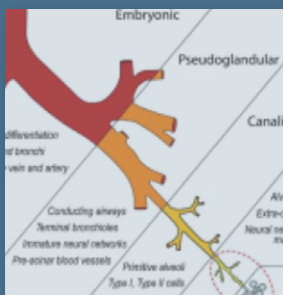
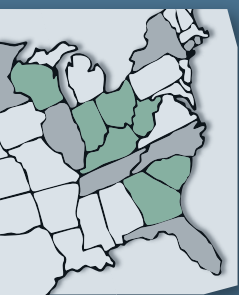


A Story of Health

Cognitive Decline: Sam's Story



ACKNOWLEDGEMENTS

Primary Development Organizations

The Agency for Toxic Substances and Disease Registry (ATSDR), the Center for Integrative Research on Childhood Leukemia and the Environment (CIRCLE) at the University of California, Berkeley, Commonwealth, the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (OEHHA), the Science and Environmental Health Network (SEHN), and the Western States Pediatric Environmental Health Specialty Unit (WSPEHSU) teamed up to leverage our combined resources to develop and produce *A Story of Health*.

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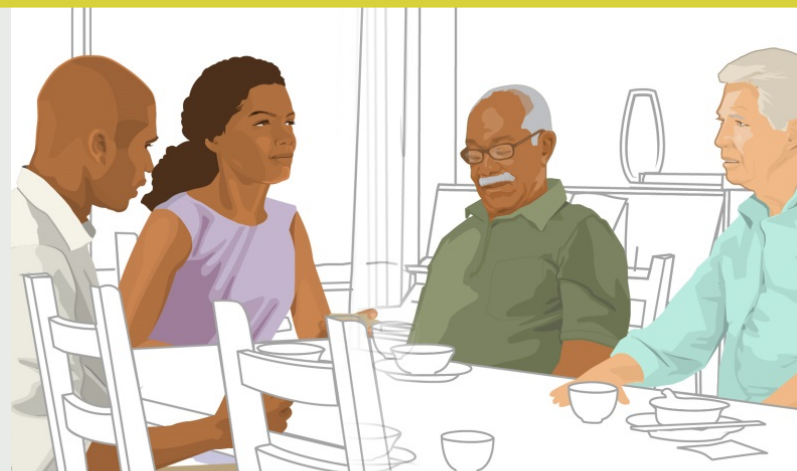
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A Story of Health would not have been possible without the contributions of Brian Tencza.

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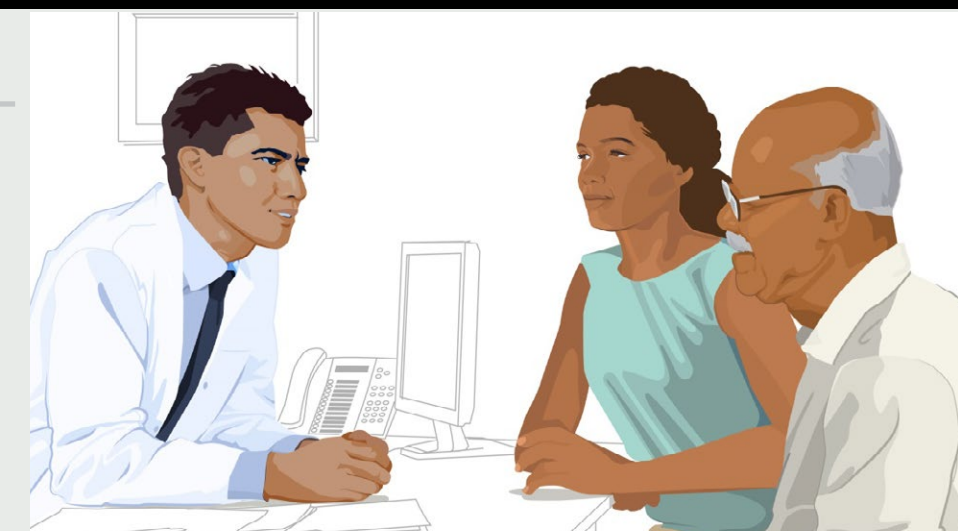
Cognitive Decline: Sam's Story. Agency for Toxic Substances and Disease Registry, Commonwealth, Science and Environmental Health Network, Western States PESHU. PDF file [online](#).

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Western States PEHSU

The US Environmental Protection Agency

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DISCLAIMERS:

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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 as supporters or primary development organizations.

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

REVIEWERS

We gratefully acknowledge the following people who reviewed draft sections of a Story of Health, noting that their review does not constitute an endorsement of the findings or conclusions.

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

Original Cognitive Decline (Sam's story):

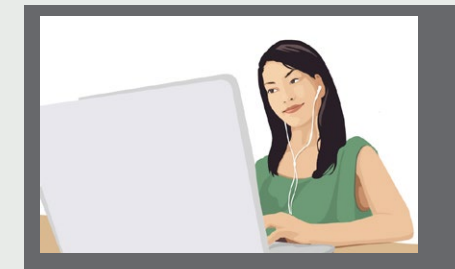
Deborah Cory-Slechta

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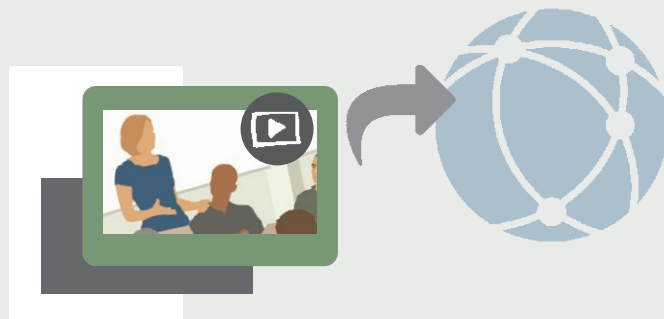
THE INDIVIDUAL STORIES OF HEALTH in this eBook are written to address many audiences. For example, some sections are more technical than others – you can skip sections if you wish.

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



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

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



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

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

Getting Started

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

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

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

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



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

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

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

Icons

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



key concept



watch a video



additional resources, tools



technical details for health professionals



definition

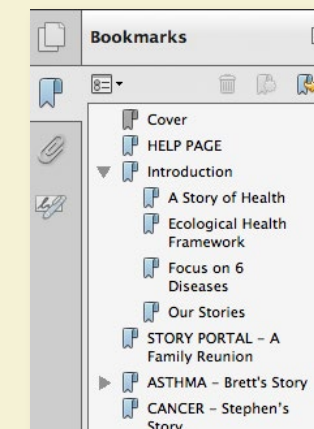


Table of Contents

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.

INTRODUCTION

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

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

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

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

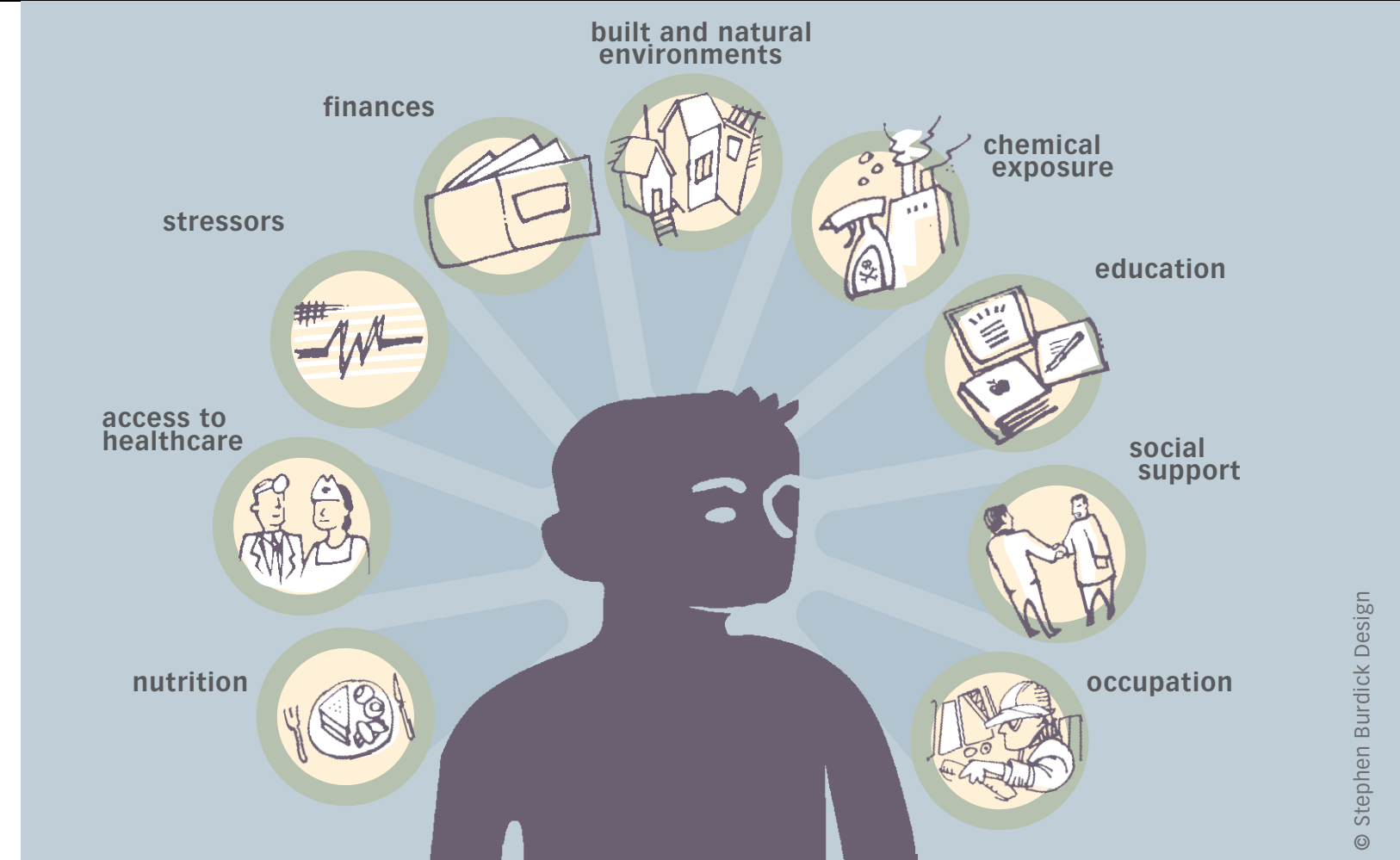


Our stories explore how many aspects of our lives, and what we are exposed to in our environments, influence health across the lifespan—from the beginning of fetal development to elder years—and how they can promote health and resilience, or disease and disability.

