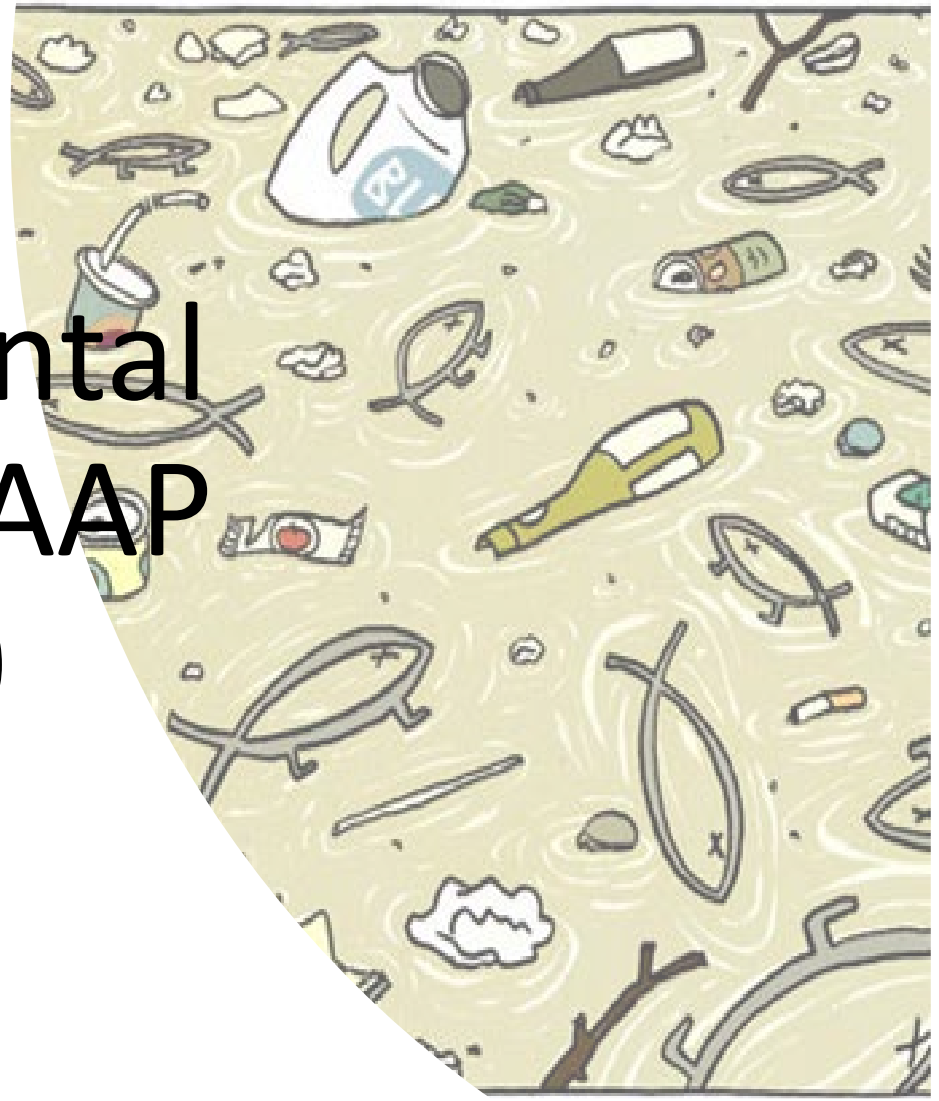
Pediatric Environmental Health – Annual NE AAP Conference 2020



