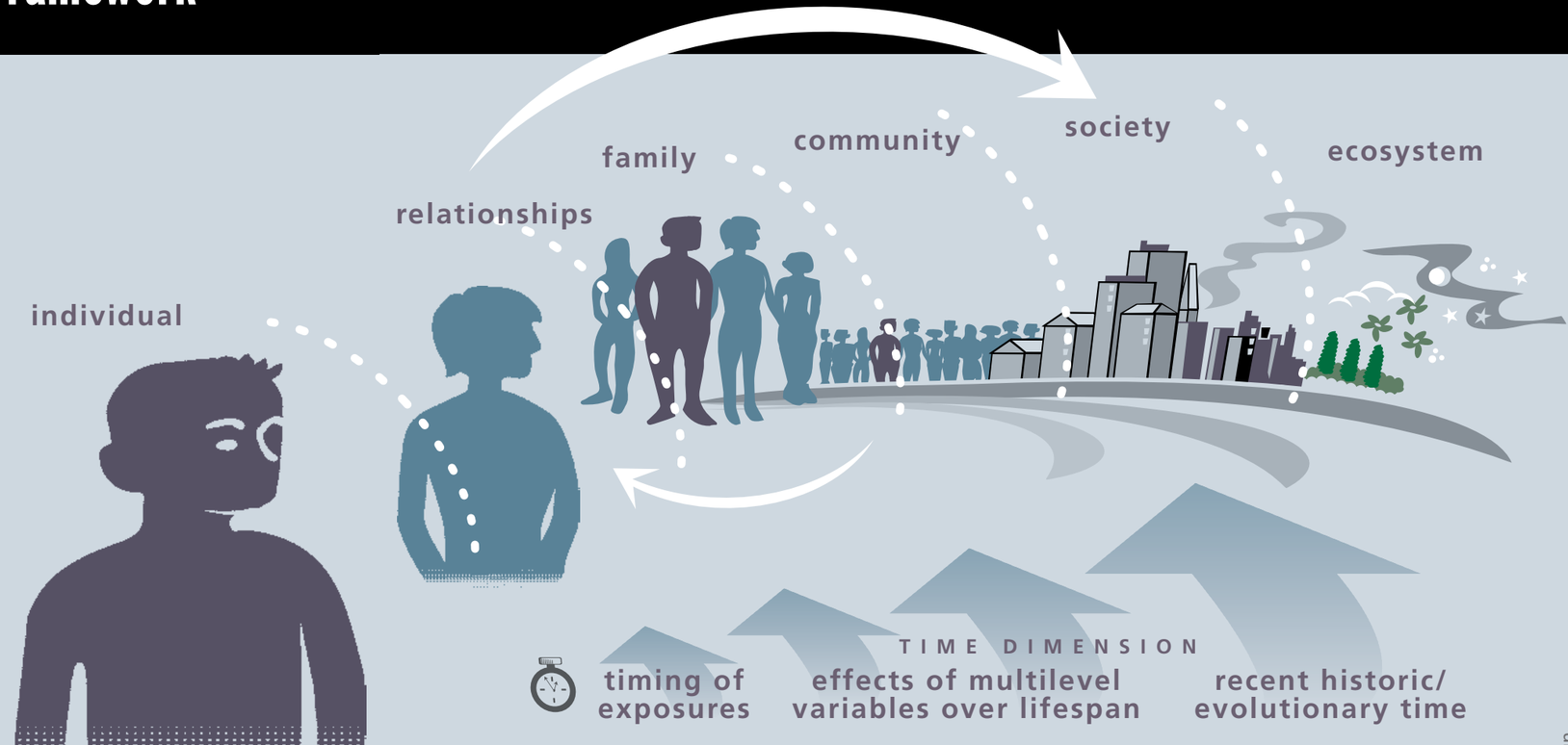
Rarely is one particular thing responsible for health or disease, so we refer to this as a multifactorial (or ecological) approach, the best way to promote health and prevent disease.

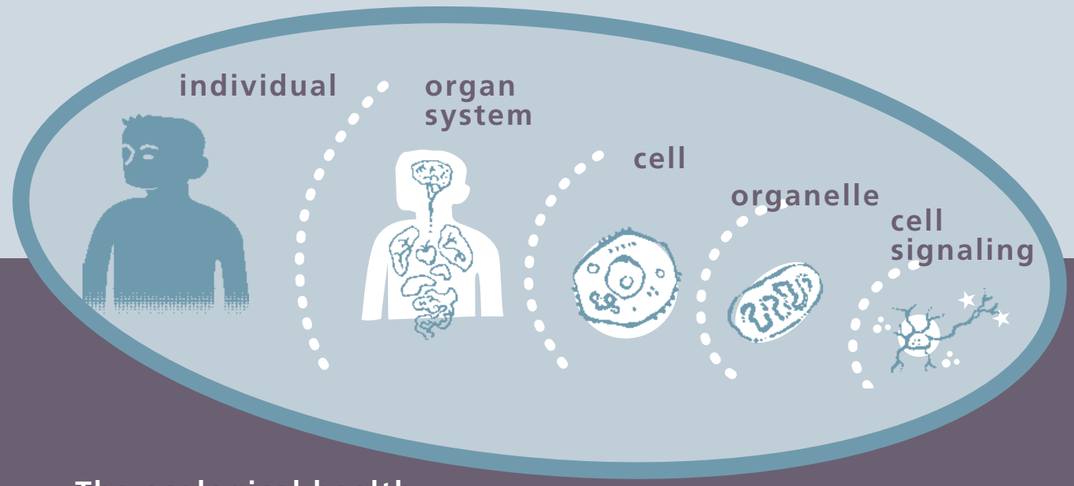
INTRODUCTION Ecological Health Framework

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.

INTRODUCTION Focus on Six Diseases

Following are stories 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 we will explore include some of the most common and troubling diseases and disorders of our time.

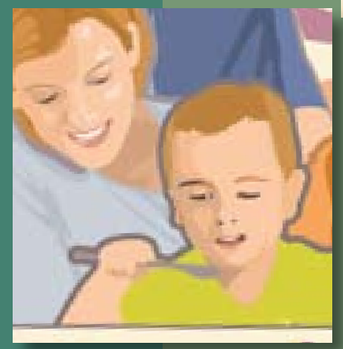
They include:

- Asthma
- Cancer (childhood leukemia)
- Diabetes
- Infertility
- Learning and developmental disabilities
- Cognitive decline

Asthma

Diabetes

Cancer



Cognitive decline

Infertility

Learning and developmental disabilities

INTRODUCTION Our Stories

These stories are not meant to be an exhaustive accounting of every variation of a disease or every possible cause.

Rather, we present current, authoritative scientific evidence to enable you to better understand environmental contributors and make more informed decisions and take action to help improve your health, and the health of your family, friends, community, and patients.

A FAMILY REUNION Six Stories

This page is your portal to six stories of health.

It is recommended that you read through the introduction first and then choose stories in the order you wish.

Health professionals can receive CE credits for completing *A Story of Health*. Click here for more details.

Choose stories in the order you wish. Select a disease term to highlight the affected person. Click the arrow button to read his or her fictional story of health.

Asthma | Cancer | Learning/ Developmental Disabilities | Diabetes | Infertility | Cognitive Decline

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

Each of the fictional stories in *A Story of Health* offers free continuing education (CE). On the "Final Thoughts" page of the last story of the entire eBook, or of each story (if you download them separately), you will be prompted to register for CE through a hyperlink.

This hyperlink links to the CDC/ ATSDR CE page where you can register and take the test for CE credits for each story (credits are offered by story). Before you begin each story, please review the learning objectives at right. These will help you focus as you read each story, and prepare you for each CE test.

Review these learning objectives for each story:

- Brett's Story (Asthma) >
- Stephen's Story (Cancer/Childhood Leukemia) >
- Amelia's Story (Developmental Disabilities) >

FREE CONTINUING EDUCATION

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)

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 .

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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.

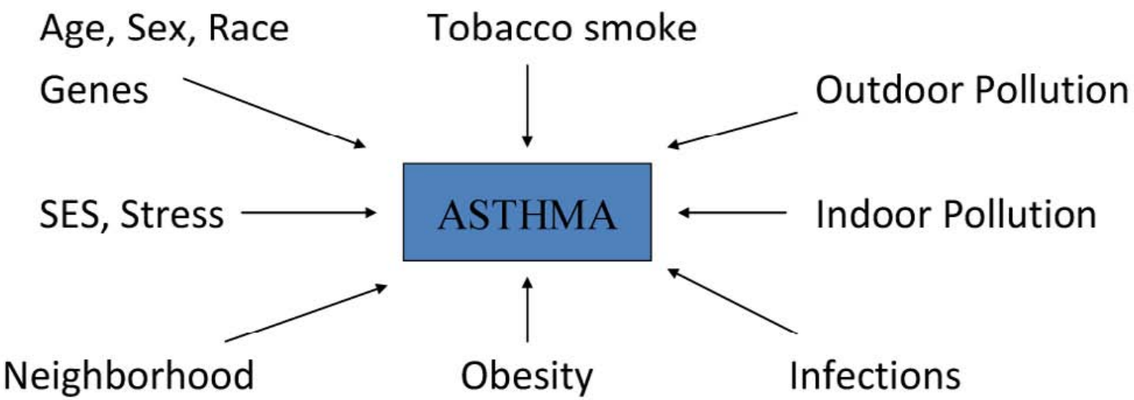
Key Concept: Addressing disease risks in individuals and populations

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

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KEY CONCEPT:

Addressing Disease Risks in Individuals and Populations

Health care practitioners generally provide advice and care to people and their families, based on individual histories and circumstances. Public health practice widens the lens to include the health of groups or populations of people. Public health practices include advocating for and helping to create and maintain the conditions that promote health for entire communities. Public health practitioners have long recognized the benefits—or risks—associated with small shifts in determinants of health within populations.

In 1985, epidemiologist Geoffrey Rose was interested in strategies for disease prevention. He recognized that small downward population-wide shifts in blood pressure where hypertension was common could have large public health benefits. Community-level interventions differed from what individuals could do to accomplish the same goal.

The North Karelia project in Finland put these ideas to work about 25 years after demographer, Vaino Kannisto, published his doctoral thesis pointing out that eastern Finland had the highest heart disease mortality in the world.[i] By this time, the Framingham Heart Study, started in 1948, had begun to identify risk factors that contribute to cardiovascular disease by following its development over a long period of time in a large group of participants. Based on its findings, efforts to reduce smoking, cholesterol, and blood pressure, and to increase physical activity, were undertaken in N. Karelia. These efforts did not focus entirely on educating at-risk individuals in order to change their behavior with respect to physical activity, diet, and smoking, but also included community-level interventions that would help reduce cardiovascular risk factors across the entire population. This involved campaigns and activities in partnerships with the media, supermarkets, food manufacturers, and others, to make healthier choices more readily available to everyone.

The results were dramatic. In 35 years the annual age-adjusted coronary heart disease mortality rate among 35-64 year-old men declined 85 percent. Cancer-related mortality was also reduced, and all-cause mortality reduced for men and women.

One early commentary on the North Karelia project critically called it "shot-gun prevention."[ii] But, it worked. It showed the value of multi-level interventions in a population rather than focusing solely on individuals at highest risk. Data from five different surveys showed that an estimated 20 percent of the coronary heart disease mortality could be prevented by reducing cholesterol levels in the entire population by 10 percent, while a 25 percent cholesterol reduction in only those with the highest levels would reduce morality by only five percent. Lifestyle changes, they concluded, are not just responsibilities of individuals but also of communities.

We often debate which public health interventions should be directed at entire populations or focused more on individuals at risk to address disorders such as cancer, diabetes, cardiovascular disease, obesity, and dementia, among others. But it's undeniably clear that disease prevention and response after diagnosis is not just an individual responsibility. It belongs to the community as well.

[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.

Schettler T. The ecology of breast cancer: The promise of prevention, and the hope for healing. Science and Environmental Health Network and the Collaborative on Health and the Environment. October, 2013.

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KEY CONCEPT:

Causation and Association

Epidemiologic studies identify associations between an exposure and a health outcome of interest. Identifying the risk factors causally related to a disease is a difficult task for researchers. Origins of individual cases of a disease may result from different combinations of risk factors.

Carefully designed studies can help establish cause and effect relationships, but ultimately causation must be inferred from available epidemiologic and laboratory data. Randomized controlled double blind studies (where neither the subjects of the experiment nor the persons administering the experiment know the critical aspects of the experiment), which are often used for evaluating intentional medical interventions, are typically not applicable or possible when studying the origins of environmentally-related diseases. A randomized controlled trial that would expose subjects to hazardous chemicals raises ethical concerns.

Human studies should be supported by strong biologic explanations and/or animal experiments. Still, it is hard to be certain of the causal relationship and its strength, especially when many complicated factors contribute to a particular disease. Associations between exposures and health outcomes are frequently robust enough to support recommendations. In fact, much preventive medicine depends on making those judgments regularly.

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.