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

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

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



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

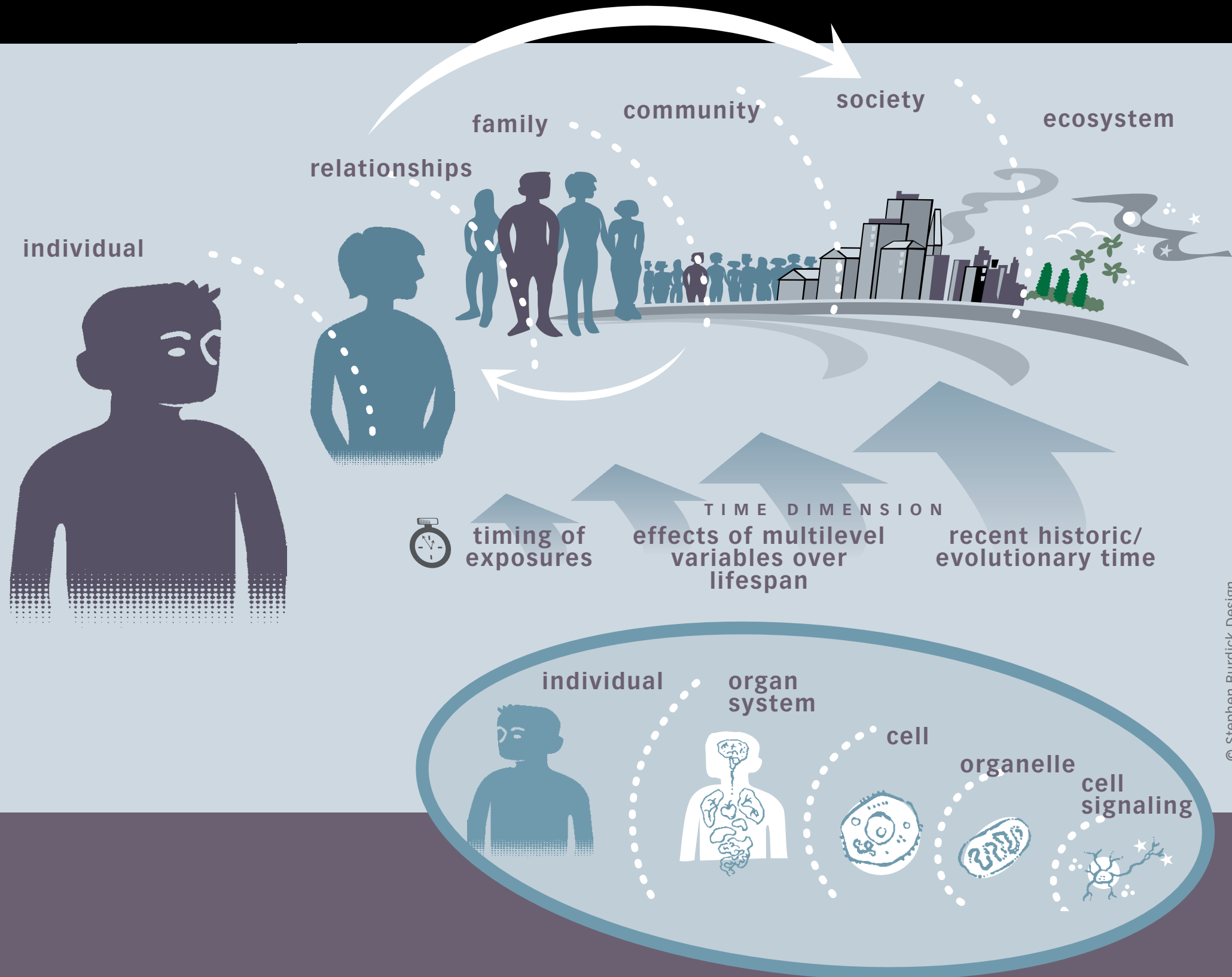
Rarely is one particular thing responsible for health or disease, so we refer to this as a multifactorial (or ecological) approach, the best way to promote health and prevent disease.

INTRODUCTION Ecological Health Framework

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

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

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



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

INTRODUCTION

Six Different Stories

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

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

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



Asthma



Wildfire health impacts

Childhood cancer



Cognitive decline



Infertility



Learning and developmental disabilities

INTRODUCTION Free Continuing Education

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

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

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

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

Free Continuing Education available by specialty:

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



LEARNING OBJECTIVES

Sam's Story (Cognitive Decline):

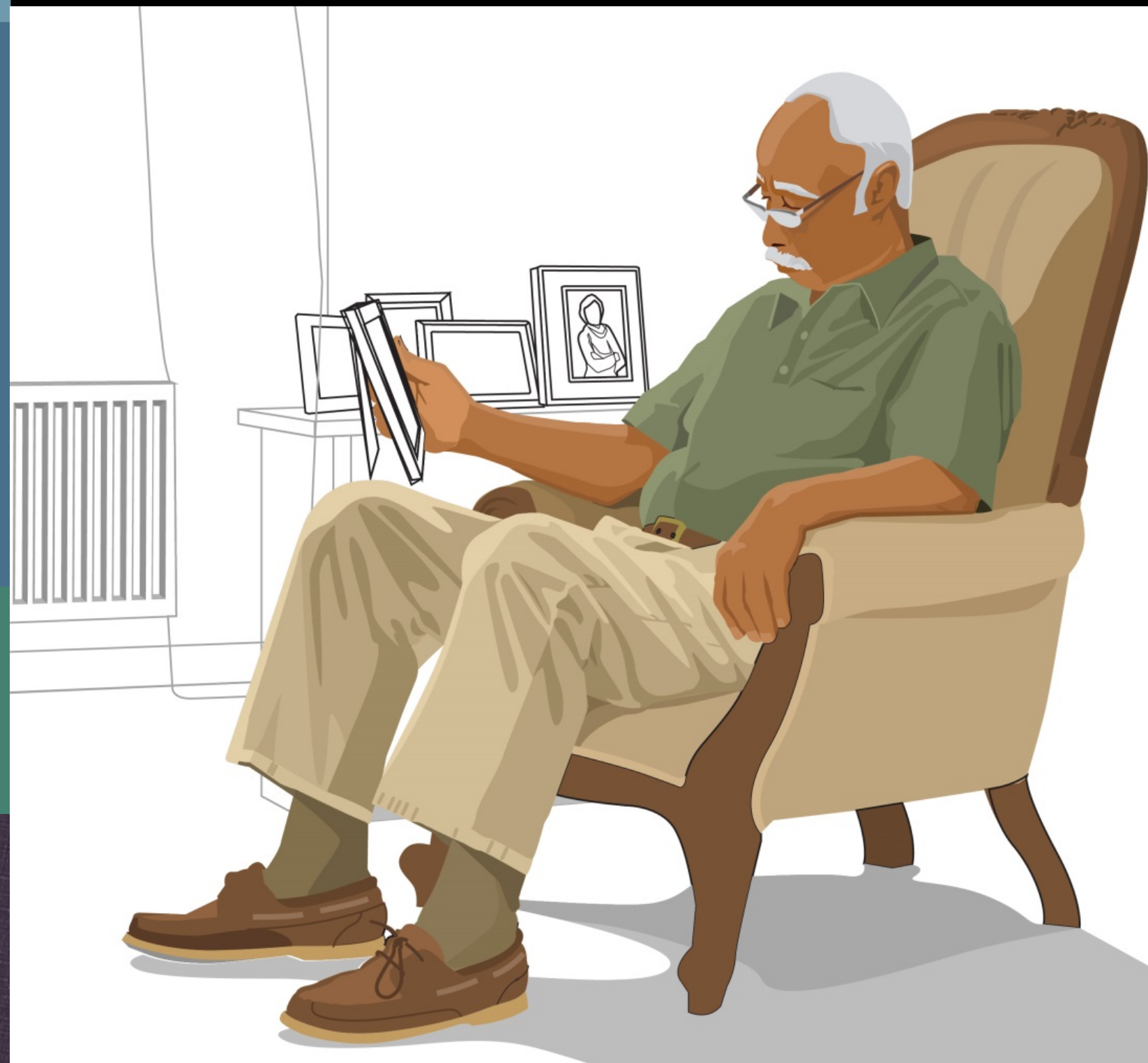
1. Describe the characteristics of cognitive decline.
2. Discuss the characteristics of Parkinson's disease.
3. Describe environmental risk factors for Parkinson's disease.
4. Describe environmental risk factors for cognitive decline,
5. Discuss factors that may reduce the risk of cognitive decline.
6. Describe how to improve collaborative practice across the healthcare team regarding cognitive decline.

COGNITIVE DECLINE Sam's Story

Sam is a 72 year-old widower from the “Baby Boom” generation who grew up and still lives in the Boston area. His wife of over 40 years passed away last year. Since her death he has not been as social and doesn't see friends and family as much as he used to.

Sam's family is concerned that he is forgetting things more than usual and missing appointments. They wonder if this is just normal for someone his age or if there is something else going on with his brain function.

They don't want to insult him and wonder how to approach the topic with him.



Sources: U.S. Census Bureau, International Data Base, decennial censuses, and 2014 National Population Projections. For more information, see Federal Interagency Forum on Aging Related Statistics (www.agingstats.gov): Older Americans 2016; and U.S. Census Bureau (www.census.gov): *An Aging World: 2015, 65+ in the United States: 2010*, and *The Older Population: 2010*.

COGNITIVE DECLINE

Sam's Story

Sam's son Jessie and his wife Lisa decide to invite him over for dinner for a discussion. They also invite Sam's good friend, Patrick, a Marine who served with Sam in Vietnam.

Sam is an hour late so it gives Jessie, Lisa and Patrick some time to talk. Patrick says, "I'm worried about him. He is more and more forgetful."

Lisa jumps in..."We have noticed the same thing. He also repeats himself. I worry that he is alone too much and sometimes wonder if he needs to move in here with us?"

Reference: Palmer NT, Ortega BT, Joshi P. Cognitive Impairment in Older Adults: Epidemiology, Diagnosis, and Treatment. *Psychiatr Clin North Am.* 2022 Dec;45(4):639-661.

[Link: Alzheimer's Association: Resources for caregivers](#)



COGNITIVE DECLINE

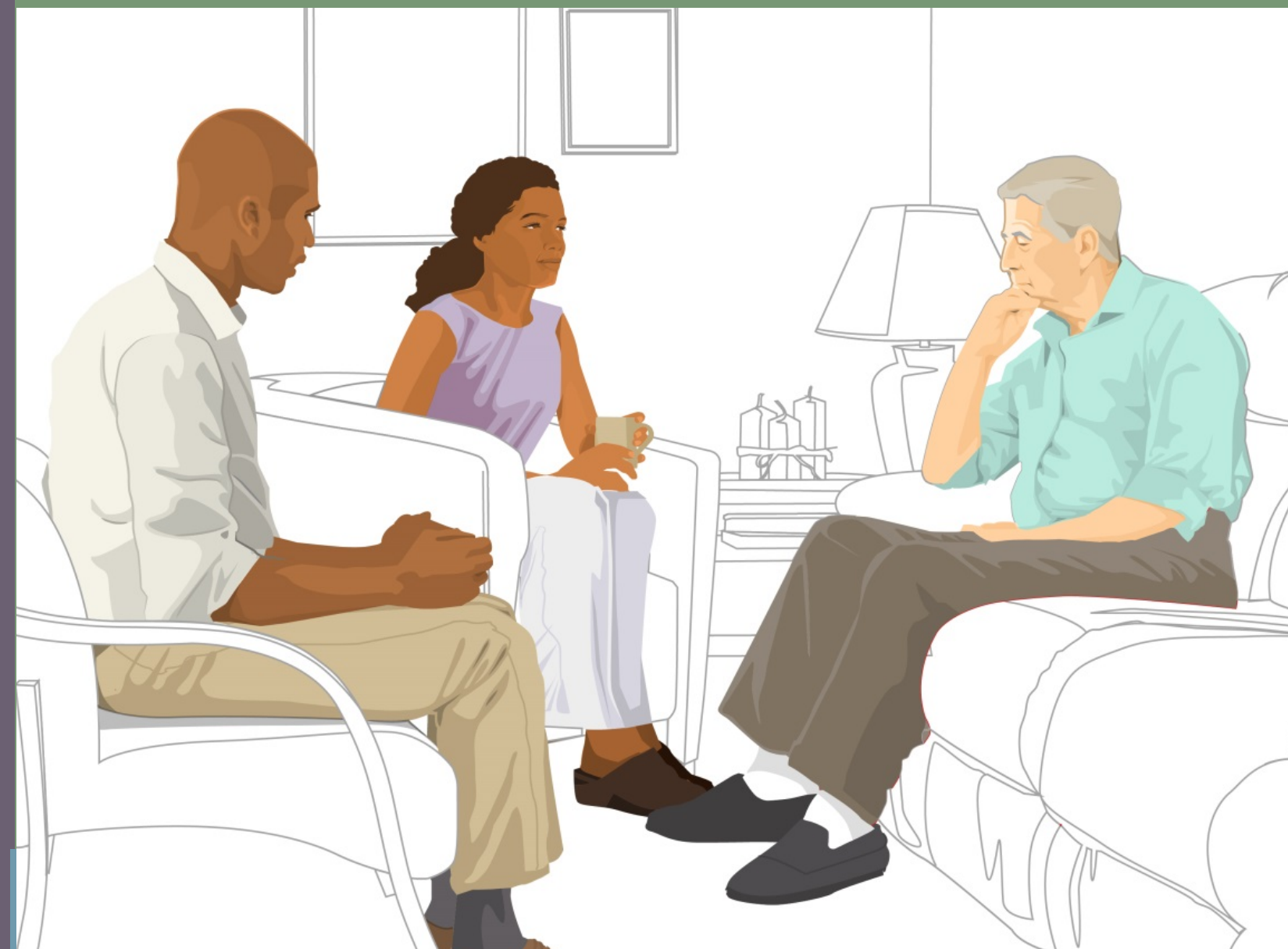
Sam's Story

Jessie says, “Dad hasn’t been coming into the shop as much, and he’s dropped some hobbies like checking out auto shows and fishing, which he used to love.”

Lisa raises the issue of Alzheimer’s disease, as she hears people talking about it during her volunteer work at the local senior center.

They wonder what all the symptoms are and if Sam’s “forgetfulness” is just a part of natural aging.

Reference: Liu CC, Kanekiyo T, Xu H, Bu G. Apolipoprotein E and Alzheimer disease: risk, mechanisms, and therapy. *Nat Rev Neurol*. 2013 Feb; 9(2): 106–118.



COGNITIVE DECLINE

Sam's Story

They all agree to bring up the topic gently during coffee after dinner.

Lisa notes that Sam's yearly physical at the Veteran's Administration (VA) is in two weeks, so it's a good time to discuss this. Sam is close to his daughter-in-law and since his wife died he has confided in Lisa about personal issues.

They hear the doorbell ring.

Lisa calls the children Michael and Zoe (ages 12 and 10) and asks them to get the door for their grandpa.

Sam apologizes for being so late. "I thought you said 7:30," says Sam.

They chat for a while and then go into the dining room for dinner.

[Link: Talking with Older Patients About Sensitive Subjects](#)



COGNITIVE DECLINE

Sam's Story

During coffee and after the children are gone, Jesse broaches the subject to Sam.

“Dad, we’re worried about you.”

Sam bristles at first and asks why, but then admits things are not going so well for him. He says he has been forgetting things more than usual and getting a little confused sometimes.

He also pats his stomach and says he knows he’s getting overweight and he doesn’t like it because he was always so active with work and stayed in shape.

Patrick sympathizes and says he knows how difficult it is to keep as fit when not working at a physical job.



COGNITIVE DECLINE

Sam's Story

Finally, Sam admits he hasn't been getting out much since his wife died, as she was always the one who organized the social activities.

They talk more and Lisa mentions Sam's yearly physical at the VA in a couple of weeks. Lisa asks if she could go with him so they could ask some questions together and she could be his "health advocate."

Sam reluctantly agrees. He already dislikes going to the doctor, much less having someone with him.

More information:

Determine a
["walkability score"](#)

[AARP's Livable
Communities: An
Evaluation Guide](#)

[National Institute on
Aging: Social Interaction
and Health](#)

[Watch: Environmental
drivers of chronic disease,
cognitive decline](#)



COGNITIVE DECLINE Sam's Story

Key Concept: Pathways of Neurodegeneration

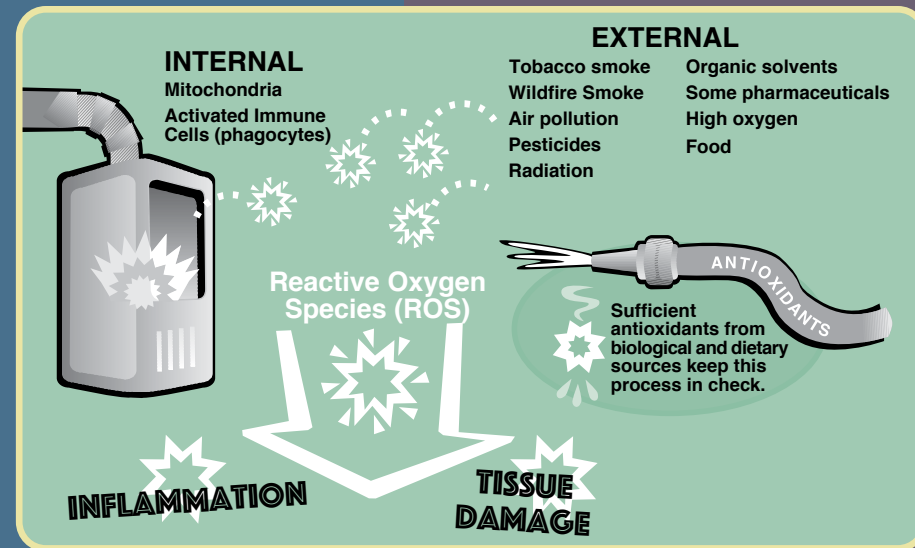
Multiple interrelated events are involved in the development of neurodegenerative diseases. These include inflammation, oxidative stress, microglial activation, mitochondrial dysfunction and protein aggregation.

These mechanisms clearly overlap, and regardless of which ones are the primary inciting processes in a given individual, each contributes to the ongoing neurodegeneration.

INFLAMMATION is a response to injuries, 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.

OXIDATIVE STRESS is both a consequence of and an important contributor to inflammation. Antioxidants, including those from dietary sources, help to keep reactive oxygen species (ROS) at healthy levels. Excessive oxidative stress (OS) occurs when levels of ROS are chronically elevated, damage tissues, and increase disease risk. ROS are highly reactive oxygen molecules,

Continued at right ->



Key Concept: Pathways of Neurodegeneration – Part 2:

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.

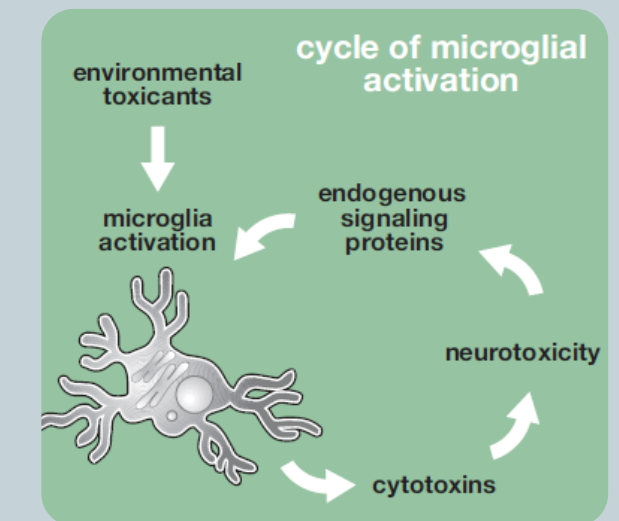
Overproduction of ROS and/or insufficient antioxidants leads to excessive OS. Exposure to air pollution, various industrial chemicals, pesticides, heavy metals, and radiation can also cause excessive ROS. Certain people may be genetically predisposed to have a limited capacity to detoxify ROS.

Microglial Activation - Microglia are immune cells that reside in the nervous system. Similar to macrophages in other tissues, they function to fight invading pathogens and to clean up debris that results from many types of injuries and cell death. Microglia are extremely sensitive to signals in their surroundings that indicate distress. Although the brain is normally protected from most pathogens by the blood-brain-barrier, when infectious agents or other inflammatory triggers do enter the brain microglia quickly "activate" in order to minimize damage to sensitive neuronal tissue. Microglia can also activate in response to heightened inflammatory signals from the peripheral circulation, such as can occur with some peripheral infections, inflammatory conditions, or even in response to dietary factors like saturated fats and some environmental toxicants.

The microglial response to distress signals is threefold--propagating distress signals to other microglia through the release of chemical messengers, releasing cytotoxic chemicals that can lead to cell death, and phagocytosing (devouring and digesting) debris. These cells are essential to the development of the nervous system and to its defense, but activated microglia can also be a double-edged sword. Persistently or inappropriately activated microglia can damage healthy neurons and are thought to play a role in perpetuating neurodegenerative processes in both AD and PD. This "double-edged" behavior of microglia

is exemplified by observations that some early-life infections, dietary factors or other environmental experiences may actually protect against microglial over-activation later in life.

Whereas some early life environments may launch harmful inflammatory cascades, healthful early life environmental enrichment may actually help to reduce microglial over-responsiveness later in life.



Certain substances from the nutritional and chemical environment are able to cross the blood-brain barrier and trigger microglial activation. When activated, microglia attempt to eliminate the perceived threat by releasing cytotoxic chemicals that may also damage neurons, which in turn can lead to the release of more microglia-activating compounds.