Causes vs. Triggers of Asthma

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)

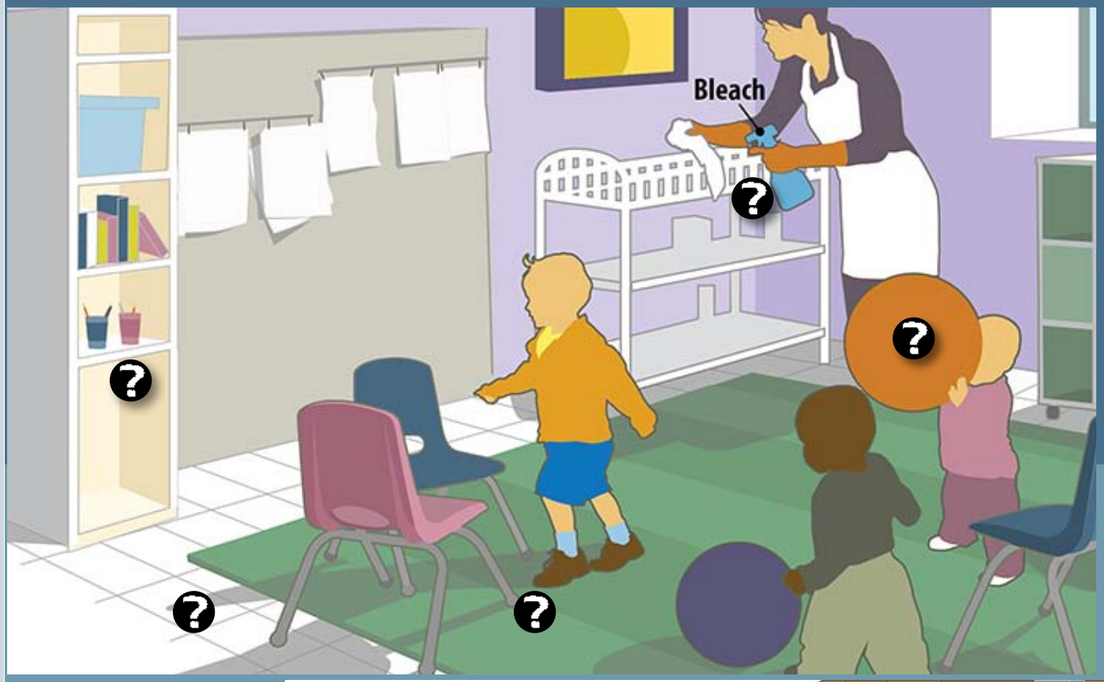
EPA's Asthma Home Environment Checklist

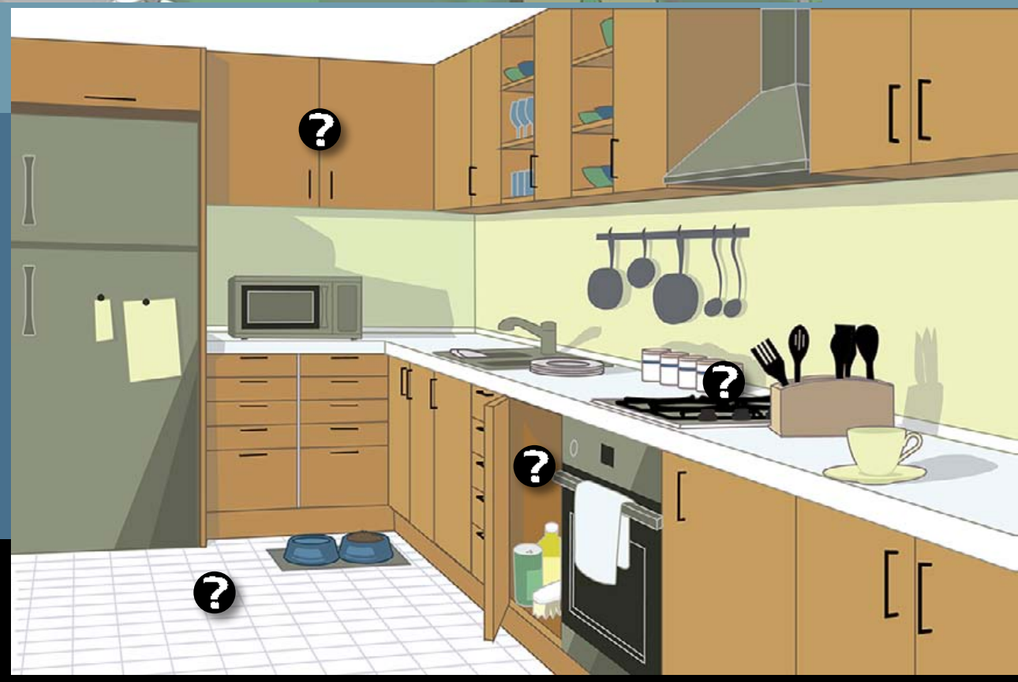
For Clinicians:

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.)





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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

ASTHMAGENS: Risk factors for the development of 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 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, Vice-chair, Clinical and Translational Research, Department of Pediatrics, Icahn School of Medicine at Mount Sinai

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.

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Vitamin D and Asthma

Higher cord blood levels of vitamin D are associated with decreased risk of transient childhood wheezing. Higher vitamin D intake during pregnancy is associated with decreased risk of wheeze in early childhood. Reduced risk of wheezing may be due to reduced frequency of respiratory infections.

The American Congress of Obstetricians and Gynecologists (ACOG) recommends testing pregnant women who are at increased risk of vitamin D deficiency (e.g., women with limited sun exposure, women with darker skin that limits absorption of vitamin D). If a woman's Vitamin D (25-hydroxy-D) level is 20 ng/mL (50 nmol/L) or less, ACOG recommends vitamin D supplementation in a dosage of 1,000 to 2,000 IU daily.

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.

The Centers for Disease Control and Prevention and the American Academy of Pediatrics (AAP) also find that most US infants and children are not consuming enough vitamin D according to 2008 recommendations. The AAP recommends that all infants, whether being breast fed or formula fed, receive a vitamin D supplement.

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.

Other References:

Carmago CA Jr, et al. References. Carmago CA Jr, et al. Randomized Trial of Vitamin D Supplementation and Risk of Acute Respiratory Tract Infection in Mongolia. Pediatrics 2012. doi: 10.1542/peds. 2011-3029.

Camargo CA Jr, Ingham T, Wickens K, Thadhani R, et al. Cord-blood 25-hydroxyvitamin D levels and risk of respiratory infection, wheezing, and asthma. Pediatrics. 2011 Jan;127(1):e180-7. doi: 10.1542/peds.2010-0442. Epub 2010 Dec 27.

Hollams EM.Vitamin D and atopy and asthma phenotypes in children. CurrOpin Allergy Clin-Immunol. 2012 Jun;12(3):228-34.

Zosky GR, Berry LJ, Elliot JG, James AL, Gorman S, Hart PH.Vitamin D deficiency causes deficits in lung function and alters lung structure. Am J RespirCrit Care Med. 2011 May 15;183(10):1336-43. Epub 2011 Feb 4.

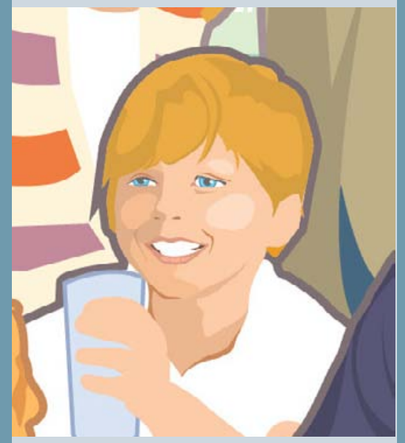
ASTHMA: Triggers

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:

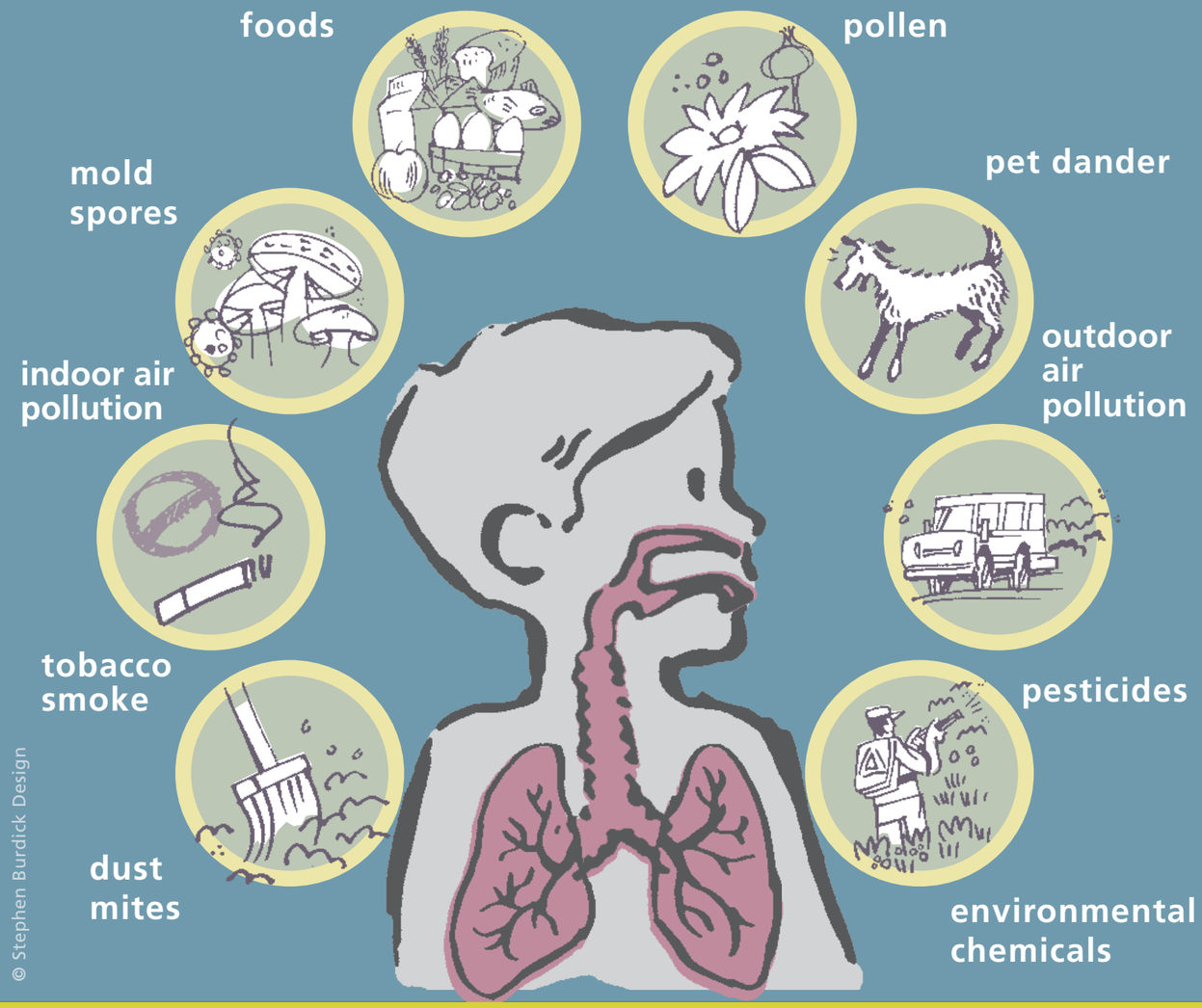
- indoor air pollutants such as tobacco smoke, outdoor air pollution;
- other environmental chemicals including pesticides, and;
- allergens including mold, pollen, cockroach droppings and pet dander.

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.



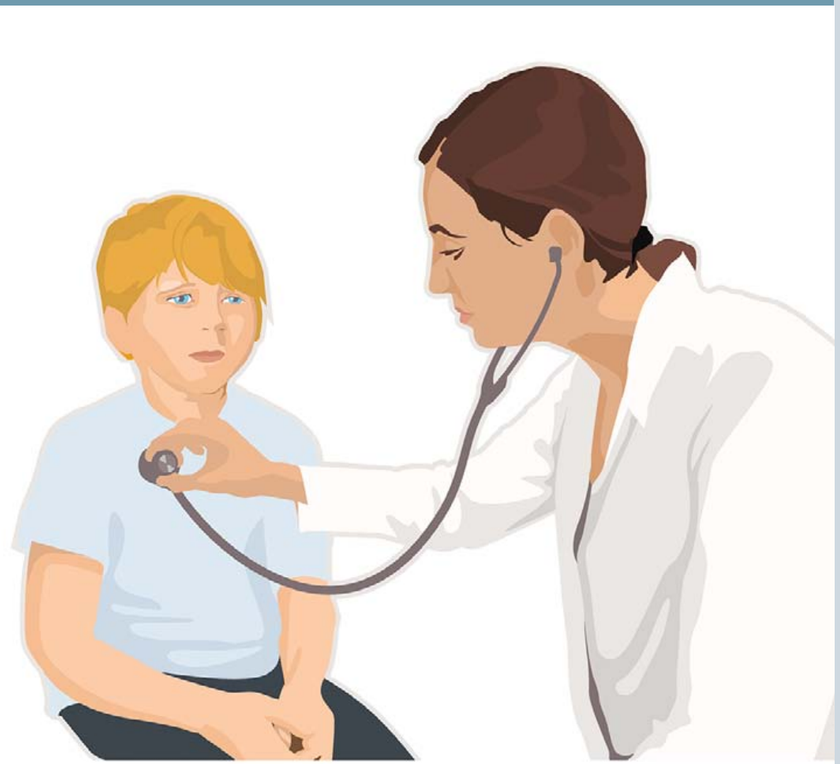
Potential Asthma Triggers

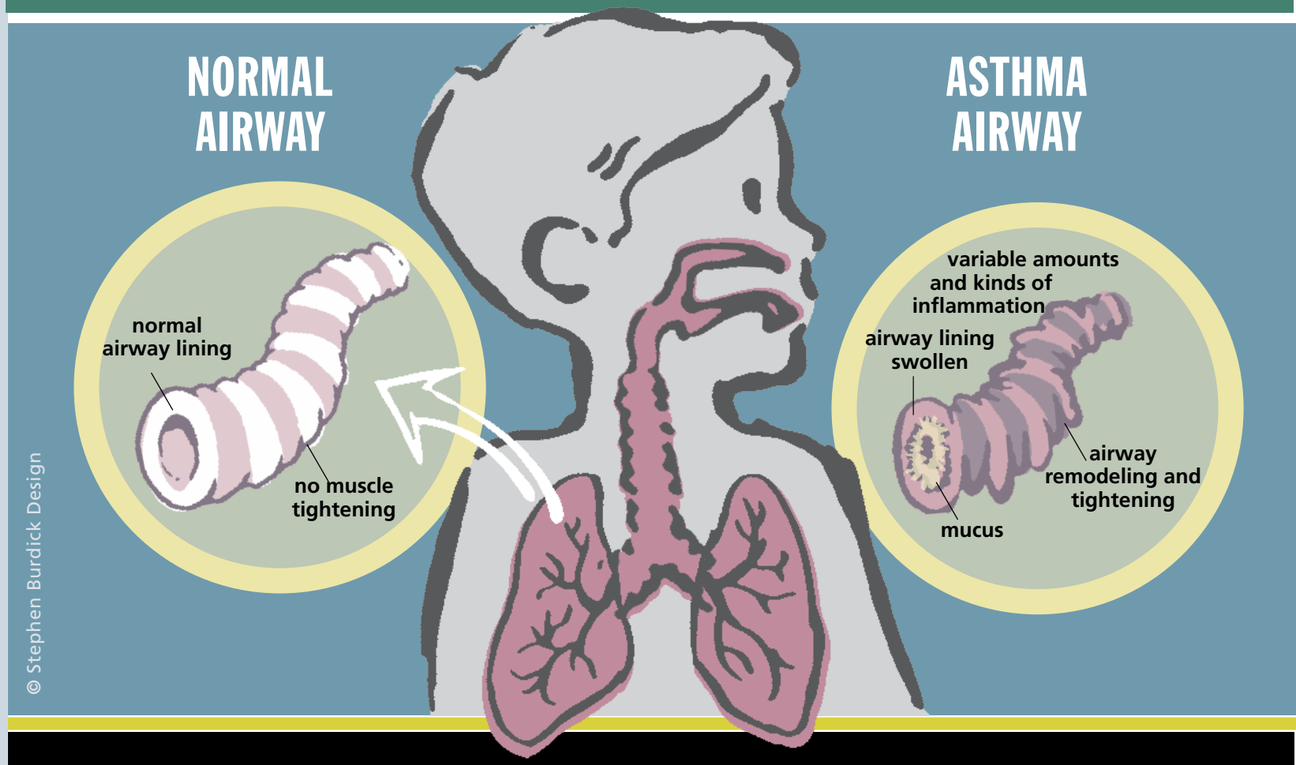


ASTHMA: Effects on the Lungs and Immune System

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.)