Mitochondrial Dysfunction - Mitochondria are intracellular organelles present in most human cells. Energy producing furnaces that metabolize glucose and make ATP, mitochondria provide the primary energy source for most of our biological processes. Because neurons are extremely energy-dependent cells that require large amounts of mitochondria, damage to mitochondria can markedly impair neuronal function and resilience. Mitochondria are susceptible to damage by oxidative stress and to certain toxicants such as the pesticide rotenone. Impaired mitochondrial function is seen in both PD and AD.

COGNITIVE DECLINE

Sam's Story

Sam and Patrick leave together. As they walk to their cars Patrick tells Sam not to worry too much.

“Let’s see what the doctor has to say first,” says Patrick.

“What if I do have something like Alzheimer’s?” says Sam. “That really scares me.”

“Don’t worry about that yet,” says Patrick.

“You’re right,” says Sam, “I don’t need any more worries right now.”

For more info:

[Alzheimer’s Association](#)

[Alzheimer’s Disease International](#)

References:

Alzheimer’s disease facts and figures. [Alzheimers Dement.](#) 2023 Apr;19(4):1598-1695.

GBD 2019 Dementia Forecasting Collaborators. Estimation of the global prevalence of dementia in 2019 and forecasted prevalence in 2050: an analysis for the Global Burden of Disease Study 2019 [Lancet Public Health.](#) 2022 Feb;7(2):e105-e125.



COGNITIVE DECLINE Sam's Story

Key Concept: Additional benefits of public policy

Example: Reducing exposures to air pollution and lead benefit the aging brain

A growing number of studies indicate that the age-specific risk of Alzheimer's and other dementias in the U.S. and Northern Europe may have declined in the past 25 years. An autopsy study in Switzerland also reported reduced age-adjusted amyloid deposition from 1972 to 2006 (Kovari, 2014).

These declines have largely been attributed to increasing levels of education and improved control of cardiovascular risk factors but they do not fully account for the trend (Satizabal, 2016). Additional possible explanations include environmental policies initiated in the 1970s that resulted in sharply lower population-wide exposures to air pollution and lead—exposure to each of which is linked to higher risk of cognitive decline and dementia.

In the US, in response to growing, widespread air pollution, the 1970 Clean Air Act amendments for the first time required comprehensive federal and state regulations for stationary and mobile sources of air emissions. Airborne lead was among the pollutants addressed, and the US EPA first announced regulations to limit the amount of lead in gasoline in 1973. The phase-out of lead in gasoline was completed in most areas of the country by the early 1990s. Most European countries phased-out lead in gasoline during the same time period (Lovei, 1997).

Cleaner air, less lead, positive outcomes

During the 45 years since the 1970 Clean Air Act amendments, air quality has dramatically improved in most of the US. According to the US EPA, aggregate national emissions of six common pollutants—particles, ozone, lead, carbon monoxide, nitrogen dioxide, and sulfur dioxide—dropped by an average of 69 percent from 1970-2014. Between 1980 and 2014, national concentrations of air pollutants



[Link: Gasoline-Related Air Pollutants in California – Trends in Exposure and Health Risk, 1996 to 2014](#)

continued from left:

improved 98 percent for lead, 85 percent for carbon monoxide, 80 percent for sulfur dioxide, 60 percent for nitrogen dioxide, and 33 percent for ozone. Fine particle concentrations fell by 36 percent and coarse particle concentrations fell by 30 percent between 2000—when trend data for fine particles began—and 2014. But these improvements are not evenly distributed. Air pollution in some communities in various regions of the US frequently and chronically exceeds regulatory health-protective levels.

With removal of lead from gasoline and most kinds of paint, childhood and adult lead levels dramatically declined. According to the CDC, average blood lead levels in US toddlers has fallen from about 16 micrograms/dL in 1974 to less than 2 micrograms/dL today.

In adults, blood lead levels began to fall in the mid-1970s from an average of about 15 micrograms/dL to 9 micrograms/dL in 1980, a reduction of nearly 40 percent (Annest, 1983). This was largely attributable to reduction in lead in gasoline. By 1990, the average adult blood lead level fell further to 3 micrograms/dL. The CDC also reports a steady decline in the number of adults with blood lead levels higher than 25 micrograms/dL since 1994 when systematic tracking began, although an estimated 10/100,000 workers still exceed that level.

Impacts

Estimates of benefits coming from improvements in air pollution generally focus on avoided premature mortality and cardiovascular and pulmonary disorders. For lead, enduring harmful impacts on the developing brain of children are primary motivations for further reduction of even low-level exposures.

As populations age, projected increases in dementia-related disability, family stress, and costs of care are staggering. Better diets, more exercise, and avoiding smoking surely help slow and may prevent dementia onset. But, as evidence mounts, we can more confidently include delayed and prevented cognitive decline and dementia among the benefits of public policies that have reduced population-wide exposure to air pollution and lead.

continued on right ->

COGNITIVE DECLINE Sam's Story

Still, Sam can't help but worry over the next couple of weeks while he waits to see his primary care doctor.

He visits his neighbor, George, to share some of his worries. George has Parkinson's disease so Sam figures he'll find a sympathetic listener as George has told him that cognitive impairment and dementia are features of PD.

For more info:
[Parkinson's Foundation](#)

Graphics used with permission from:
Poewe W, Seppi K, Tanner CM, Halliday GM, Brundin P, Volkmann J, Schrag AE, Lang AE. Parkinson's Disease. Nat Rev Dis Primers. 2017 Mar 23;3:17013.



COGNITIVE DECLINE

Sam's Story

Sam tells George what's been going on with him forgetting things and missing appointments. Sam says he doesn't know what could be causing these problems but that he knows he's kind of let himself go since his wife died. George says he understands how that can happen.

“George, did your doctor tell you what could have caused your disease?” asks Sam.

“He told me it could be any number of things, from exposure to environmental chemicals such as pesticides to head trauma to genetics, or even some combination of them,” says George.

Sam shakes his head.

“I don't think I was exposed to pesticides but apparently they are used everywhere,” says George. “A lot of my neighbors spray their lawns all the time.”

“Yes, I see that too,” says Sam.” Well, George, I have to get going, says Sam. “Take care, I'll stop by again soon.”

Reference: Marras C, Canning CG, Goldman SM. Environment, lifestyle, and Parkinson's disease: Implications for prevention in the next decade *Mov Disord.* 2019 Jun;34(6):801-811.



COGNITIVE DECLINE Sam's Story

Pesticides and Parkinson's Disease

- Many epidemiologic studies find that pesticide use/exposure is associated with an increased risk of Parkinson's disease, although exposure levels are usually difficult to assess. Meta-analyses of data from ~50 studies found 60-70% increased risk, although risk varied considerably among the individual studies (van der Mark, 2012; Pezzoli, 2013). Pesticides may also increase the rate of progression in people with Parkinson's (Li, 2023).
- Because many people don't know which specific pesticides they may have been exposed to, individual agents have been infrequently studied. Nonetheless, a more than doubling of Parkinson's disease risk has been associated with the insecticide rotenone (Tanner, 2011), the herbicide paraquat (Tanner, 2011; Gatto, 2009), and with several organochlorine insecticides (Elbaz, 2009; Fitzmaurice, 2014), among others (Goldman, 2014).
- These findings are biologically plausible since studies in tissue models and in laboratory animals (predominantly rodents) show that many pesticides damage dopaminergic neurons in the striatal region of the brain, a primary area involved in the pathology of Parkinson's disease (Uversky, 2004; Baltazar, 2014). In fact, several of these compounds (e.g., rotenone, paraquat) are used to produce animal models of Parkinson's disease, because they so closely reproduce the pathological and clinical features of the disease (McCormack, 2002; Cannon, 2009).
- Studies in rodents also show that prenatal or early life exposures may be particularly important, and may increase sensitivity to these same chemicals later during adult life (Barlow, 2004; Nasuti, 2017).



For more info:
[USDA Agricultural
Chemical Use Program](#)

Watch: Pesticides and Parkinson's disease

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Professor, Division of
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and Climate Medicine at
University of California
San Francisco



Protecting workers from pesticide exposures

- People who handle pesticides occupationally or are exposed because of proximity to agricultural pesticide applications may be at higher risk (Gatto, 2009; Tanner, 2011). Some people are at higher risk because they have genetic polymorphisms that may affect their ability to metabolize and detoxify certain pesticides (Goldman, 2012; Narayan, 2015).
- Although we have no control over our genetic makeup, using protective equipment such as respirators and chemically resistant gloves when handling pesticides may help reduce risk (Furlong, 2015). PD risk from some pesticides may also be lower in persons who consume high levels of polyunsaturated fats, possibly due to anti-inflammatory activity of omega-3 fatty acids. Conversely, risk may be higher in those who consume high levels of saturated fats (Kamel, 2014).

More info:

[Pesticide Safety Rules
for Farmworkers](#)

COGNITIVE DECLINE

Sam's Story

Pesticides and cognitive decline/dementia

- Despite challenges in quantitative exposure assessments, a growing number of studies link pesticide exposure to cognitive dysfunction and dementia, including Alzheimer's disease.
- A review of 14 studies (6 prospective cohort, 7 case-control, 1 ecologic) evaluated the association of pesticide exposure with cognitive and neurobehavioral performance, cognitive dysfunction, Alzheimer's disease, frontotemporal lobe dementia, vascular dementia and Parkinson's disease dementia (Zaganas, 2013). Three studies of cognitive function each reported poorer performance associated with a history of pesticide exposures. Five of seven studies of Alzheimer's disease reported a significantly increased risk with a history of pesticide use (OR or RR 1.42-4.35). Three studies also showed an increased risk of vascular dementia (OR 2.05; 2.6) or PD-dementia.
- In a more recent study of 430 older Mexican Americans from the Sacramento Area Latino Study on Aging, those who were exposed to higher levels of organophosphate pesticides beginning five years prior to assessment, as determined by residential proximity to agricultural fields where pesticides were applied, experienced faster cognitive decline and higher mortality over a follow-up period of nine years (Paul, 2018).



Watch: Pesticides and Alzheimer's disease
 Samuel M. Goldman, MD, MPH,
 Professor, Division of
 Occupational, Environmental
 and Climate Medicine at
 University of California
 San Francisco



Pesticides and insulin resistance, metabolic syndrome

- A large and growing number of studies find an association between exposure to various endocrine disrupting chemicals, including some pesticides, and a higher risk of obesity, insulin resistance, diabetes (Petrakis, 2017; Gore, 2015). As previously noted, these conditions increase the risk of cognitive decline and dementia in later years.

COGNITIVE DECLINE Sam's Story

His conversation with George doesn't make Sam feel any better. He continues to worry if he has Alzheimer's or some kind of senility as they used to call it years ago – and, if there's anything he can do about it now.