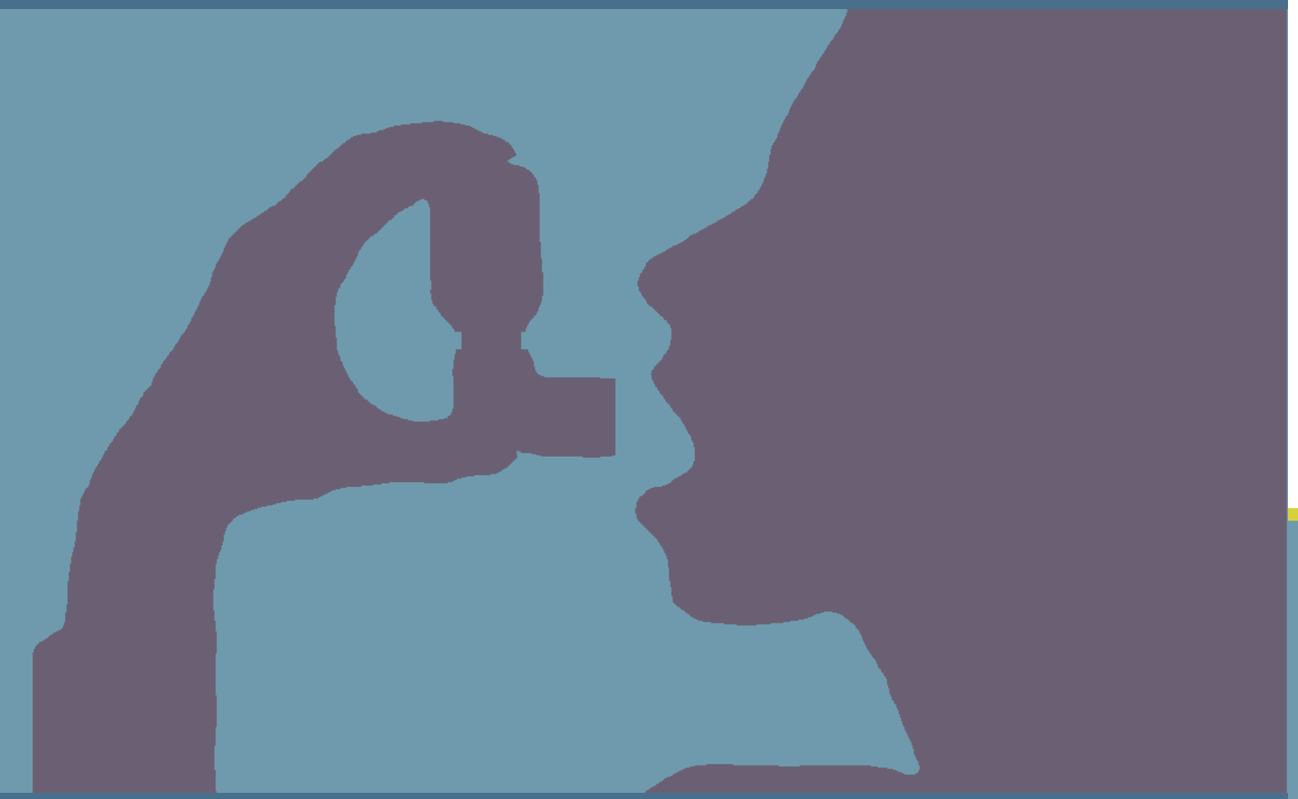
ASTHMA and Lung Development

THE LUNG IS SUSCEPTIBLE TO MANY INFLUENCES DURING EARLY DEVELOPMENT.

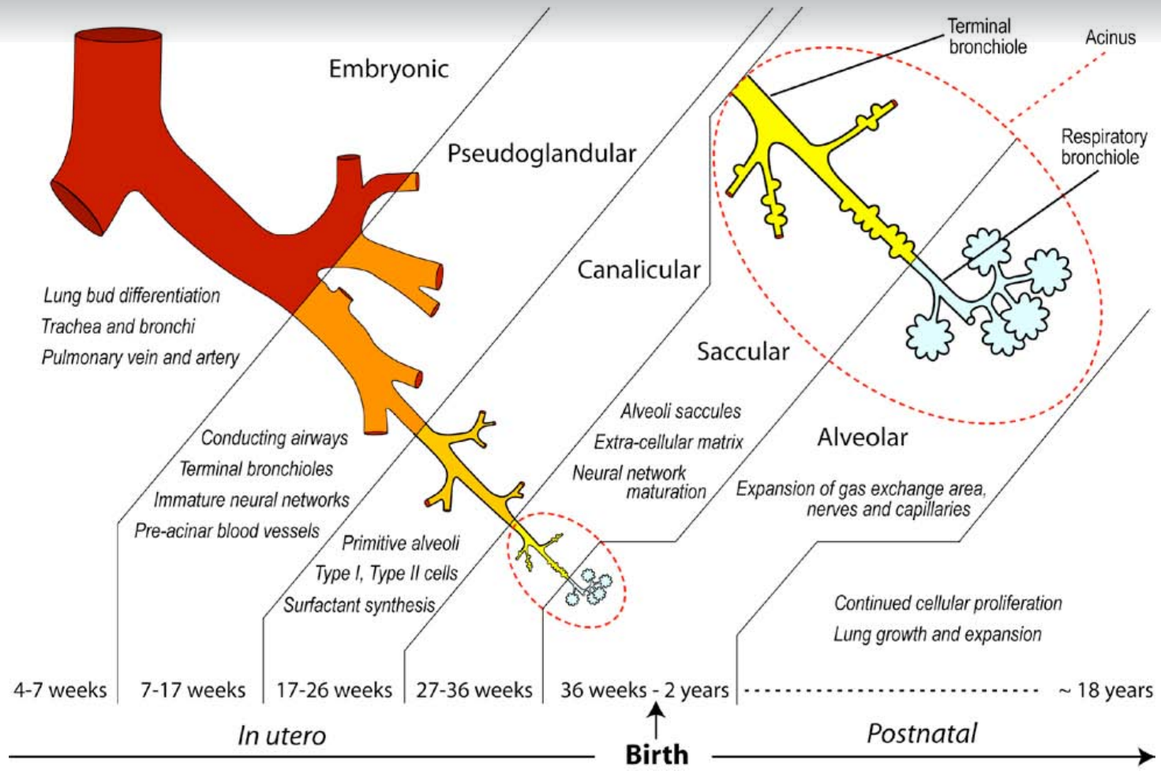
Though the lung develops into a functioning organ during the fetal period, important stages in lung growth and development continue during early childhood and may be altered by environmental exposures.

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.

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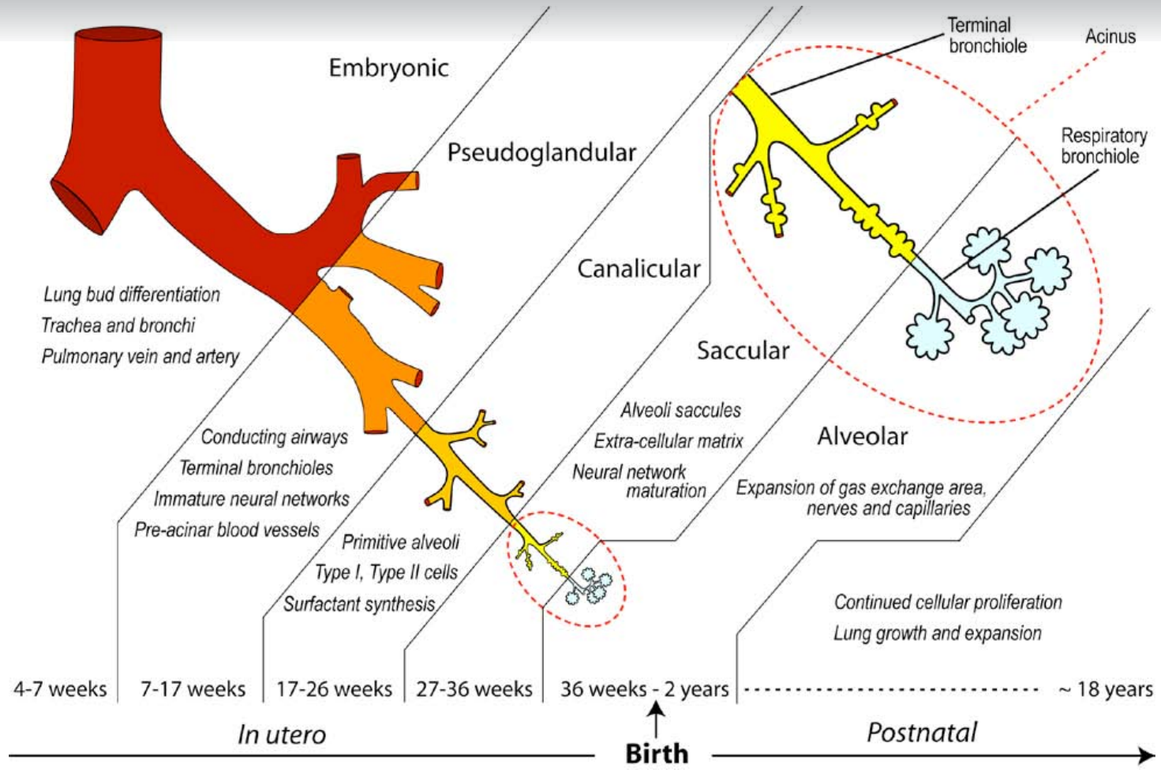
STAGES OF LUNG DEVELOPMENT

In humans, primary lung buds develop during the fourth week of gestation from the endoderm of the foregut. After early embryonic development, stages in prenatal lung development are pseudoglandular, canalicular, saccular, and alveolar, which are represented in Figure 2, along with associated developmental features (Kajekar, 2007). Only a portion of maturational events are required prenatally for successful survival, with most continuing postnatally during alveolarization (Pinkerton and Joad, 2000).

During the embryonic period primary bronchi develop from the primitive gut, and elongate and divide into two main bronchi. During the pseudoglandular phase (6–16 weeks of gestation in humans), branching continues and mesenchyme differentiates into cartilage, smooth muscle, and connective tissue around the epithelial tubules. By the end of this time, major conducting airways to the terminal bronchioles are developed. Respiratory bronchioles, develop in the canalicular period along with a rich vascular supply. During the saccular phase, first contact between the air space and proliferating pulmonary capillaries takes place. During alveolarization, the primitive alveoli develop secondary septa that form the walls of the true alveoli, resulting in a dramatic increase in surface area.

Chemicals that disrupt the cellular signaling important for these events may alter lung development.

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"

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Examples of Chemicals that can Alter Lung Structure and Function During Development

Chemical	Cellular and subcellular level impacts	Structural or functional impacts	Possible clinical impact
Nitrofen 2,4-dichloro-*p*-nitrophenyl-ether (pesticide)	GATA 6, Wnt7, BMP4, FGF, retinal dehydrogenase2, inhibition T3 receptor binding	Decreased branching, altered smooth muscle, alteration in surfactant and alveolar septation	Pulmonary hypoplasia, immature lung
TCDD (dioxin)	Arylhydrocarbon receptor, thyroid hormone	Delayed lung development, decreased total lung space, increased septal area	Chronic bronchitis, decreased functional capacity, COPD?
Nicotine	Suppression glycolysis and glycogenolysis, reduced synthesis phosphorylase and phosphofructokinase, inhibition Na^+K^+ ATPase	Slower septal formation, bleb formation, decrease number alveoli, increase alveolar volume	Emphysema, decreased functional capacity
4-ipomeanol, naphthalene	Bronchiolar cell differentiation and repair inhibited	Injury/loss of Clara cells	Increased susceptibility to inhaled toxicants, alteration in surfactant
Ozone	Depletion proteoglycan and FGF-2, thinned basement membrane zone	Altered bronchiolar growth (longer/decreased diameter), fewer branches, alteration in orientation bronchiolar smooth muscle	Increase airway hyper-reactivity, emphysema?
Arsenic	Increase expression estrogen receptor alpha, alteration gene expression for extracellular matrix (e.g. collagen type III), Sprouty-2, β-catenin, EGFR, L-myc	Alteration branching and cell migration, decreased elasticity and structural support	Cancer, bronchiectasis, airway hyperreactivity
Di(2-ethylhexyl) phthalate	PPARγ, decrease type 2 pnuemocyte	Thickened primary septa, fewer/more dilated airspace, increased Type II pneumocytes	Bronchopulmonary dysplasia, altered lung mechanics

Close Window

Stag

Lung bu
Trachea
Pulmona

4-7 weeks

years

structural, and functional impacts on lung development of xenobiotics"

on Lung Development - Miller et al., 2010

Online link - Table 1: Cellular, structural, and functional impacts on lung development of xenobiotics

ASTHMA and Lung Development

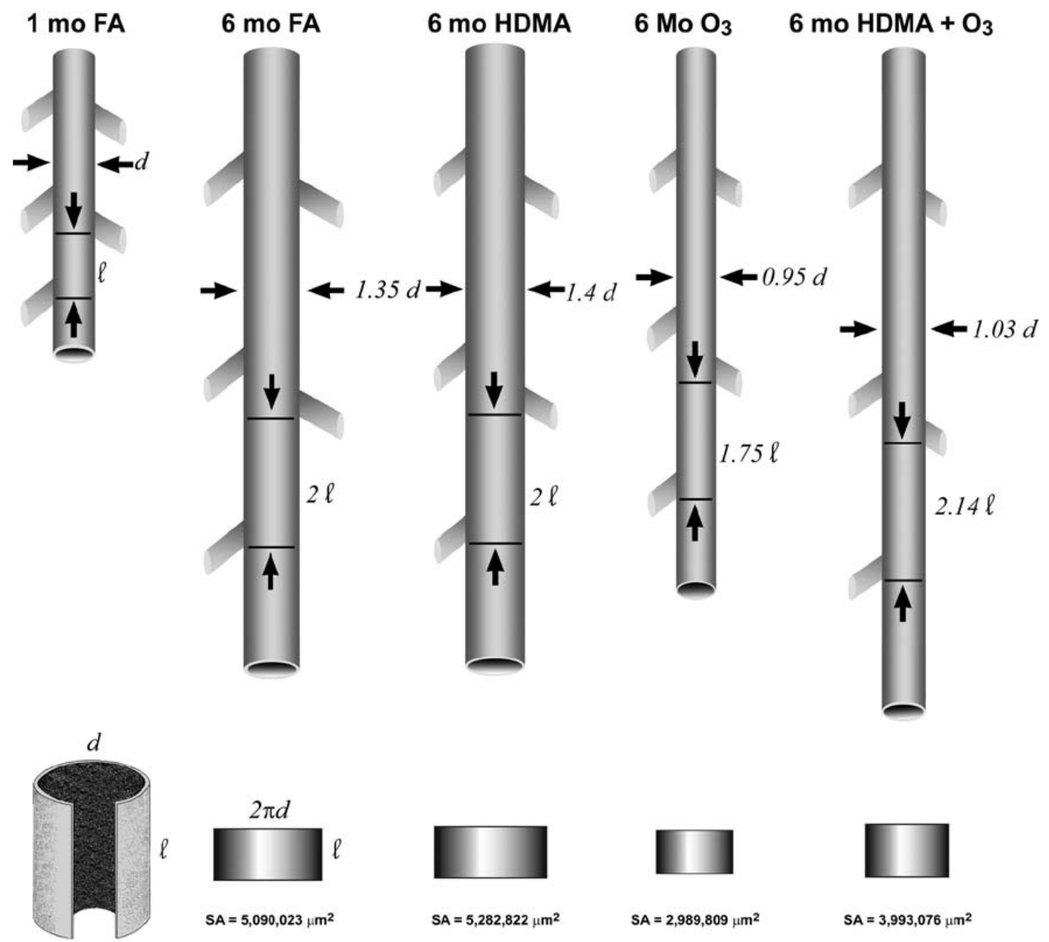
THE LUNG IS SUSCEPTIBLE TO MANY INFLUENCES DURING EARLY DEVELOPMENT.

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.

You may skip this section and go to "Growing Problem of Asthma"

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



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.

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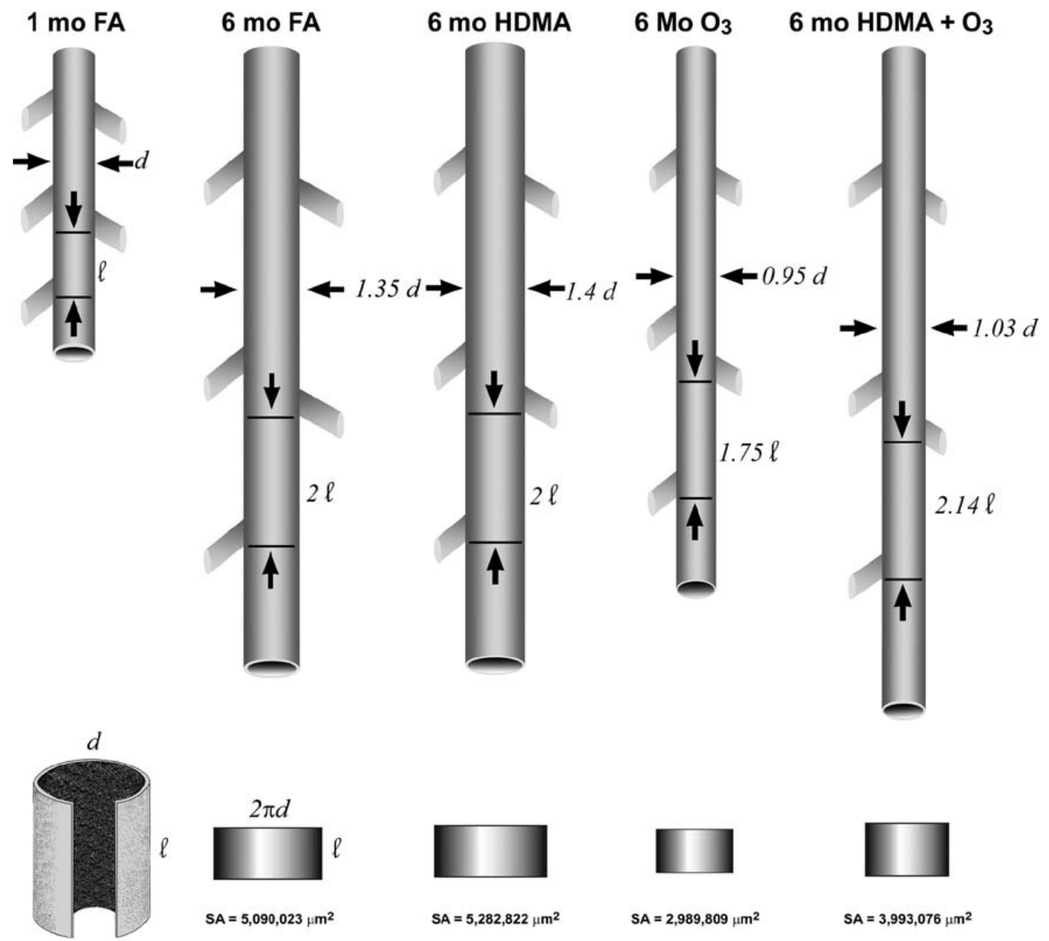
STUDIES CONDUCTED at the University of California–Davis evaluated the impact of ozone (O3) and allergens on lung development in rhesus monkeys. These studies integrated early-life exposures through multiple windows of susceptibility to observe functional and structural changes relevant to human lung development and lung disease. In 2004, Tran et al. described conducting airways doubling in length and increasing by 33% in diameter between 1 and 6 months of age.

Postnatal exposure to O3, alone or combined with house dust mite antigen (HDMA), resulted in changes in bronchiolar growth patterns, inhibiting growth in diameter and promoting growth in length as well as reducing the number of conducting airway branches (by as many as six generations) (Fanucchi et al., 2006; Plopper et al., 2007). These changes are consistent with increased propensity to develop asthma and appeared to be permanent because they persisted at least 6 months after exposure ended.

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



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ASTHMA: The Growing Problem

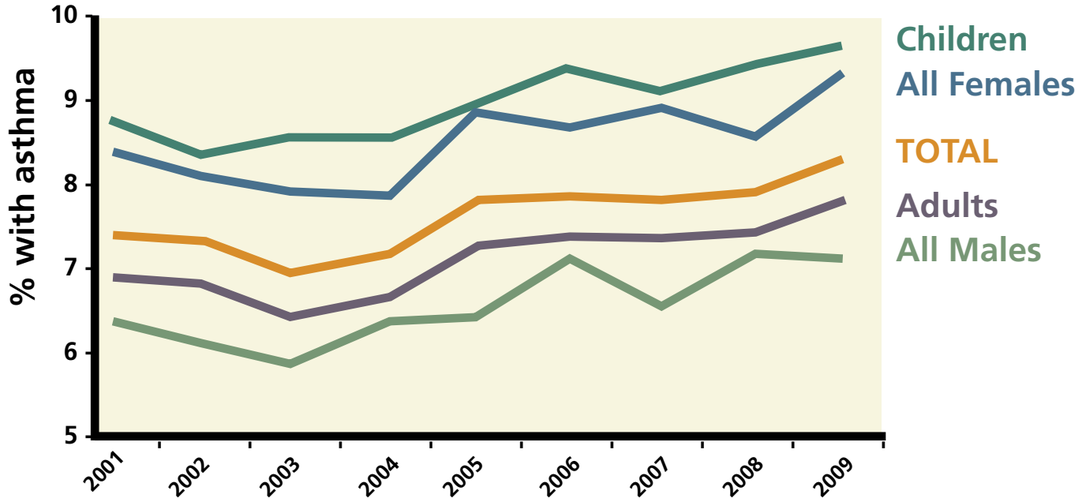
When Brett gets an attack, he has a difficult time breathing and sometimes feels as if he is going to pass out.

He is careful to carry an inhaler with him at all times. Lots of kids have them, so it seems common now even though his doctor says it wasn't like this many years ago. The number of people with asthma, continues to grow.

From 2001 to 2010 overall asthma rates increased 1.5% per year, to about 8.4%.

1 in 10 children, or 10%, now have asthma.

In addition to the human costs, estimated monetary costs measured in 2007 dollars was $56 billion. (CDC and Amer Children 3rd ed.)



Percentages are age-adjusted

SOURCE: National Center for Health Statistics; 2010
From CDC "Vital Signs" on asthma

ASTHMA: Racial and Socioeconomic Disparities

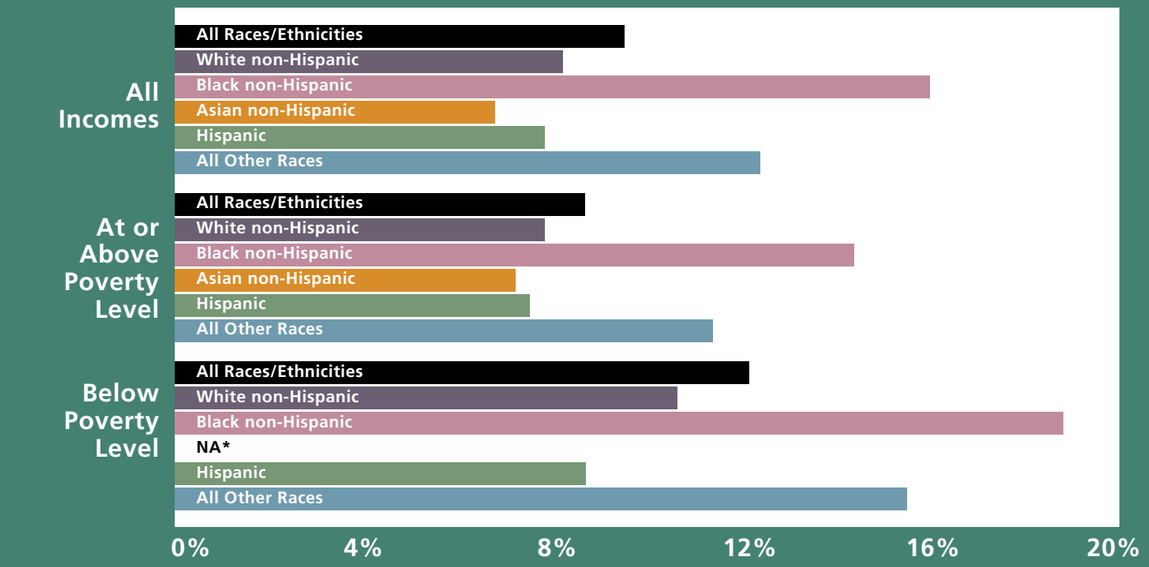
Many of Brett's friends who live in apartments in the city also have asthma.

Racial and socioeconomic disparities are dramatic (see figure). About 1 in 9 (11%) of non-Hispanic black persons of all ages and about 1 in 6 (17%) of non-Hispanic black children had asthma in 2009, the highest rate among racial/ethnic groups.

The greatest rise in asthma rates was among black children (almost a 50% increase) from 2001 through 2009. Racial disparities (with increased asthma and hospital visits for asthma) are noted with increased risk for blacks compared to whites even after controlling for factors such as economic status. The disparities hold true across economic strata and in urban as well as rural communities. (McDaniel et al.. 2006)

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

Percentage of children ages 0 to 17 years reported to have current asthma, by race/ ethnicity and family income, 2007-2010



*Not available. The estimate is not reported because it has large uncertainty: the relative standard error, RSE, is 40% or greater (RSE = standard error divided by the estimate).

Data: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey, *America's Children and the Environment, Third Edition.* Graphic used with permission.

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.

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.)

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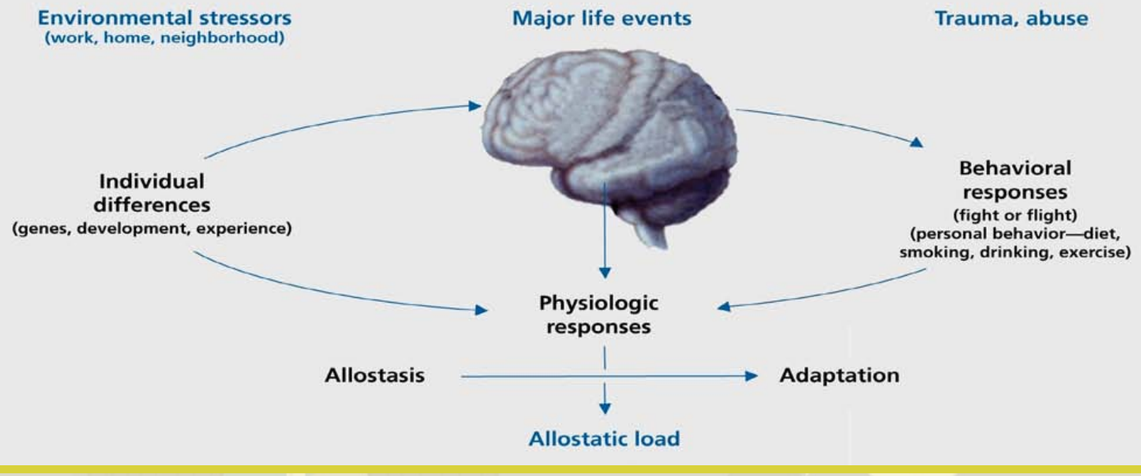

KEY CONCEPT:

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 allostatic 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.

Graphic: McEwen B., 2006, with permission

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KEY CONCEPT:

Effect Modifier

An effect modifier is a variable that differentially modifies the observed effect of a risk factor on disease status. Different groups have different risk estimates when effect modification is present. For example, stress can increase the asthma risk associated with exposure to a given amount of traffic related air pollution addressed later in this story.

An additional reference: Shankardass K, McConnell R, Jerrett M, Milam J, Richardson J, Berhane K. Parental stress increases the effect of traffic-related air pollution on childhood asthma incidence. Proc Natl Acad Sci USA. 2009 Jul 28;106(30):12406-11.

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

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

Mark Miller MD MPH, Director, Children's Environmental Health Program, Office of Environmental Health Hazard Assessment, California EPA; Director, UCSF Pediatric Environmental Health Specialty Unit

ASTHMA: Family and Community Stressors

Windows of Vulnerability

A window of vulnerability is a time window (s) during pregnancy or child development when the fetus, infant, or child is especially susceptible to particular environmental exposures, general environmental deprivation, suboptimal nutrition, or psychosocial stress. Exposures during these time windows can disrupt important developmental processes, altering structural or functional development of various organs or physiologic systems, with potential lifelong consequences. Time windows of vulnerability can be relatively long and extend throughout fetal and infant development or they can be relatively short and precise. For example, thalidomide can cause severe limb abnormalities if exposure occurs in the fetus 20-36 days after conception. Alternatively, the manifestations of fetal alcohol exposure can vary considerably depending on the timing and extent of exposure. (continued >)

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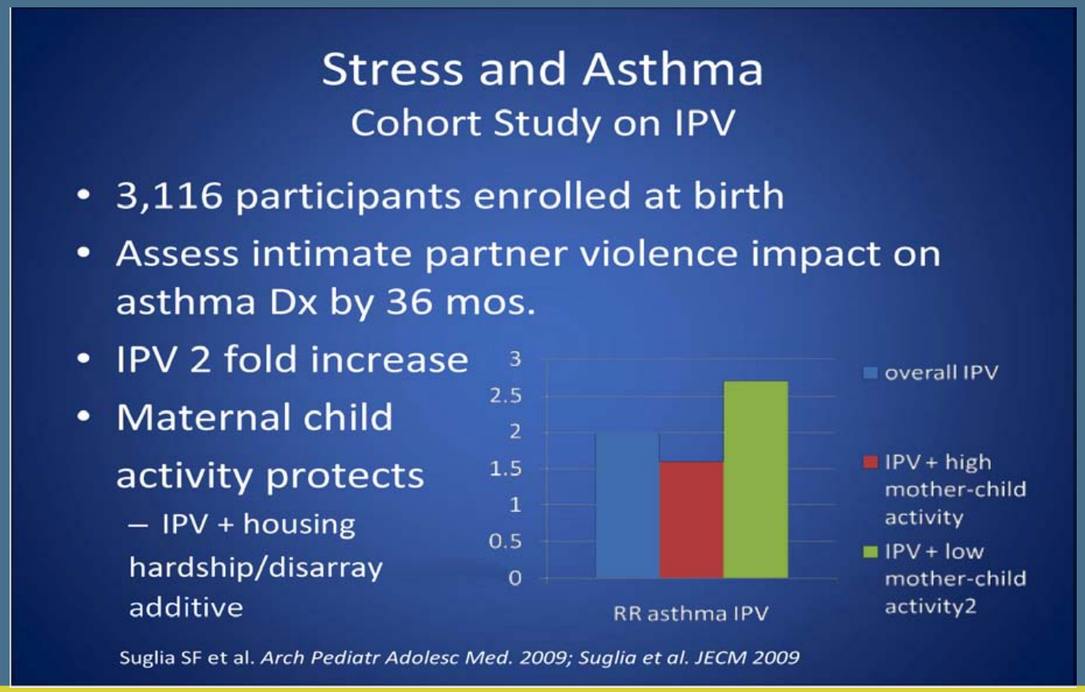
Example: Stress and Asthma Development of Lung Function is Affected by the Home Environment



Graphic used with permission.