COGNITIVE DECLINE Sam's Story

Two weeks later Sam meets Lisa at the VA hospital where he has his appointment with his primary care physician, Dr. Gomez.

Lisa stays in the waiting area while Sam is examined.

Sam apologizes for missing his last appointment and tells Dr. Gomez of his concerns about forgetting things and missing appointments. He says his wife was ill and passed away during that time.

Dr. Gomez offers condolences and says that Sam must have been under a lot of stress during that time.

Sam nods yes.



COGNITIVE DECLINE Sam's Story

Dr. Gomez looks over Sam's blood work and blood pressure then continues with a physical exam.

He reminds Sam that during his last visit (over a year ago) Sam's blood sugar level was higher than it should have been and that he had cautioned Sam about his diet.

Dr. Gomez says that now it's high enough to indicate he has pre-diabetes.

He also says that Sam's blood pressure is too high and he's worried about hypertension.

For more info:
[Mayo Clinic
Patient Care &
Health Information](#)

Note: See also [references](#) addressing diabetes as a risk factor for dementia.



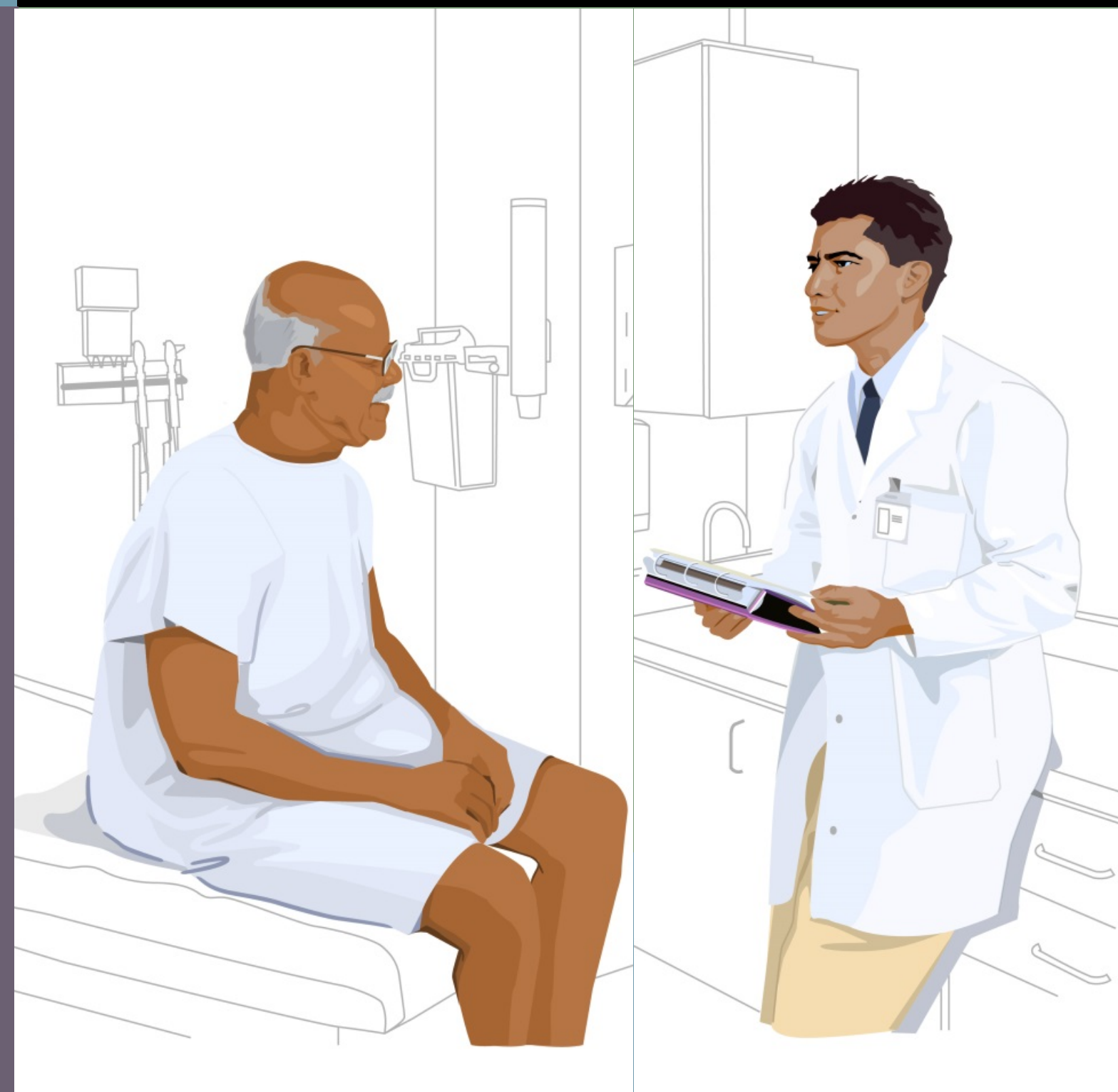
COGNITIVE DECLINE Sam's Story

Dr. Gomez also asks Sam if he is feeling lonely, down or depressed.

When Sam replies that he has been depressed since his wife died, Dr. Gomez asks him if he is drinking more than usual or using other kinds of drugs.

Sam says he has been drinking more than he used to, several beers a day.

When his exam is over Dr. Gomez invites Sam into his office for further discussion. Sam says he'd like his daughter-in-law Lisa to be there.



COGNITIVE DECLINE

Sam's Story

Dr. Gomez welcomes Lisa and listens to more concerns from Sam and Lisa about Sam's memory. He says he would like to take a brief history relating to Sam's service postings and occupations.

He pulls up Sam's service record on the computer and sees that Sam was in boot camp at Camp Lejeune in North Carolina in the 60's prior to deployment to Vietnam.

Dr. Gomez is aware of the issue of water contamination at the base and possible health effects there because of another one of his patients who was stationed there.

He also notes the areas where Sam was deployed in Vietnam. Health concerns due to exposure to Agent Orange and other pesticides sprayed by the US to defoliate have been identified by the VA.

Link:

[Environmental
Exposure History
Form](#)

More information:

[Camp Lejeune:
Help for Veterans](#)

Links for more information:

[Veterans' Diseases
Associated with Agent
Orange](#)

[Exposure to Agent Orange
by Location](#)

[Health care and disability
benefits](#)



COGNITIVE DECLINE

Sam's Story

Dr. Gomez also asks about Sam's work history.

Sam says he worked as a house painter for many years and then started an auto body shop that is now managed by his son Jessie.

Sam explains that he used to go to the shop every day to help Jessie. Now he mainly goes in for coffee a few times a week and visits the shop much less.

Lisa tells Dr. Gomez that Sam was a pioneer in retrofitting his body shop to prevent community pollution as well as to prevent employee exposures to toxicants, in conjunction with a local neighborhood initiative.



For more info:

[The MA Clean Auto Repair Guide](#)



Local organizing resources:

- [Dudley Street Neighborhood Initiative](#)
- [Alternatives for Community and Environment](#)
- [Urban Environmental Infrastructure in Boston: Case Study](#)

Business interventions resources:

- [Clean Air Act Partnership programs](#)
- [Reducing pollution from auto body shops](#)
- [MA Toxics Use Reduction Institute](#)
- [California Healthy Nail Salon Collaborative](#)
- [Clean Production Action's Chemical Footprint project](#)
- [Association for the Advancement of Alternatives Assessment](#)

COGNITIVE DECLINE Sam's Story

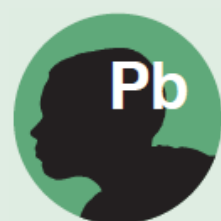
Workplace risk factors: Effects of lead on cognitive function

While lead's role as a neurodevelopmental toxicant and a danger to infants' and children's health has been well known, more recent evidence shows that lead is a neurotoxicant across the lifespan.

Higher cumulative lifetime lead exposures, as estimated by bone lead levels, are associated with higher risk of impaired cognitive function (Shih, 2007; Bandeen-Roche, 2009; Weuve, 2009) as well as Parkinson's disease (Coon, 2006; Weisskopf, 2010; Weuve, 2013). The impacts on various measures of cognitive function are particularly pronounced in studies of older people whose bone lead levels are elevated, regardless of current blood lead levels. These findings are supported by experimental data (Wu, 2008; Basha, 2005).

Lead in the workplace

Lead is still used in some industrial processes and fuels. Some people are more highly exposed because of recycling practices, occupation, or environmental contamination. OSHA estimates that approximately 804,000 workers in general industry and an additional 838,000 workers in construction are potentially exposed to lead (Shaffer and Gilbert 2018). Organic lead compounds continue to be used in high octane fuel in the aviation industry for piston engine aircraft.



INTERACTIVE EFFECTS OF LEAD AND STRESS ON ELDER COGNITION

It's well established that childhood lead exposure harms cognitive development in childhood. More recent evidence shows that cumulative lead exposure harms cognitive function later in life as well. Chronic stress can exacerbate the adverse impacts of lead on cognitive function.

Where is the Lead?

- Formerly used in house paint, gasoline, water-pipes, solder in food cans.
- Currently found in car batteries, building material, imported pottery, some cosmetics, some traditional (indigenous or folk) medicine, older water pipes, older house paint, some types of industrial paint, aviation fuel, fishing and wheel weights, ammunition. Used as a stabilizer in some plastics.
- Most common sources of exposures: older paint, dust, and water pipes.



Workplace risk factors - Neurotoxic effects of solvents

Organic solvents, used to dissolve other substances, are widely used in the workplace and at home. They include dozens of substances, including ethanol, toluene, formaldehyde, glycol ethers among many others and are used extensively in consumer products and workplace manufacturing. Health effects from exposure to solvents include neurotoxic effects.

Workplace exposures to organic solvents can result in acute and chronic neurobehavioral disorders depending on the extent and duration of exposure. Acute neurotoxic effects are CNS depression, impaired psychomotor function as measured by reaction time, manual dexterity, and coordination. High exposure levels can cause unconsciousness or death.

Lower-level exposures occurring repetitively over a prolonged period of time can result in peripheral neuropathy and chronic solvent-induced encephalopathy (CSE), characterized by fatigue, mood changes, memory loss, difficulty in concentration, loss of



initiative, and headache. More severe cases of CSE can result in severe deterioration of intellect and dementia. A systematic review of published studies meeting specified inclusion criteria and reporting on long-term neurological, neuropsychological, physical and mental health perceptions and social consequences of CSE found that it is generally a non-progressive disease without severe deterioration after diagnosis, presumably attributable at least in part to cessation of exposures (van Valen, 2009).