In a prospective cohort study children were followed from pregnancy through 3 years of age.

If there was intimate partner violence (IPV) in the home they had double the risk of developing asthma.

If there was IPV in the home and mother was less interactive with the child/ played less with the child/the child had few educational toys, the risk went up to 2.5 times those without IPV.

If the home had IPV but mother was more interactive, child had more toys etc., the risk was partially ameliorated to about 1.6 times those without IPV.

ASTHMA: Family and Community Stressors

Windows of Opportunity

A window of opportunity is a concept related to *window of vulnerability*. It is a time window when structural or functional developmental processes in the body's organs or physiologic systems can be positively influenced by a rich, low hazard environment, with healthy nutrition, good education, a positive home environment without unrelenting chronic stress, etc. From conception through the first few years of life, development is rapid, and many key developmental processes (e.g., language acquisition) are programmed during this time. The functional effects of this programming may be apparent immediately or delayed until later in life. Many functions remain plastic (able to be changed) for prolonged periods, providing an opportunity for external influences to partially remediate the potential effects of earlier exposures.

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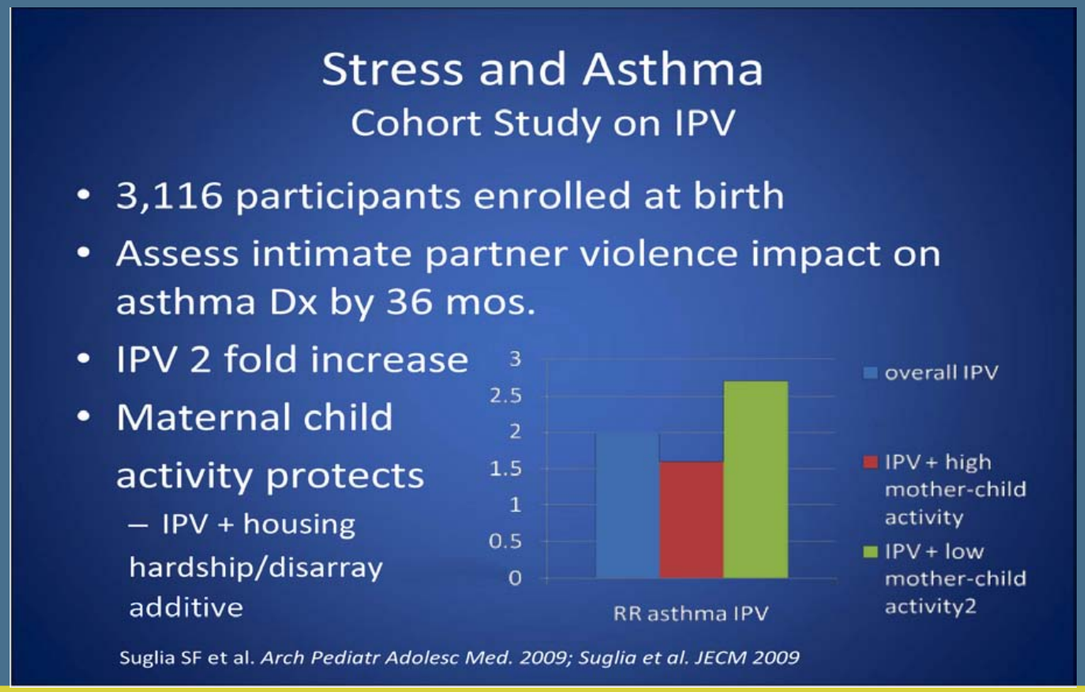

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ASTHMA: Family and Community Stressors

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.

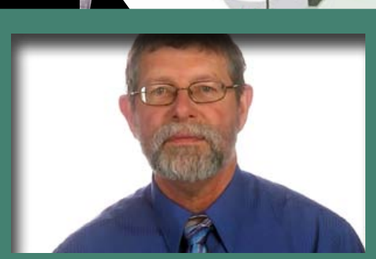
Watch: Dr. Rosalind Wright discusses how caregiver stress, early childhood stress and community violence all have an impact on the development of asthma. (5 min.)

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**

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.)

ASTHMA and Air Pollution

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Diesel Emissions and Asthma Demographics in Southern California

Diesel PM

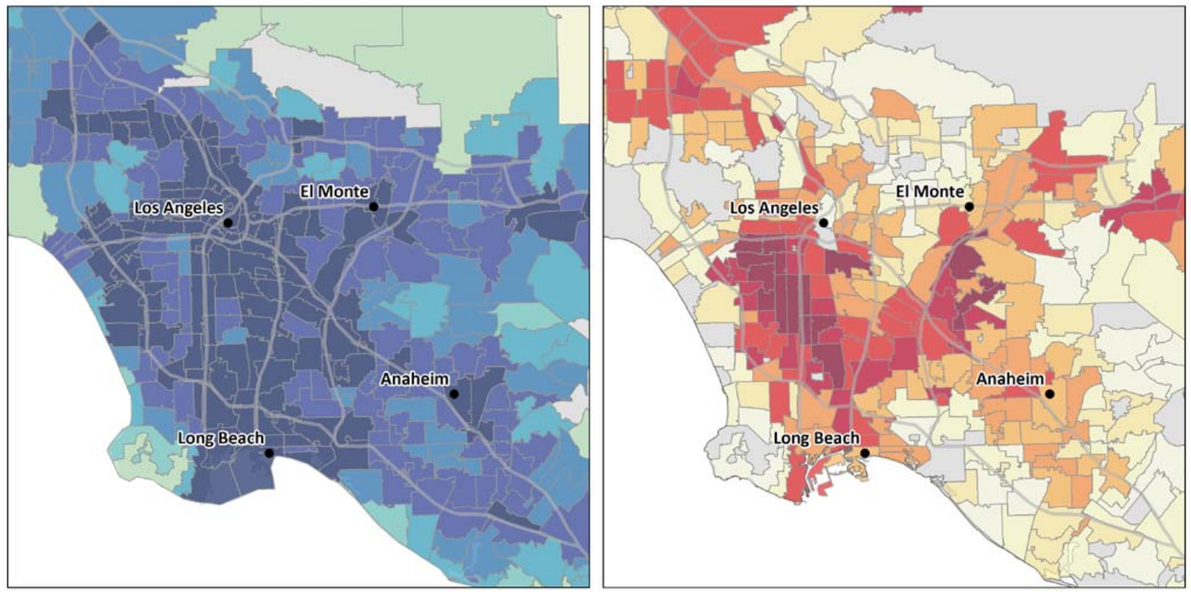
Diesel PM emissions from on-road and non-road sources for a 2010 July day (kg/day)

0.0 - 0.2	4.8 - 8.6
0.3 - 0.7	8.7 - 15.2
0.8 - 2.2	15.3 - 25.7
2.3 - 4.7	25.8 - 163.7

Children's Asthma

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

19.2 - 37.6	67.4 - 79.0
37.7 - 48.2	79.1 - 92.9
48.3 - 57.5	93.0 - 116.0
57.6 - 67.3	116.1 - 408.7



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

Link: California Environmental Health Tracking Program Web Portal

Graphic used with permission.

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

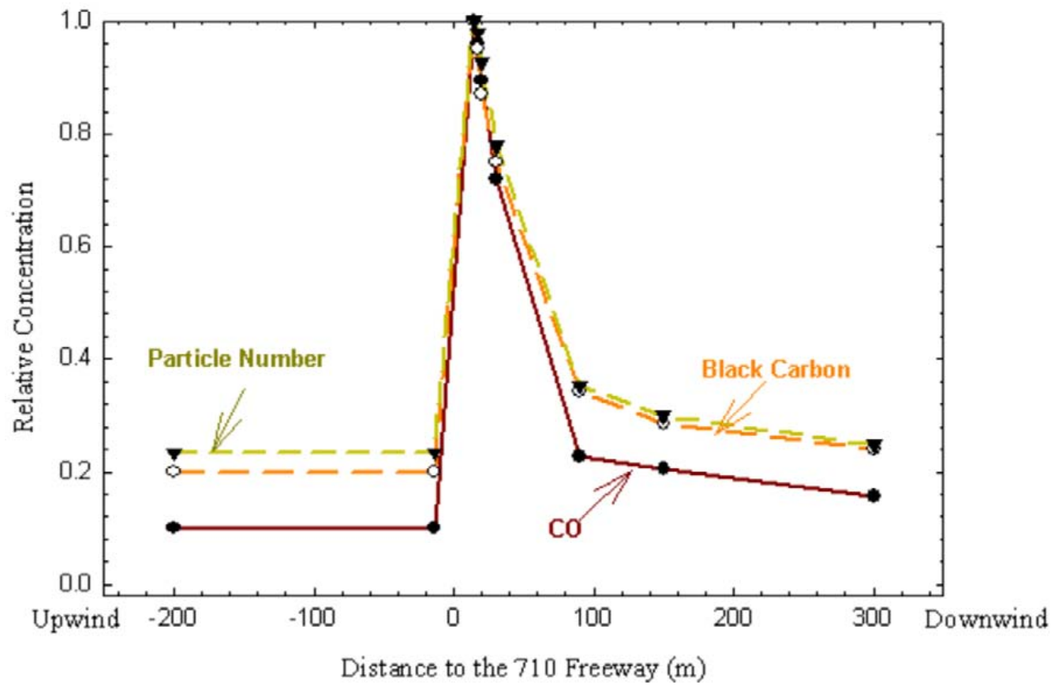
- Respiratory symptoms
- Wheezing (acute)
- Bronchitis (chronic)
- Increased rescue medication use
- Decreased lung function
- Emergency department visits
- Hospitalizations
- School absences

+ Diesel emissions and asthma demographics in southern California

+ Asthma and near roadway exposure to air pollution

Asthma and Near Roadway Exposure to Air Pollution

Children in neighborhoods with more traffic-related air pollutants have increased risk of developing asthma and increased risk of bronchitis and asthma episodes



Slide 1: Air quality is worse close to freeways. Air pollutants are increased closer than 150-300 meters downwind.

Zhu et al., 2002, 2006.

Slide 2: Asthma risk increases for children living closer than 150 meters from a major road.

McConnell et al., 2006

ASTHMA and Air Pollution

EFFECT MODIFIERS – AIR POLLUTION, STRESS AND SOCIOECONOMICS

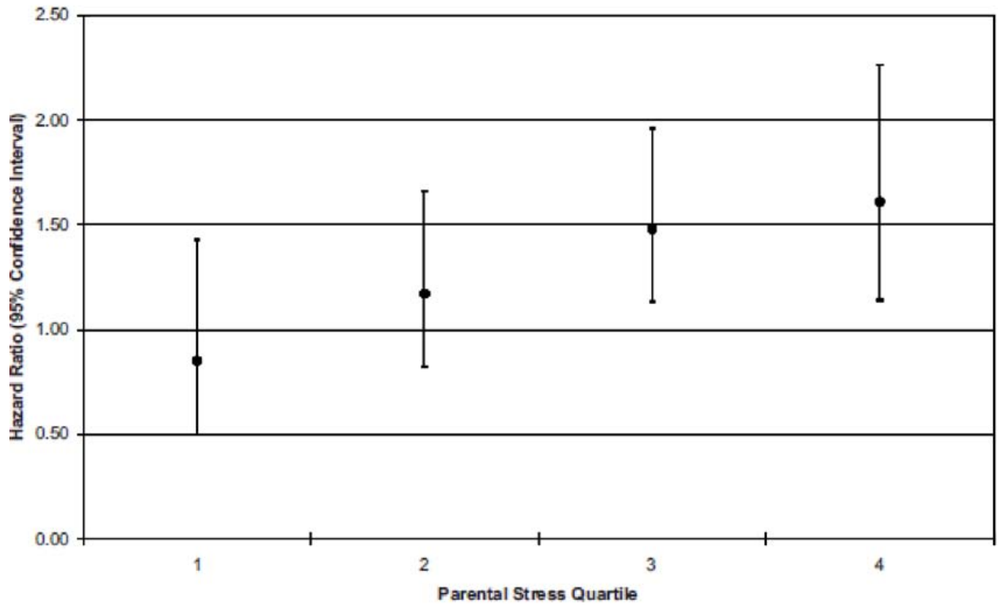
Brett lives in a low-income neighborhood close to Los Angeles and near a major roadway. Children in relatively low-income families and exposed to traffic-related air pollution, such as in Brett's case, are at greater risk of frequent asthma symptoms. Importantly, they are at greater risk than children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

ASTHMA and Air Pollution

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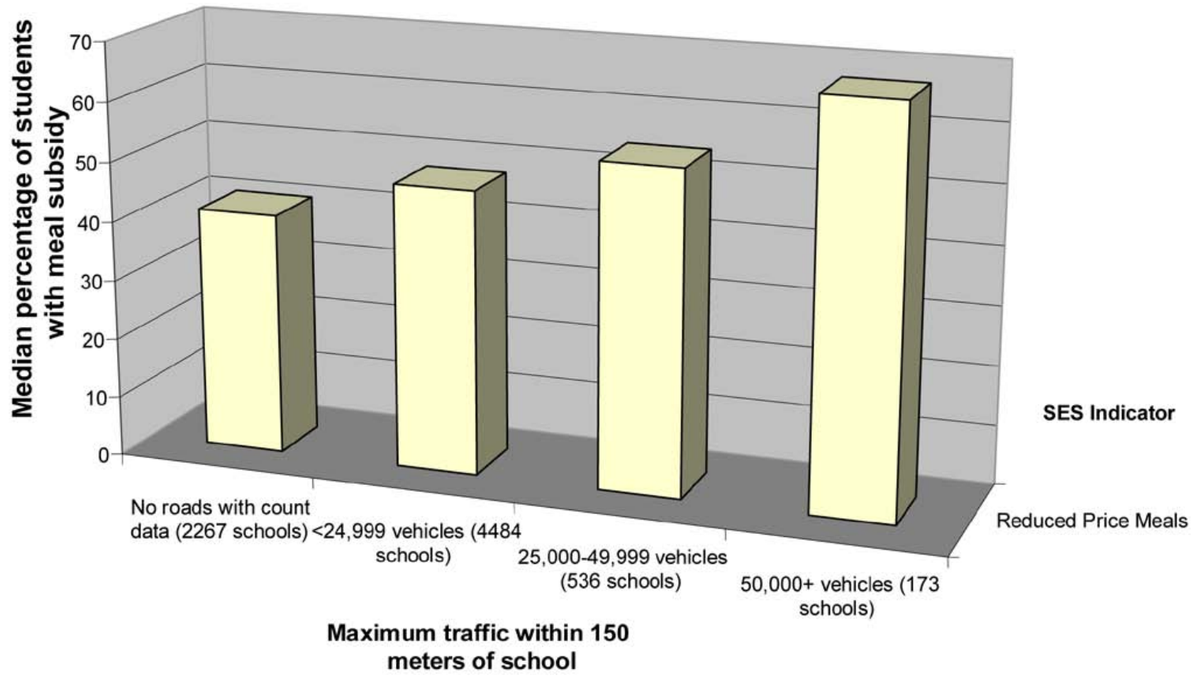
+ Examples: Air pollution and socioeconomics

+ Link: National Environmental Health Tracking Program

+ Asthma in California

Examples: Air pollution and socioeconomics



Slide 1:
Economically disadvantaged students in CA Public Schools have higher traffic exposure.
(Green et al., EHP 2004)

Slide 2 (rollover to view):
Hispanic and non-Hispanic black children are more likely to have high traffic exposure.
(Green et al., EHP 2004)

ASTHMA and Air Pollution

EFFECT MODIFIERS – AIR POLLUTION, STRESS AND SOCIOECONOMICS

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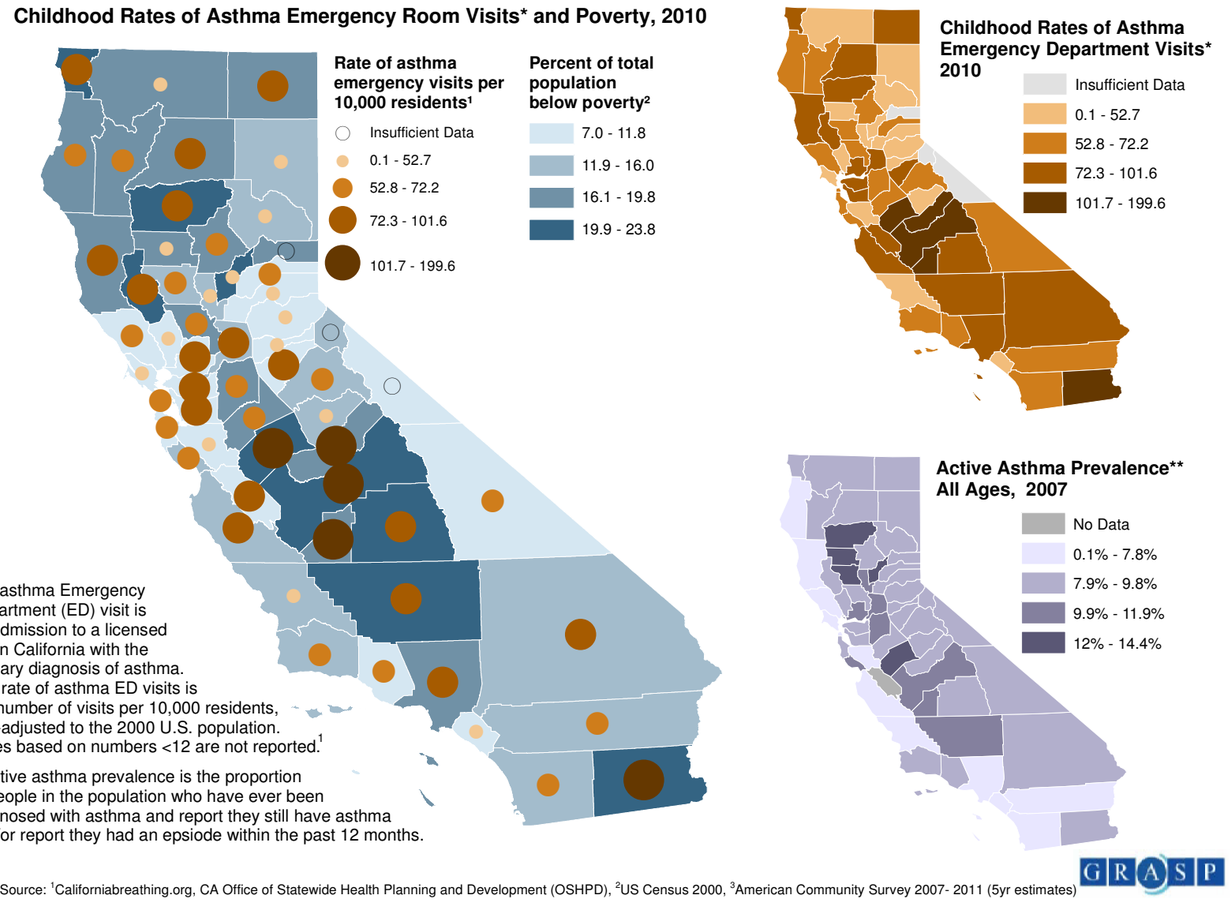
Asthma in California

Asthma in California



*An asthma Emergency Department (ED) visit is an admission to a licensed ED in California with the primary diagnosis of asthma. The rate of asthma ED visits is the number of visits per 10,000 residents, age-adjusted to the 2000 U.S. population. Rates based on numbers <12 are not reported.[1]

**Active asthma prevalence is the proportion of people in the population who have ever been diagnosed with asthma and report they still have asthma and/or report they had an epsiode within the past 12 months.

Data Source: [1]Californiabreathing.org, CA Office of Statewide Health Planning and Development (OSHPD), [2]US Census 2000, [3]American Community Survey 2007- 2011 (5yr estimates)

GRASP

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.

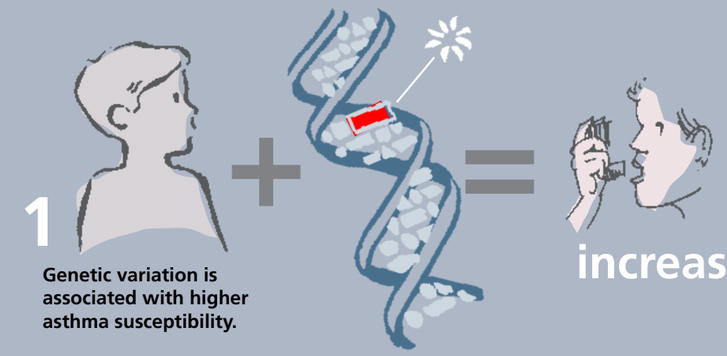
Key Concept: Inflammation and Oxidative Stress

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.

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

Genetics Increase Susceptibility to Air Pollution



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KEY CONCEPT:

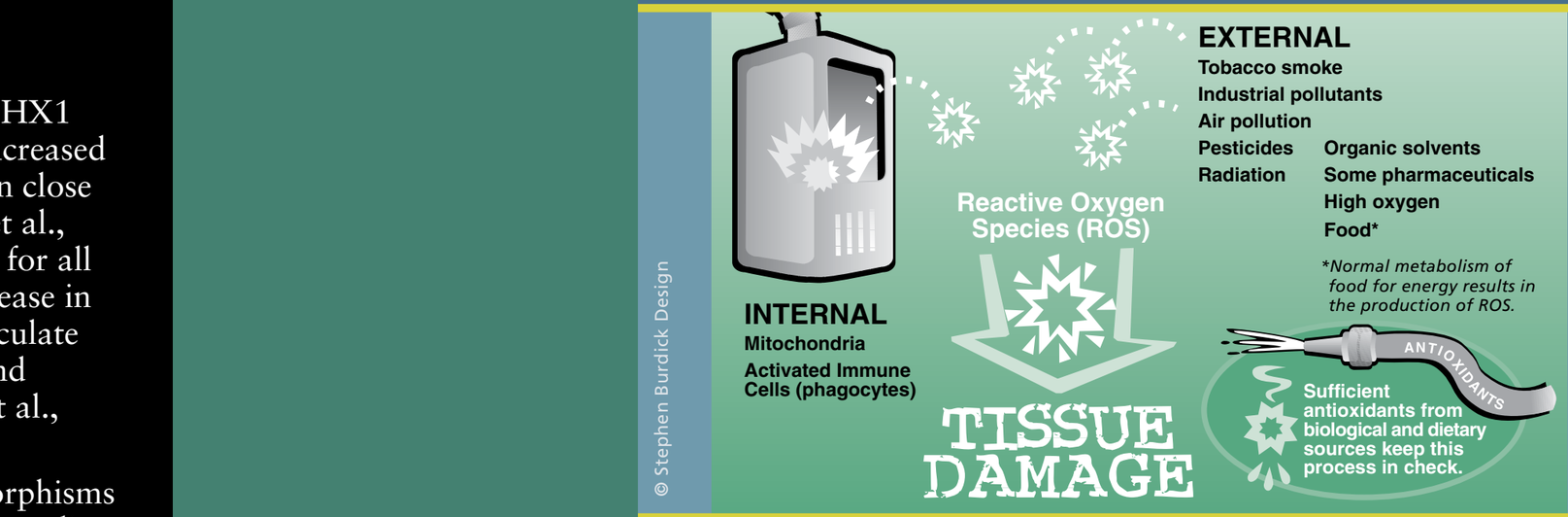
Inflammation and Oxidative Stress

Chronic inflammation and oxidative stress are two mechanisms that underlie many common chronic diseases, including asthma, diabetes, metabolic syndrome, obesity, cardiovascular disease, some neurodegenerative disorders, cancer, and other chronic illnesses.

Inflammation

Inflammation is the body's attempt at self-protection in response to injury, infections, and other stresses - the aim being to remove harmful stimuli, including infectious agents, damaged cells, or irritants - and begin the healing process. It can be acute and short-lived or chronic. The inflammatory response can affect blood vessels, the immune system, and cells within involved tissue. Excessive, prolonged, or recurrent inflammation is an aspect of many diseases. Various inflammatory "markers" are involved, some of which can be measured through laboratory testing, for example, various cytokines.

An important contributor to inflammation is oxidative stress.



Oxidative Stress

Excessive oxidative stress (OS) occurs when levels of "reactive oxygen species" (ROS) are chronically elevated, damage tissues, and increase disease risk. ROS are highly reactive oxygen molecules, sometimes called free radicals, normally present in the body as a result of using oxygen to metabolize food and create energy. They play an essential role in some aspects of cell signaling. Antioxidants, including those from dietary sources, keep ROS at healthy levels. Overproduction of ROS and/or insufficient antioxidants leads to excessive OS. Exposure to air pollution, various industrial chemicals, pesticides, heavy metals, and radiation can also cause excessive ROS. Certain people may be genetically predisposed to have a limited capacity to detoxify ROS.

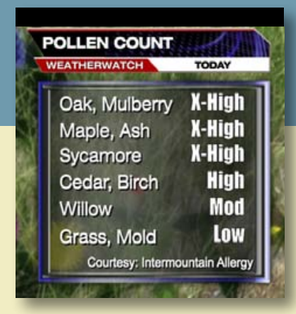
ASTHMA and Climate Change

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. 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.



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.

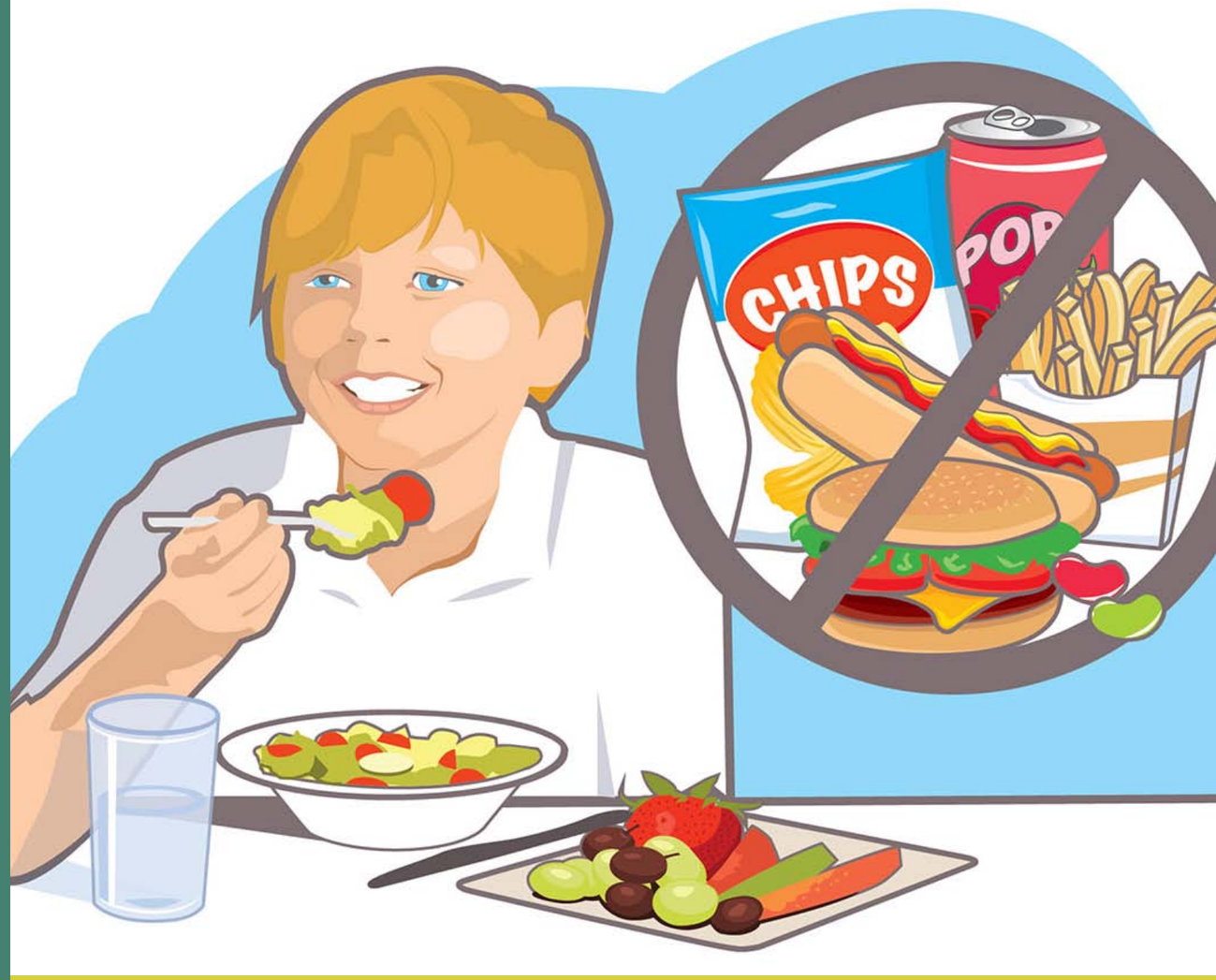
*pollutants measured: PM 2.5, ozone

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.