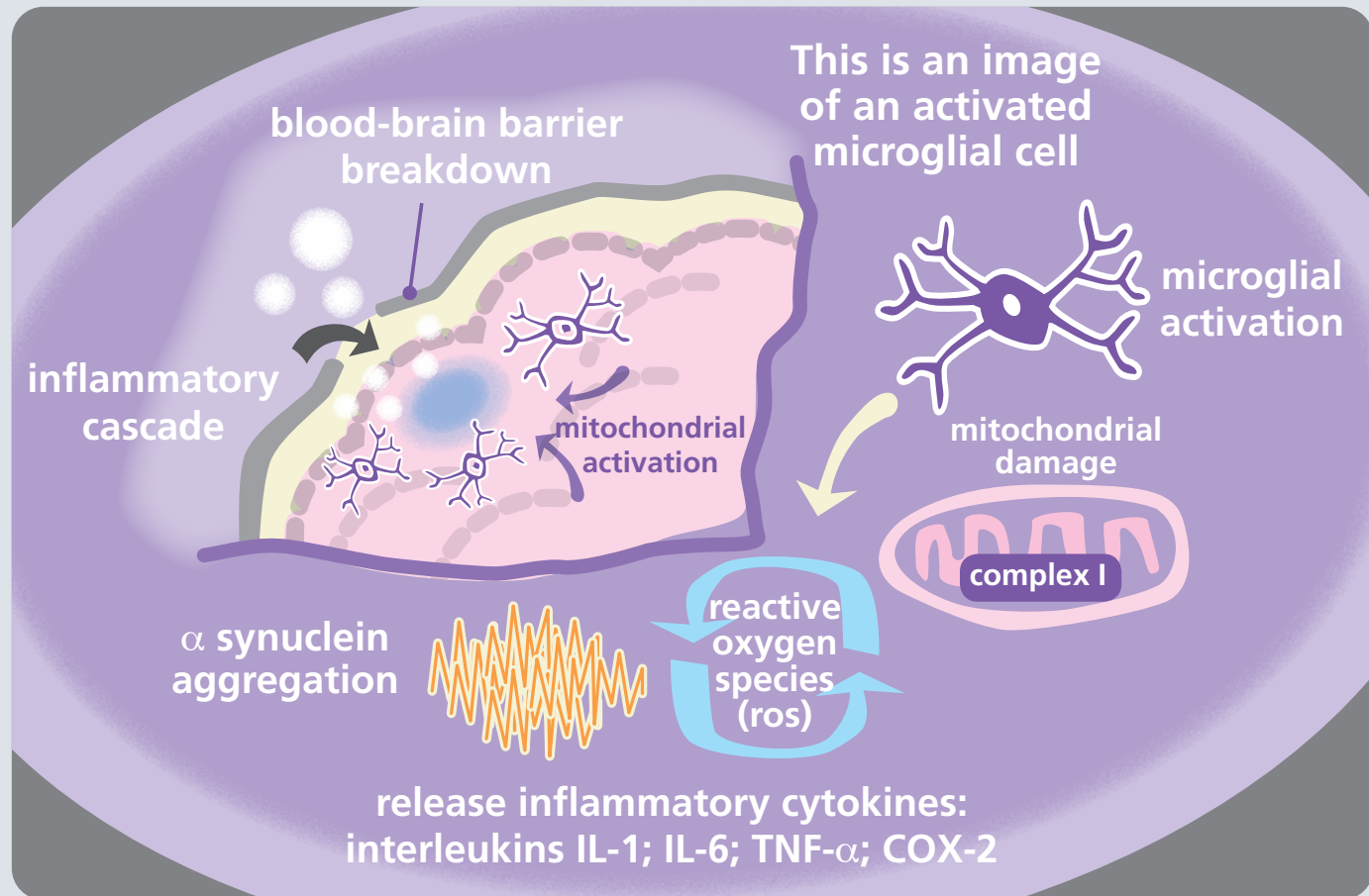
COGNITIVE DECLINE Sam's Story

Dr. Gomez then asks if Sam ever played football.

Sam says he played in high school but never had any unusual injuries.

Lisa says she's read a lot about football head injuries because her son wants to play and she is concerned.

Head Injury



COGNITIVE DECLINE Sam's Story

Dr. Gomez asks Sam a few more questions about his depression to get a better understanding of it.

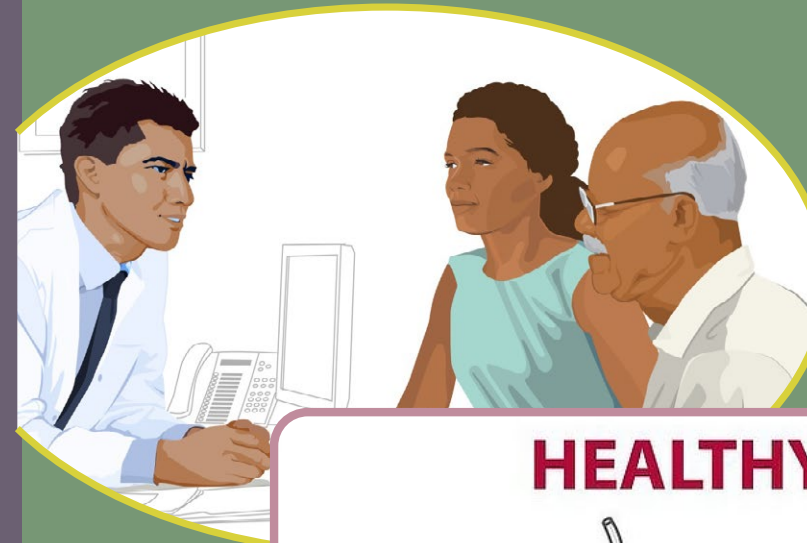
After he finishes his questions, Dr. Gomez says that it's completely understandable for Sam to feel depressed after the loss of his wife and that it may be contributing to his memory problems. While he recommends addressing this, Sam also needs to pay attention to other things, so Dr. Gomez is prescribing blood pressure medication for Sam to start and emphasizes the need for Sam to improve his diet and exercise routine. He gives Sam some handouts on the "DASH" and Mediterranean diets and some exercise routines he could start such as walking for 30 minutes every day. He explains that these diets are also beneficial to heart and brain health.

In addition, he says that based on everything he has heard he'd like Sam to see a specialist in neurology at the VA. He adds that at this point it is really a precaution.

This worries Sam. He is not happy to have to see another doctor but reluctantly agrees. Dr. Gomez tells Sam he'll get a call about the appointment in the near future.

Sam and Lisa head home. Lisa invites Sam over but he says he wants to go home.

Lisa drops Sam off at his house and asks him to let her know the date of the appointment with the specialist so she can schedule it. She says she'll call him tomorrow.

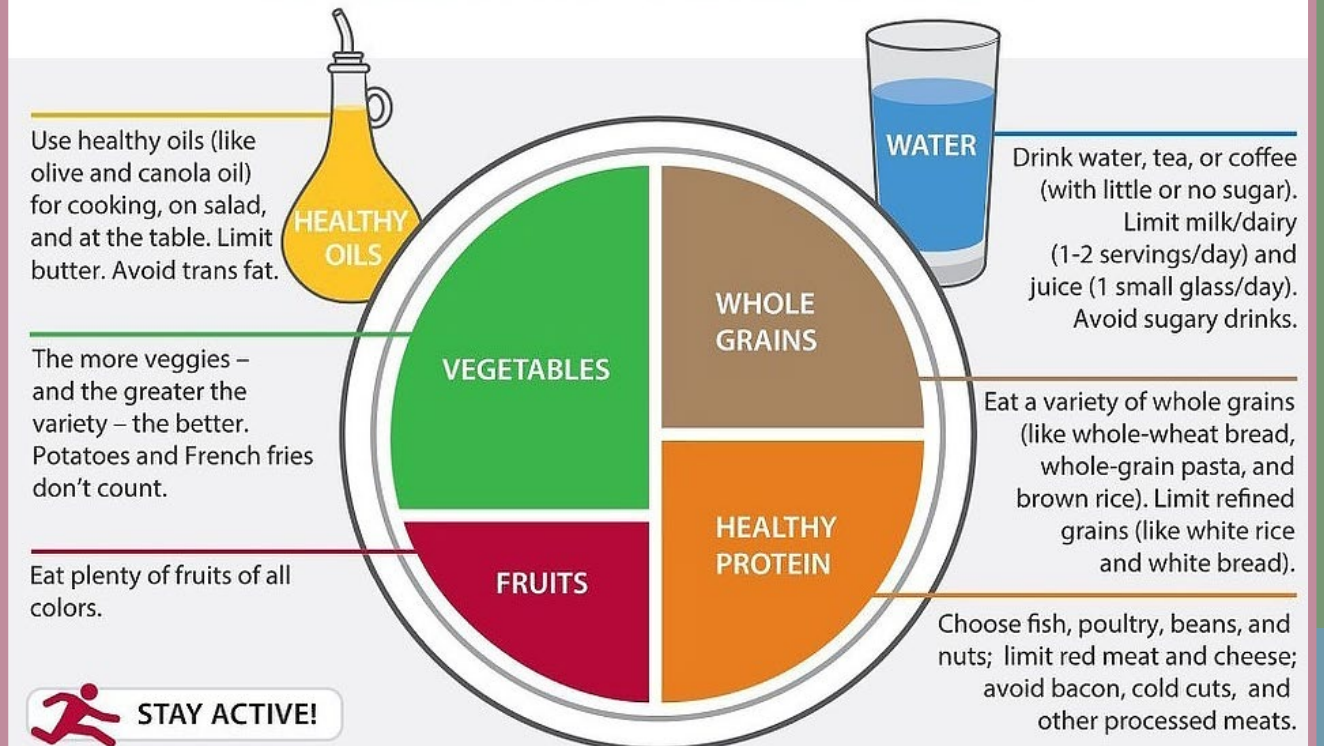


NIH: About the DASH Eating Plan

Mayo Clinic: Mediterranean diet: A heart-healthy eating plan

del Pozo Cruz B, et al. Association of Daily Step Count and Intensity with Incident Dementia in 78, 430 Adults Living in the UK. JAMA Neurol. 2022; 79(10):1059-1063.

HEALTHY EATING PLATE



© Harvard University

Harvard School of Public Health
The Nutrition Source
www.hsph.harvard.edu/nutritionsource

Harvard Medical School
Harvard Health Publications
www.health.harvard.edu



Harvard Health Publishing: The Healthy Eating Plate

COGNITIVE DECLINE Sam's Story

The next day Sam calls Patrick to update him.

“More doctors and probably more tests,” says Sam.

Patrick says, “I know it’s not fun but if it helps that will be good. I’ll go over there with you if you want.”

Sam says “That’s OK, I can do it, and Lisa insists on coming with me, which is probably good because I’m not listening too well these days.”

“OK pal, but I’m here for you if you need me.”



COGNITIVE DECLINE

Sam's Story

Sam gets a call about an appointment with the specialist at the VA. It is in a few weeks.

He is nervous because he wants to know more as soon as possible.

After dwelling on it for a while Sam thinks about how his diet has gone downhill since his wife died, and how he isn't getting much exercise either.

Sam starts his daily blood pressure medication and reviews the diet recommendations from Dr. Gomez. He sees it's mostly like the food his wife had started to make before her illness - lots of fresh vegetables and fruits, fish and lean meats, olive oil and whole grains.

He doesn't think it will be very difficult to get back into that routine because he's always enjoyed cooking although his skills are a bit rusty. He also thought he could check out the nearby takeout restaurant that advertised more healthy foods.



COGNITIVE DECLINE

Sam's Story

The weeks go by and it's time for Sam to go to the VA hospital clinic to see the neurology specialist, Dr. Todd. He meets Lisa again outside the hospital and they go in together.

Lisa waits while Sam sees the doctor.

Dr. Todd has reviewed the notes from Sam's environmental and social histories. Over the next hour she conducts a physical and a mental status examination.

She asks Sam if he has had any hearing loss. She says hearing loss can be mistaken for cognitive decline. She also asks Sam more questions about his past including possible exposures to substances such as lead, even when he was a child.



For more detailed practice guidelines, see:

[AAN: Practice guidelines on MCI](#)

[AAFP: Evaluation of Suspected Dementia](#)



COGNITIVE DECLINE Sam's Story

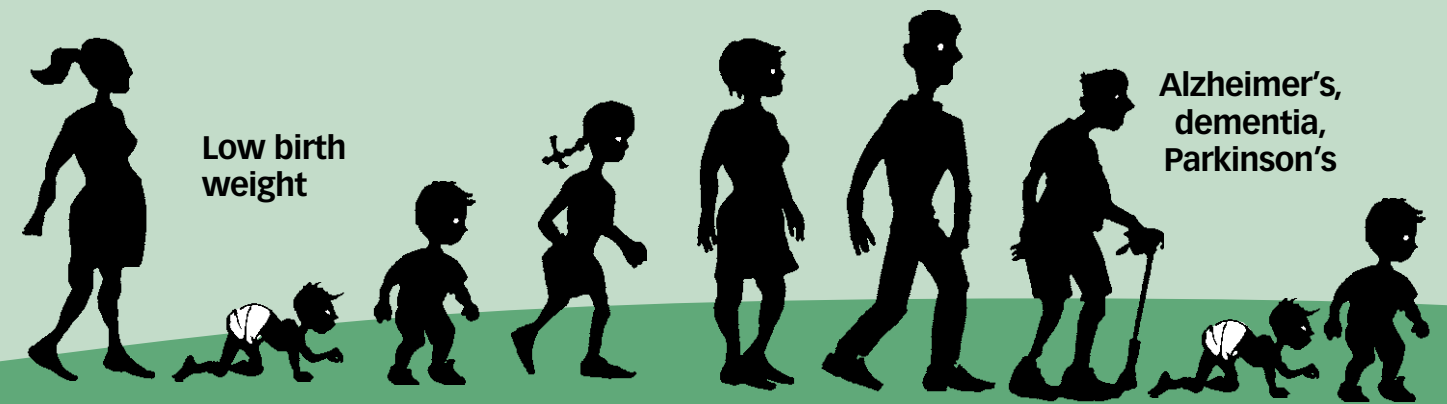
Sam says he really isn't sure about what he was exposed to when he was a child, but says he lived in the city in a rather poor neighborhood.



Early life experiences can influence later-life health, disease.

Toxic exposures, oxidative stress

Obesity, hypertension, cardiovascular disease, diabetes



Aging begins at conception.



Watch: Lead and Neurodegeneration

Samuel M. Goldman, MD, MPH, Professor, Division of Occupational, Environmental and Climate Medicine at University of California San Francisco

COGNITIVE DECLINE

Sam's Story

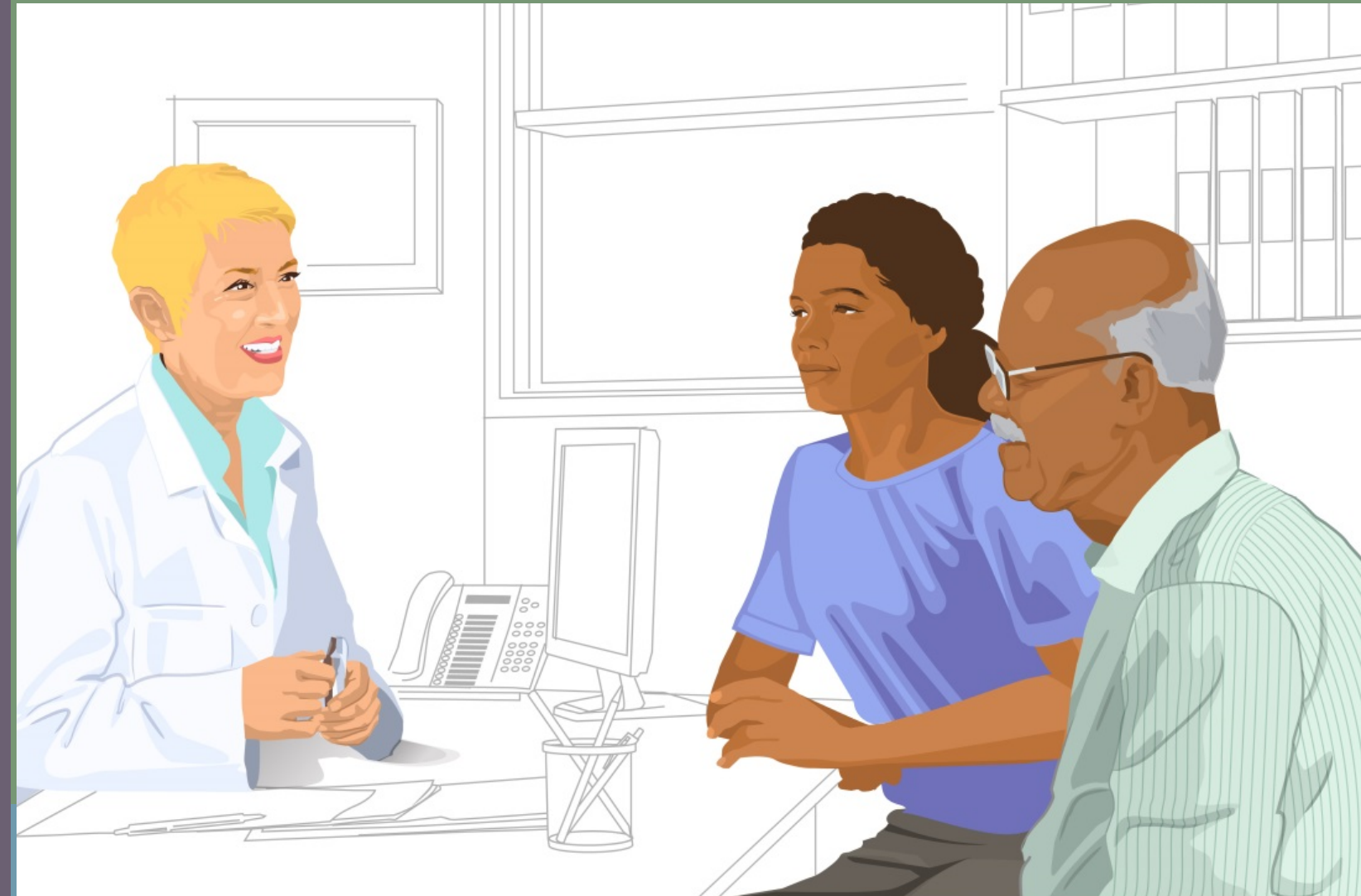
Dr. Todd completes the exam. She asks Sam and Lisa to join her in the office for some discussion.

She says she agrees with Dr. Gomez that it's important to treat Sam's blood pressure. She also emphasizes the importance of improving his diet including cutting down on his alcohol intake, and getting more exercise.

She says she will speak to Dr. Gomez about addressing Sam's depression, and gives him a pamphlet about VA support groups for grief that she thinks might help Sam.

Dr. Todd tells Sam she'd like to do some more blood tests with a goal of trying to identify any underlying, treatable conditions that might exist. She also says she'd like Sam to get a hearing test at the audiology lab.

Dr. Todd says he can go to the lab for the blood work, and she'll see if she can also get him in for the hearing test that day.



COGNITIVE DECLINE Sam's Story

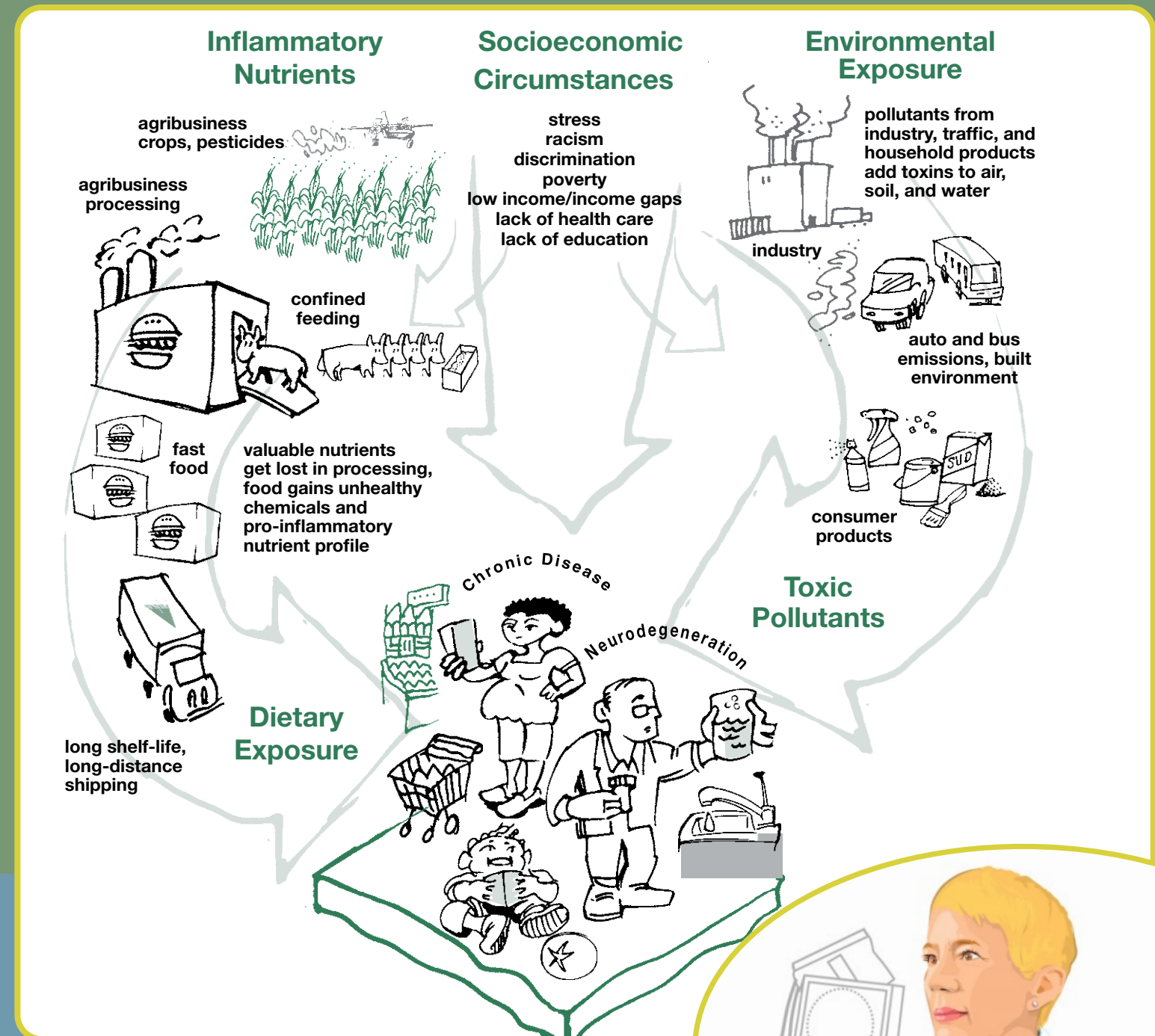
Finally, Dr. Todd tells Sam and Lisa that everything she has seen so far is consistent with mild cognitive impairment, perhaps related to Sam's depression.