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.

ASTHMA: Brett's Story

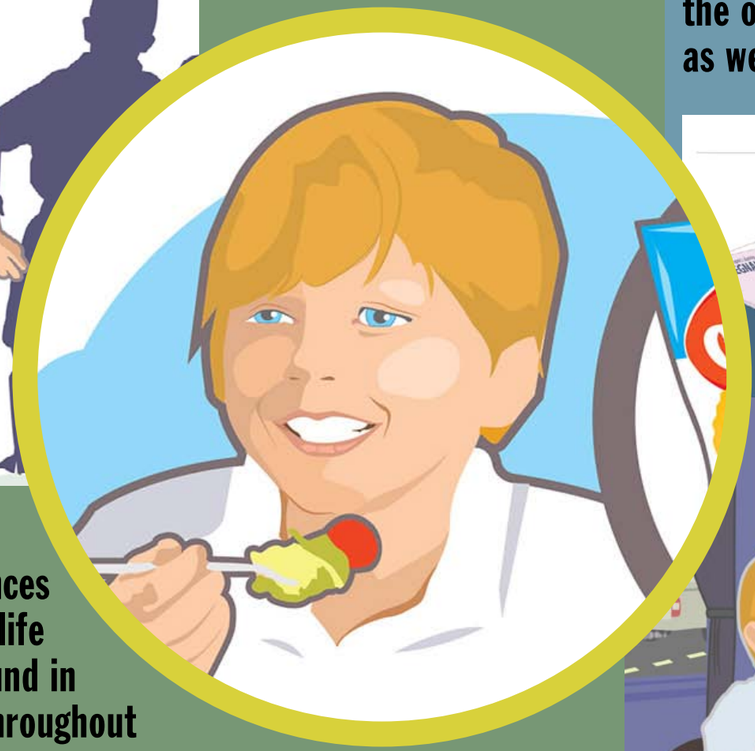
We have seen throughout the pages of Brett's story that a wide range of factors, and their interactions across his lifespan, are risk factors for both the onset of asthma, as well as triggering it. These include environmental chemicals and other contaminants, family and community social stressors, diet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

A Story of Health

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.

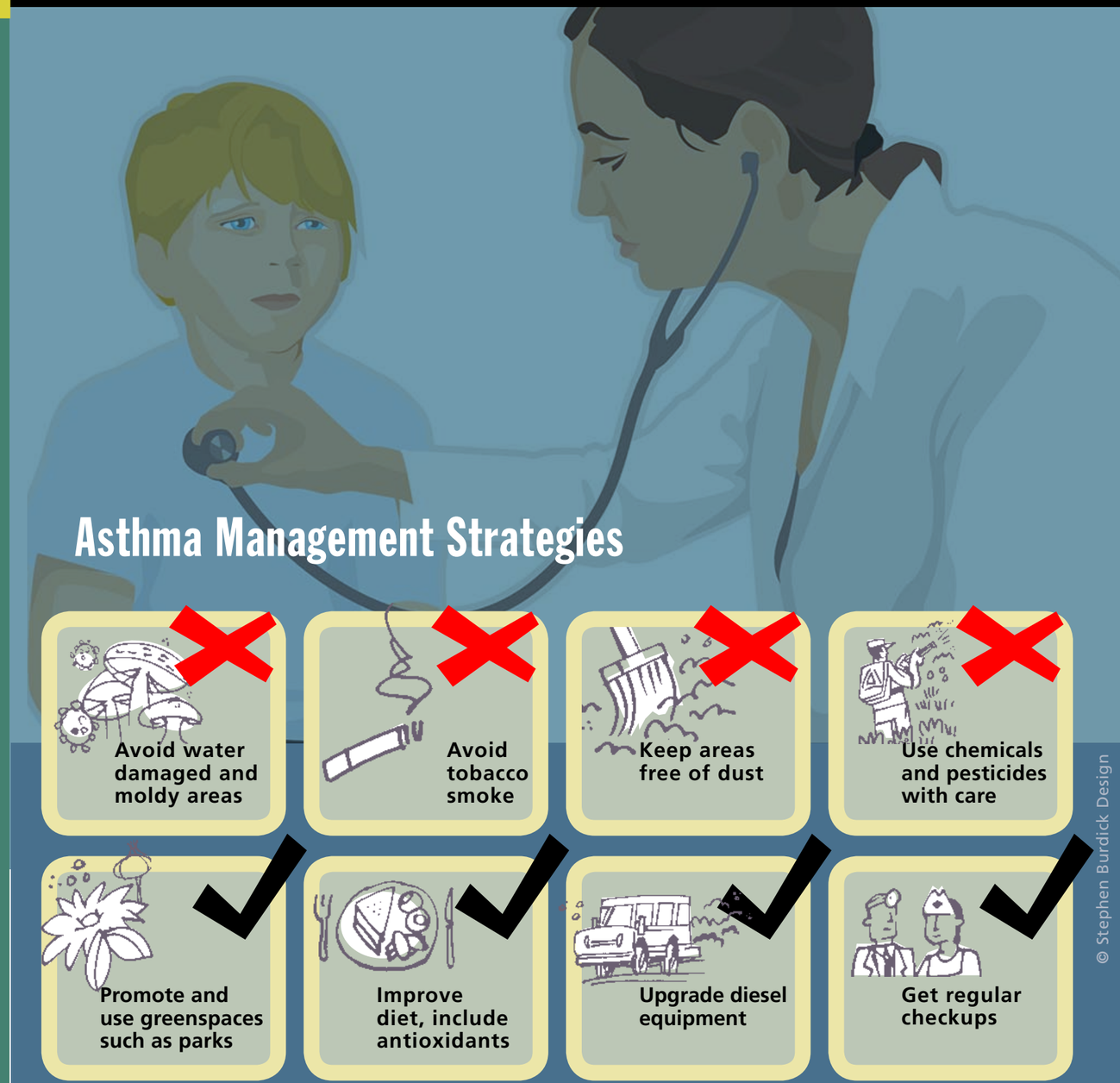
Other protective factors include the following, if possible:

- 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: Policy Initiatives to Protect Health

Policy initiatives to protect health include:

- 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.

Continue to Final Thoughts >

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 Pollustion

Asthma Community Network

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.

- Reduction of diesel emissions
- On-road bus and truck rule
- Off-road construction vehicles
- Other surface goods movement efforts (ports and rail yards)
- Financial incentives for cleaner trucks and school buses
- Advanced Clean Cars rule - Smart growth = decreased VMTs
- No-burn rules to limit wood smoke emissions

Graphic used with permission.

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:

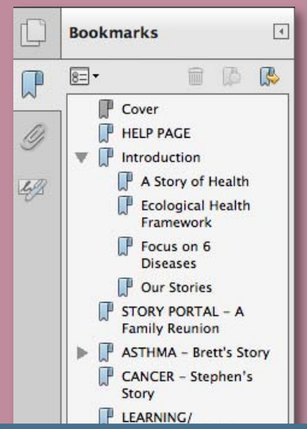
- Important environmental influences come from the natural, chemical, food, built, and social environments.
- Although there are exceptions, most diseases as well as good health are the result of complex interactions among multiple environmental influences and genetics.
- Early-life experiences, particularly 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.

REFERENCES: Asthma

Asthma

Childhood Leukemia

Learning/ Developmental Disabilities

Diabetes

Infertility

Cognitive Decline

Asthma Case References and Resources by Topic

Note: there are many topic overlaps

Acetaminophen

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

Air Pollution

Galizia A, Kinney PL. Long-term residence in areas of high ozone: associations with respiratory health in a nationwide sample of nonsmoking young adults. Environ Health Perspect 1999;107(8):675-9

Gauderman WJ et al. Association between air pollution and lung function growth in Southern California children. Am. J. Respir. Crit. Care Med.July 1, 2002 vol. 166 no. 1 76-842002

Li N, et al. Ultrafine particulate pollutants induce oxidative stress and mitochondrial damage. Environ Health Perspect Vol 11: 4, 2003

Li N, Hao M, Phalen RF, Hinds WC, Nel AE. Particulate air pollutants and asthma. A paradigm for the role of oxidative stress in PM-induced adverse health effects. Clin Immunol. 2003 Dec;109(3):250-65

Nadeau K, McDonald-Hyman C, Noth, EM, Pratt B, Hammond, K, Balmes, J and Tager I. Ambient air pollution impairs regulatory T-cell function in asthma. J Allergy Clin-Immunol Volume 126, Number 4

Tager IB, Balmes J, Lurmann F, et al. Chronic exposure to ambient air pollution and lung function in young adults. Epidemiology. 2005;16(6):751-9

Air Pollution - Exercise

McConnell R, Berhane K, Gilliland F, London SJ, Islam T, Gauderman WJ, Avol E, Margolis HG, Peters JM.. Asthma in exercising children exposed to ozone: a cohort study. Lancet. 2002 Feb 2;359(9304):386-91

Gene-environment – Air Pollution

Salam MT, Lin PC, Avol EL, Gauderman WJ, Gilliland FD. Microsomal epoxide hydrolase, glutathione S-transferase P1, traffic and childhood asthma Thorax. 2007 Dec;62(12):1050-7

Air Pollution - Traffic specific

Balmes J. Can traffic-related air pollution cause asthma? Thorax 2009;64:646-647 doi:10.1136/thx.2009.116418

Gauderman WJ. Children's health and traffic exposures Powerpoint

Gauderman WJ, Vora H, McConnell R, Berhane K, Gilliland F, Thomas D, Lurmann F, Avol E, Kunzli N, Jerrett M, Peters J. Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. Lancet. 2007 Feb 17;369(9561):571-7

Green R, Smorodinsky S, Kim JJ, McLaughlin R, Ostro1 B. Proximity of California public schools to busy roads. Environ Health Perspect 2004;Vol 112:1

Jerrett M, Shankardass K, Berhane K, Gauderman WJ, Künzli N, Avol E, Gilliland F, Lurmann F, Molitor JN, Molitor JT, Thomas DC, Peters J, McConnell R. Traffic-related air pollution and asthma onset in children: a prospective cohort study with individual exposure measurement. Environ Health Perspect 2008 Oct;116(10):1433-8. doi: 10.1289/ehp.10968. Epub 2008 Jun 18

Kim JJ, Smorodinsky S, Lipsett M, Singer BC, Hodgson AT, Ostro B. Traffic-related air pollution near busy roads: the East Bay Children's Respiratory Health Study. Am J Respir Crit Care Med. 2004 Sep 1;170(5):520-6. Epub 2004 Jun 7

Kim JJ, Huen K, Adams S, Smorodinsky S, Hoats A, Malig B, Lipsett M, Ostro B. Residential traffic and children's respiratory health. Environ Health Perspect. 2008 Sep;116(9):1274-9. doi: 10.1289/ehp.10735

Meng Y, Wilhelm M, Rull R, PEnglish P, Nathan S, and Ritz B. Are frequent asthma symptoms among low-income individuals related to heavy traffic near homes, vulnerabilities, or both? AEP Vol. 18, No. 5 May 2008: 343-350

McCormack MC, Breysse PN, Eggleston PA, Matsui EC, Hansel NN, Brosnan JC, Eggleston PA, Diette GB. In-home particle concentrations and childhood asthma morbidity. Environ Health Perspect 2009 Feb; 117(2):294-8.

Sarnat JA. Asthma and air quality. Curr Opin Pulm Med. 2007; Jan; 13(1): 63-6

Zhu Y, Hinds WC, Shen S, Kim S, Sioutas C. Study of ultrafine particles near a major highway with heavy-duty diesel traffic. 2002 Atmospheric Environment, 36: 4323-4335

Zhu Y, Kuhn T, Mayo P, Hinds WC. Comparison of daytime and nighttime concentration profiles and size distributions of ultrafine particles near a major highway. 2006 Environmental Science and Technology 40: 2531-2536

Air pollution - Weight gain

Bolton S, Smith S, Huff N, Gilmour MI, Foster WM, Auten R, Bilbo S. et al. Prenatal air pollution exposure induces neuroinflammation and predisposes offspring to weight gain in adulthood in a sex-specific manner. FASEB Journal article fj.12-210989. Published online July 19, 2012

Allostatic Load

McEwen B. Protective and damaging effects of stress mediators: central role of the brain.Dialogues. Clin Neurosci. 2006 December; 8(4): 367–381

McEwen BS. Central effects of stress hormones in health and disease: understanding the protective and damaging effects of stress and stress mediators. Eur J Pharmacol.2008 April 7; 583(2-3): 174–185

Classifications

Koterba A, Saltoun C. Chapter 9: asthma classification. Allergy Asthma Proc. 2012; 33 (suppl 1) : S28-31

Climate change and respiratory health

D Amato G, Cagnani CE, Cecchi L, Annesi-Maesano I, Nunes C, Ansotegui I, D Amato M, Liccardi G, Sofia M, Canonica WG. Climate change, air pollution and extreme events leading to increasing prevalence of allergic respiratory diseases. Multidiscip Respir Med. 2013 Feb 11;8(1):12

Kinney PL. Climate change, air quality, and human health. Am J Prev Med. 2008; 35(5):459-67

Knowlton K, Rosenthal JE, Hogrefe C, Lynn B, Stuart Gaffin, Richard Goldberg, Cynthia Rosenzweig, Kevin Civerolo, Jia-Yeong Ku, Patrick L. Kinney. Assessing Ozone-Related Health Impacts under a Changing Climate. Environ Health Perspect. 2004 November; 112(15): 1557-1563

Demographics

CDC:

National Surveillance of Asthma: US, 2001–2010

Asthma in the US

CDC Vital Signs: Asthma in the US

National Environmental Health Tracking Network

Diet and Asthma

Dotterud CK, Storrø O, Simpson MR, Johnsen R, Oien T. The impact of pre- and postnatal exposures on allergy related diseases in childhood: a controlled multicentre intervention study in primary health care. BMC Public Health. 2013 Feb 8;13:123

Garcia-Marcos L, Castro-Rodriguez JA, Weinmayr G, Panagiotakos DB, Priftis KN, Nagel G. Influence of Mediterranean diet on asthma in children: A systematic review and meta-analysis. Pediatr Allergy Immunol. 2013 Apr 11. doi: 10.1111/pai.12071

Gilliland. Outdoor Air Pollution, Genetic Susceptibility, and Asthma Management. Pediatrics. Vol 123 No. Supplement 3 March 1, 2009. "Emerging research indicates that dietary supplementation for individuals with low antioxidant levels is one promising approach to reducing susceptibility to air pollution."