She tells Sam she wants to see what the additional tests show and see him again in two months.

She also says she is happy to refer him to the environmental health clinic as he might be eligible for benefits because of his exposures during his time in the military.

Sam says he'll think about that.

Sam asks Dr. Todd what causes cognitive decline or diseases like Alzheimer's. Dr. Todd says it's different for every individual but it is usually a complex interaction of environmental and genetic factors.



COGNITIVE DECLINE Sam's Story

Environmental chemical and pollutant influences on the brain

Virtually all people and wildlife are exposed regularly to a complex mixture of industrial chemicals and other environmental pollutants.

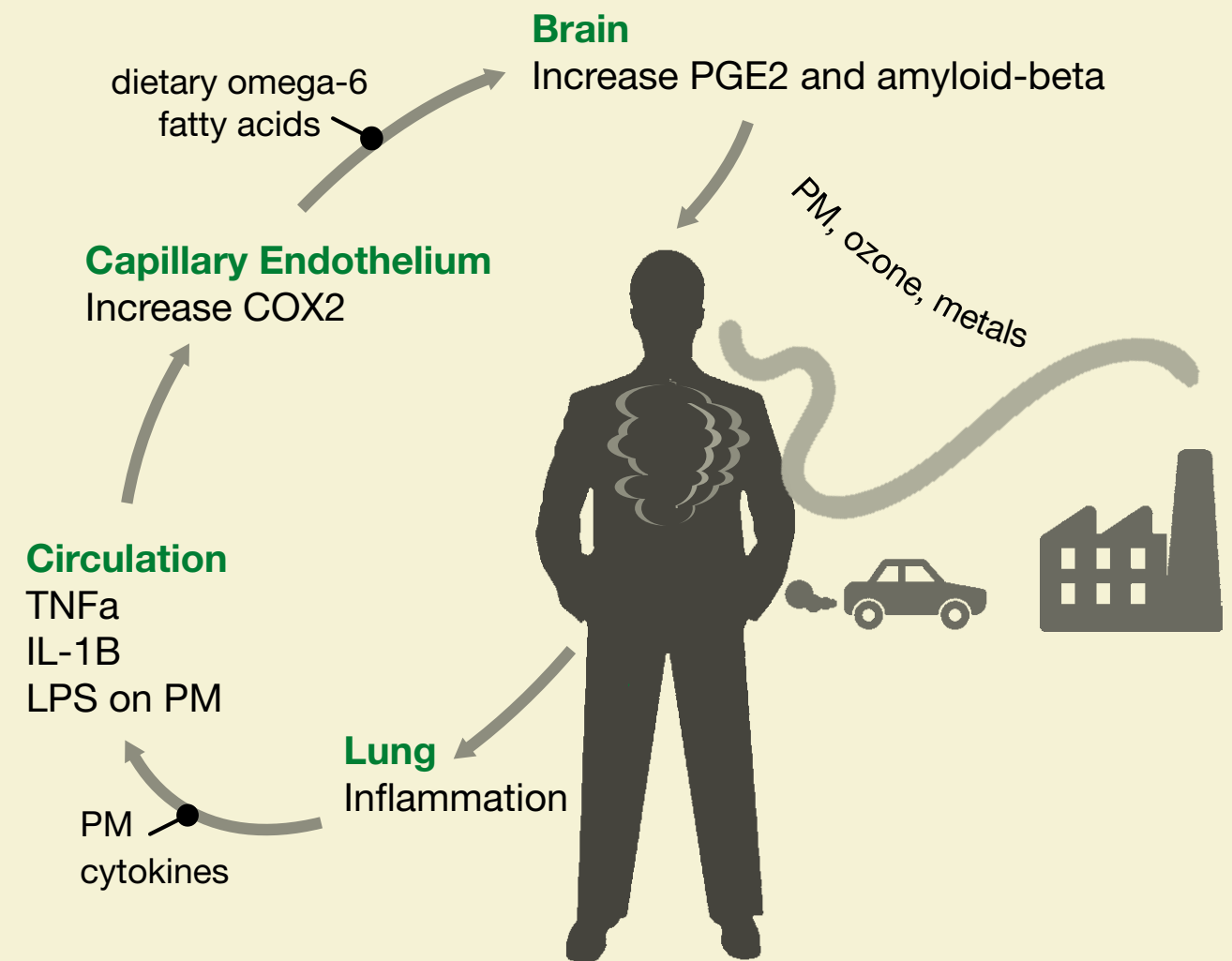
The vast majority of the many thousands of chemicals in commercial use in the U.S., including several thousand chemicals used in high volume, have not undergone adequate safety testing.

Many contribute to the risk of common diseases, including neurodegenerative disorders, through a variety of mechanisms. In addition to previously-discussed lead, pesticides, and solvents, another example is air pollution.

Air pollution is not only harmful to the cardiovascular system and lungs, but also to the brain. It increases inflammatory changes and markers of Alzheimer's-type and Parkinson's-type neurodegenerative diseases.



From the Smoke Stack to Your Brain Air Pollution is Linked to Brain Inflammation & Amyloid-Beta Deposition



This diagram represents some of the pathways and mechanisms through which air pollution is thought to have inflammatory and degenerative effects in the brain.

COGNITIVE DECLINE Sam's Story

Sam and Lisa leave Dr. Todd's office.

"Lisa, I feel like I've just gotten a wake-up call," says Sam as they leave. "I sure don't want my mind to get any worse."

He vows to eat a healthier diet, including more fruits and vegetables.

The next day he calls Patrick to make plans to go walking at least three times a week in the morning and have coffee afterward. And he even checks out the prices at the local gym where Patrick is a member.



COGNITIVE DECLINE

Sam's Story

Lisa, Jesse and the kids also try to help Sam.

“We all need to be as healthy as we can now and to prevent future disease,” says Lisa.

They decide to meet as a family on Sundays and do some healthy outdoor activity at the park, which will benefit everyone in the family, not only Sam.

Sam also thinks about volunteering with the group he worked with to help reduce pollution from his auto body shop. He saw in the paper that the annual meeting was coming up so he thought he'd go and see if he could reconnect.



SOME FINAL THOUGHTS

COMMON THEMES

Although the fictional narratives in *A Story of Health* describe the lives of children and adults with different conditions and diseases – childhood cancer, infertility, asthma, developmental disabilities, cognitive decline and health effects of wildfires, common themes resonate. They include:

- Important environmental influences come from the natural, chemical, food, built, and social environments.
- Although there are exceptions, most diseases as well as good health are the result of complex interactions among multiple environmental influences and genetics.
- Early-life experiences, particularly during critical windows of development, can have profound beneficial or detrimental lifelong effects, even into elder years.
- Healthy people and healthy communities are interdependent. All people do not have equal access to nutritious food, clean air and water, safe workplaces, healthy housing, green spaces, peaceful neighborhoods or quality health care.
- Preventing disease and promoting health require actions and commitments from the individual, family, community and society. Health promoting public policies are necessary to make healthy living available to all people.

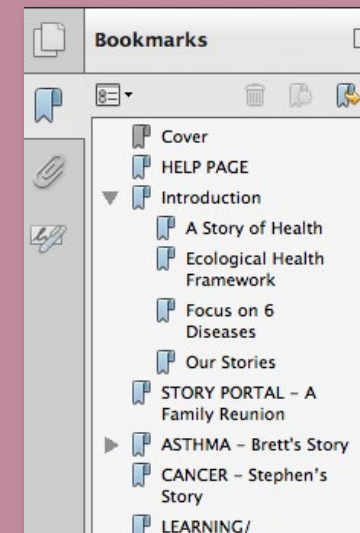


Watch: Samuel M. Goldman MD MPH's Summary: Opportunities for prevention

Samuel M. Goldman, MD, MPH, Professor, Division of Occupational, Environmental and Climate Medicine at University of California San Francisco

Bookmarks

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



Additional Resources

[Pediatric Environmental Health Toolkit application for mobile devices](#)

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



Continuing Education

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

Cognitive Decline References

Note: there are many topic overlaps

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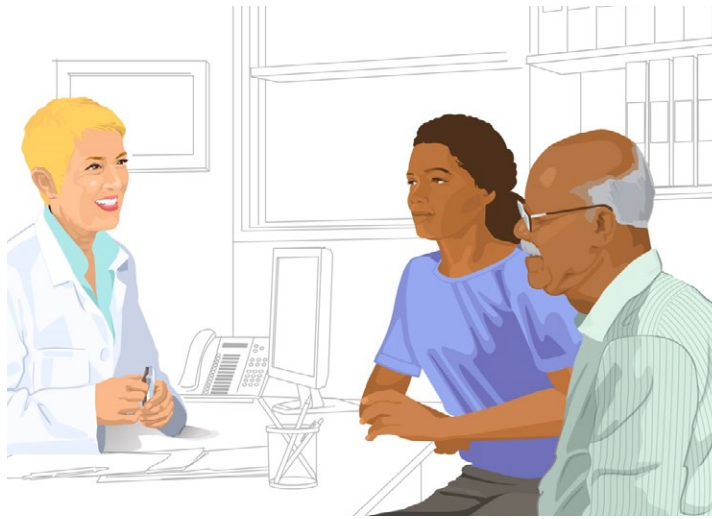
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