Nakamura K, Wada K, Sahashi Y, Tamai Y, Tsuji M, Watanabe K, Ohtsuchi S, Ando K, Nagata C. Associations of intake of antioxidant vitamins and fatty acids with asthma in pre-school children. Public Health Nutr. 2012 Oct 1:1-6. pubmed/23021626

Exercise Induced

Spector S, Tan R.Exercise-induced bronchoconstriction update: therapeutic management. Allergy Asthma Proc. 2012 Jan-Feb;33(1):7-12

Health Disparities

Roberts EM, English PB, Wong M, Wolff C, Valdez S, Van den Eeden SK, et al. Progress in pediatric asthma surveillance II: geospatial patterns of asthma in Alameda County, California. Prev Chronic Dis 2006 Jul

Heterogeneity of Asthma Phenotypes

Bhakta NR, Woodruff PG. Human asthma phenotypes: from the clinic, to cytokines, and back again. Immunol Rev.2011 Jul;242(1): 220-32

Holgate ST. A look at the pathogenesis of asthma: the need for a change in direction. Discov Med.2010 May;9(48):439-47

Lung Development, Fetal and Early life programming, Early life risk factors

Duijts L. Fetal and infant origins of asthma. Eur J Epidemiol. 2012 Jan;27(1):5-14. doi: 10.1007/s10654-012-9657-y. Epub 2012 Feb 1

Fanucchi MV, Plopper CG, Evans MJ, Hyde DM, Van Winkle LS, Gershwin LJ, et al. Cyclic exposure to ozone alters distal airway development in infant rhesus monkeys. Am J Physiol Lung Cell Mol Physiol. 2006;291(4):L644–L650

Kajekar R. Environmental factors and developmental outcomes in the lung. Pharmacol Therap. 2007;114:129–145

Miller M, Marty M. Impact of environmental chemicals on lung development. Environ Health PerspectVol 118: 8. August 2010

Pinkerton KE, Joad JP. The mammalian respiratory system and critical windows of exposure for children's health. Environ Health Perspect 2000;108(suppl 3):457–462

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? ToxicolPathol 35:97–110.

Salam MT et al. Early-Life Environmental Risk Factors for Asthma: Findings from the Children's Health Study Environ Health Perspect 112:760–765 (2004)

Stern DA, Morgan WJ, Wright AL, et al. Poor airway function in early infancy and lung function by 22 years: a non-selective longitudinal cohort study. Lancet 2007;370(9589):758–764

Tran MT, Weir AJ, Fanucchi MV, Rodriguez AE, Pantle LM, Smiley-Jewell SM, et al. Smooth muscle hypertrophy in distal airways of sensitized infant rhesus monkeys exposed to house dust mite allergen. Clin Exp Allergy.2004b;34:1627–1633

Wright R. Perinatal stress and early life programming of lung structure and function.Biol Psychol. 2010 April; 84(1): 46–56

Obesity and Asthma

Maternal obesity before and during pregnancy and childhood asthma:

Guerra S, Sartini C, Mendez M, Morales E, et al. Maternal prepregnancy obesity is an independent risk factor for frequent wheezing in infants by age 14 months. Paediatr Perinat Epidemiol.2013 Jan;27(1):100-8

Lowe A, Bråbäck L, Ekeus C, Hjern A, Forsberg B. Maternal obesity during pregnancy as a risk for early-life asthma. J Allergy Clin Immunol.2011 Nov;128(5):1107-9

Scholtens S, Wijga AH, Brunekreef B, Kerkhof M, et al. Maternal overweight before pregnancy and asthma in offspring followed for 8 years. Int J Obes (Lond).2010 Apr;34 (4):606-13.

Childhood obesity:

Papoutsakis C, Priftis KN, Drakouli M, Prifti S, Konstantaki E, Chondronikola M, Antonogeorgos G, Matziou V. Childhood overweight/obesity and asthma: is there a link? A systematic review of recent epidemiologic evidence. J Acad Nutr Diet. 2013 Jan;113(1):77-105. doi: 10.1016/j.jand.2012.08.025

continued >

REFERENCES: Asthma, continued

Asthma

Childhood Leukemia

Learning/ Developmental Disabilities

Diabetes

Infertility

Cognitive Decline

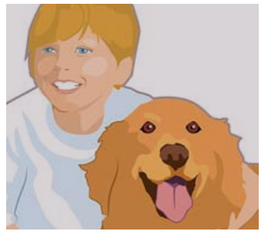
Occupational Asthma

Baur X, Aasen T, Burge P, Heederik D, et al. The management of work-related asthma guidelines: a broader perspective. Eur Respir Rev. 2012; 21(124):125-139

Burge P, Moore V, Robertson A. Sensitization and irritant-induced occupational asthma with latency are clinically indistinguishable. Occup Med (Lond). 2012; 62(2):129-133

Tarlo SM, Balmes J, Balkissoon R, Beach J, et al. Diagnosis and management of work-related asthma: American College Of Chest Physicians Consensus Statement. Chest. 2008 Sep;134(3 Suppl):1S-41S

Zock J, Vizcaya D, Le Moual N. Update on asthma and cleaners. Curr Opin Allergy Clin Immunol. 2010; 10(2):114-120



Pet Allergies

Hastert TA, Babey SH, Brown ER, Meng YY. Pets and smoking in the home associated with asthma symptoms and asthma-like breathing problems. Policy Brief UCLA Cent Health Policy Res. 2007 Feb;(PB2007-2):1-7

Popplewell EJ, Innes VA, Lloyd-Hughes S, Jenkins EL, Khdir K, Bryant TN, Warner JO, Warner JA. The effect of high-efficiency and standard vacuum-cleaners on mite, cat and dog allergen levels and clinical progress. Pediatr Allergy Immunol. 2000 Aug;11(3):142-8

Population Health

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

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

Schettler T. The ecology of breast cancer: The promise of prevention, and the hope for healing. Science and Environmental Health Network and the Collaborative on Health and the Environment. October, 2013

Protective Measures

Champagne Frances A.; Meaney, Michael J.Transgenerational effects of social environment on variations in maternal care and behavioral response to novelty. Behavioral Neuroscience, Vol 121(6), Dec 2007, 1353-1363.doi: 10.1037/0735-7044.121.6.1353

Suglia FS, Enlow MC, Kullowatz A, Wright RJ. Maternal intimate partner violence and increased asthma incidence in children: buffering effects of supportive caregiving. Arch PediatrAdolesc Med. 2009 Mar;163(3):244-50

Racial Disparities

McDaniel M, Paxson C, Waldfogel J. Racial disparities in childhood asthma in the United States: Evidence from the national health interview survey, 1997 to 2003. PEDIATRICS Vol. 117 No. 5 May 1, 2006 pp. e868 -e877

Smoking

Neuman A, Hohmann C, Orsini N, Pershagen4 G, Eller E, Fomsgaard Kjaer6 H, Gehring, U, Granell R, et al . Maternal smoking in pregnancy and asthma in preschool children: a pooled analysis of 8 birth cohorts Am J RespirCrit Care Med. 2012 Nov 15;186(10):1037-43

Burke H, Leonardi-Bee J, Hashim A, Pine-Abata H, Chen Y, Cook DG, Britton JR, McKeever TM.Prenatal and passive smoke exposure and incidence of asthma and wheeze: systematic review and meta-analysis. Pediatrics. 2012 Apr;129(4):735-44. doi: 10.1542/peds.2011-2196. Epub 2012 Mar 19

Stress

Chiu et al. Prenatal and Postnatal Maternal Stress and Wheeze in Urban Children. Am J Respir Crit Care Med Vol 186, Iss. 2, pp 147–154, Jul 15, 2012

Stress, Socioeconomics, Air pollution

Bryant-Stephens T. Asthma disparities in urban environments. J Allergy ClinImmunol June 2009

Charafeddine R, Boden LI. Does income inequality modify the association between air pollution and health? Environmental Research 106 (2008) 81-88

Chen E, Hanson M, Paterson L, Griffin MJ, Walker HA, and Miller GE.Socioeconomic status and inflammatory processes in childhood asthma: The role of psychological stress. J Allergy ClinImmunol. Volume 117, Number 5. March 2006

Clougherty JE, Levy JI, Kubzansky LD, et al. Synergistic effects of traffic-related air pollution and exposure to violence on urban asthma etiology. Environ Health Perspect 2007;115(8):1140-1146

Islam T, Urman, Gauderman WJ, Milam J, Lurmann F, Shankardass K, Avol E, Gilliland F and McConnell R. Parental Stress Increases the Detrimental Effect of Traffic Exposure on Children's Lung Function. Am. J. Respir. Crit. Care Med.October 1, 2011 vol. 184 no. 7 822-827

Reyes et al. Relationship between maternal demoralization, wheeze, and immunoglobulin E among inner-city children Ann Allergy Asthma Immunol. 2011;107:42-49

Shankardass K, McConnell R, Jerrett M, Milam J, Richardson J, and Berhane K. Parental stress increases the effect of traffic-related air pollution on childhood asthma incidence. PNAS July 28, 2009 vol. 106 no. 30

Shonkoff JP, Garner AS, and the Committee on Psychosocial Aspects of Child and Family Health, Committee on Early Childhood, Adoption, and Dependent Care, and Section on Developmental and Behavioral Pediatrics. The lifelong effects of early childhood adversity and toxic stress. AAP Technical Report.Pediatrics.2012 Jan;129(1):e232-46

Suglia FS, Duarte CS, Sandel MT, et al. Social and environmental stressors in the home and childhood asthma. J Epidemiol Community Health 2010;64(7):636-642

Williams DR, Sternthal M, Wright RJ. Social determinants: Taking the social context of asthma seriously. PEDIATRICS Volume 123, Supplement 3, March 2009

Wright RJ. Epidemiology of stress and asthma: from constricting communities and fragile families to epigenetics. Immunol Allergy Clin N Am 31 (2011) 19–39 doi:10.1016/j.iac.2010.09.011

Violence, Lung function, Asthma

Suglia FS, Ryan L, Laden F, Dockery DW and Wright RJ. Violence exposure, a chronic psychosocial stressor, and childhood lung function Psychosomatic Medicine 70:160–169 (2008)

Suglia FS, Enlow MB, Kullowatz A, et al. Maternal intimate partner violence and increased asthma incidence in children. Arch Pediatr Adolesc Med 2009;163(3):244-250

Vitamin D and Lung Development, Wheezing, Asthma

Carmago et al. Randomized trial of vitamin d supplementation and risk of acute respiratory tract infection in Mongolia. Pediatrics 2012. doi: 10.1542/peds.2011-3029

Camargo CA Jr, Ingham T, Wickens K, Thadhani R, et al. Cord-blood 25-hydroxyvitamin D levels and risk of respiratory infection, wheezing, and asthma. Pediatrics. 2011 Jan;127(1):e180-7. doi: 10.1542/peds.2010-0442. Epub 2010 Dec 27

Hollams EM.Vitamin D and atopy and asthma phenotypes in children. CurrOpin Allergy ClinImmunol. 2012 Jun;12(3):228-34

Zosky GR, Berry LJ, Elliot JG, James AL, Gorman S, Hart PH.Vitamin D deficiency causes deficits in lung function and alters lung structure. Am J RespirCrit Care Med. 2011 May 15;183(10):1336-43. Epub 2011 Feb 4

Recommendations for Vit D supplementation: American Academy of Pediatrics (AAP) Perrine C, Sharma A, Jeffers M, Serdula M, Scanlon K. Adherence to vitamin D recommendations among US infants. Pediatrics. 2010; 125(4):627-632

The American College of Obstetricians and Gynocologists: Committee Opinion 495. Vitamin D: Screening and Supplementation During Pregnancy. 2011 Obstet Gynecol. 2011;118 (1):197-198

Toxic Chemicals and Other Indoor Exposures

Heinrich J. Influence of indoor factors in dwellings on the development of childhood asthma. Int J Hyg Environ Health. 2011; 214(1):1-25

Mendell M. Indoor residential chemical emissions as risk factors for respiratory and allergic effects in children: a review Indoor Air 2007; 17: 259–277

Mold

Facts about mold and dampness. CDC.

Mold video on EPA Asthma science notebook

Phthalates

Bornehag CG, NanbergE .Phthalate exposure and asthma in children. Int J Androl. 2010 Apr;33(2):333-45. Epub 2010 Jan 4. Review

Hsu NY, Lee CC, Wang JY, Li YC, Chang HW, Chen CY, Bornehag CG, Wu PC, Sundell J, Su HJ. Predicted risk of childhood allergy, asthma, and reported symptoms using measured phthalate exposure in dust and urine Indoor Air. 2012 Jun;22(3):186-99. doi: 10.1111/j.1600-0668.2011.00753.x. Epub 2011 Nov 16

PVC

Larsson M, Hägerhed-Engman L, Kolarik B, James P, Lundin F, Janson S, Sundell J, Bornehag CG. Indoor. PVC–as flooring material–and its association with incident asthma in a Swedish child cohort study. Air. 2010 Dec;20(6):494-501. doi: 10.1111/j.1600-0668.2010.00671.x

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):

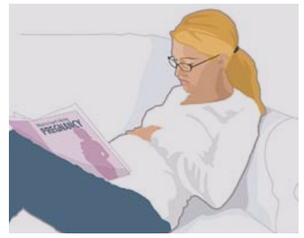
EPA/NIEHS Children's Centers 2012 Webinar Series
In particular:

- 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

Ekanayake R, Miller M, Marty, M. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. Report to the Legislature, Children's Environmental Health Program. February 2014

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



Asthma Management, Treatment

National Medical-legal Partnership

CDC: Health Care Guidelines

National Environmental Education Foundation: Pediatric Environmental History forms

Intervention Guidance

Krieger JW, Philby Miriam L, Brooks Marissa Z. Better Home Visits for Asthma Lessons Learned from the Seattle–King CountyAsthma Program. Am J Prev Med 2011;41(2S1):S48–S51

Master Home Environmentalist: Do-it-yourself Home Environmental Assessment List (HEAL)

EPA's Asthma Home Environment Checklist

EPA Air Quality Index

CHILDHOOD LEUKEMIA Stephen's Story*

Stephen is a 3-year-old boy who lives with his parents David and Tricia in a suburb in Connecticut.

He is an only child, and his parents spend as much time as they can with him even though they manage a successful plant nursery and garden center.

He spends four days a week at child care and is with his parents the other three days, sometimes at their house and sometimes at the garden center.

Stephen had been an active toddler, but during the past month, Tricia noticed that Stephen was not as lively and energetic as usual. His child care providers also mentioned this.

When he became listless and started to run a fever, Tricia became concerned. She took Stephen to see his pediatrician, Dr. Jones.

(*a fictional case)

LEARNING/DEVELOPMENTAL DISABILITIES Amelia's Story *

Amelia is a 13-year-old who lives with her parents Darrell and Gloria in a small town in Louisiana.

She enjoys being with her friends, riding her bike, playing soccer, listening to music, and helping out at the restaurant where her mother is the bookkeeper.

Amelia likes school, although she has difficulty learning and is occasionally socially awkward.

Like one in six young people in America, Amelia has a developmental disability.

+ More information on learning and developmental disabilities definitions and US trends

(*a fictional case)

DIABETES Marcela's Story

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Health professionals: (to come)

References: (to come)

STORY IN DEVELOPMENT

INFERTILITY Toshio & Reiko's Story

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COGNITIVE DECLINE Donald's Story

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