Elizabeth Friedman, MD, MPH

October 2020

MAPEHSU
MID-AMERICA PEDIATRIC ENVIRONMENTAL HEALTH SPECIALTY UNIT

BEST CHILDREN'S HOSPITALS U.S.News RANKED IN 10 SPECIALTIES 2020-21

MAGNET RECOGNIZED AMERICAN NURSES CREDENTIALING CENTER

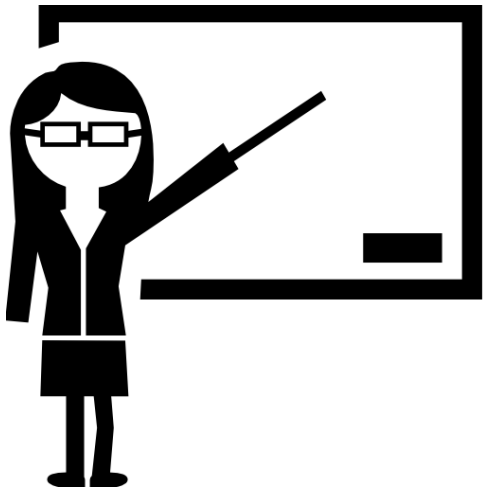
UMKC School of Medicine

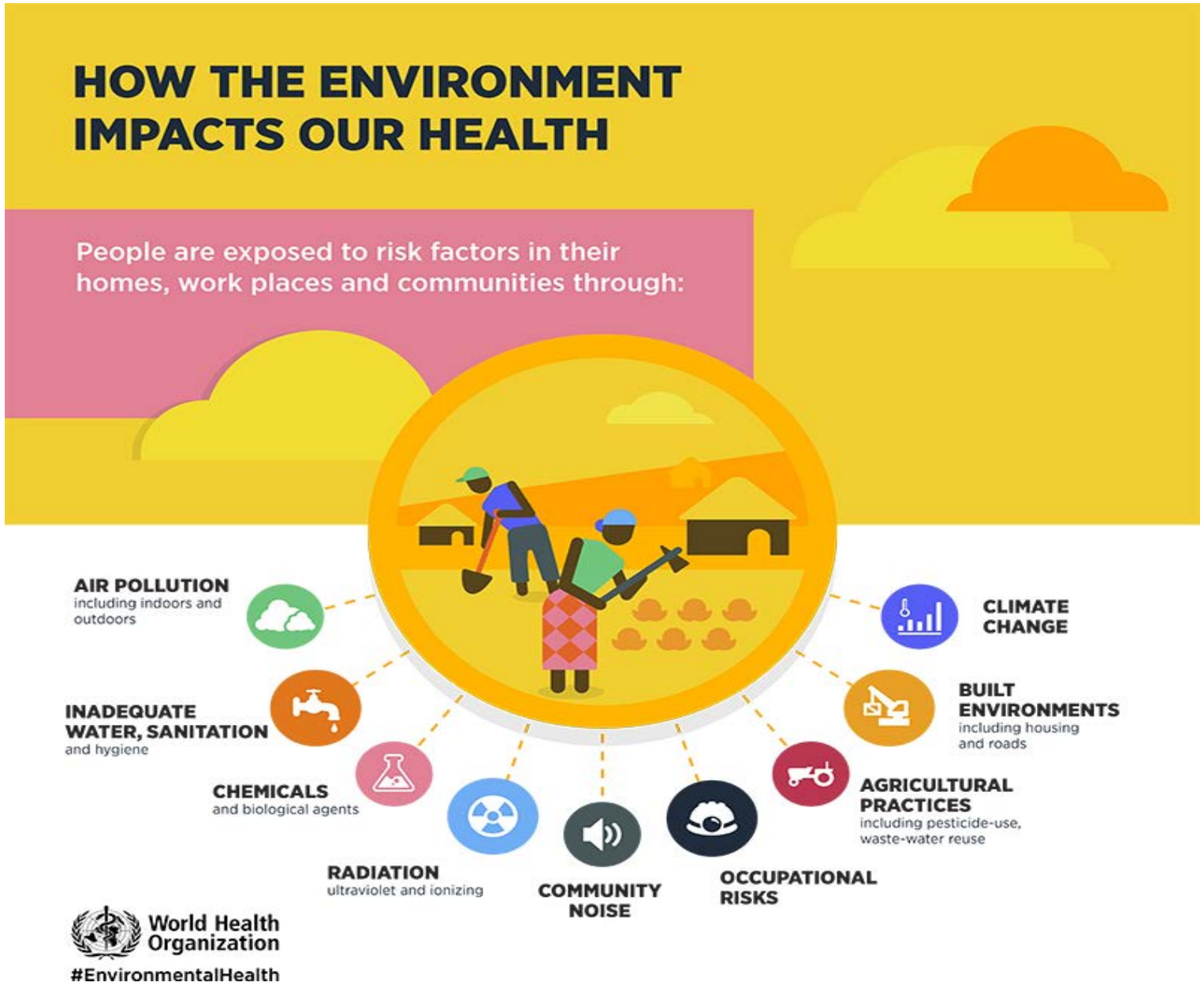
KU SCHOOL OF MEDICINE The University of Kansas

Children's Mercy KANSAS CITY

A bit about me:

- Training history
- Areas of experience and interest
- What I have available to share




HOW THE ENVIRONMENT IMPACTS OUR HEALTH
People are exposed to risk factors in their homes, work places and communities through:
AIR POLLUTION
including indoors and outdoors
INADEQUATE WATER, SANITATION
and hygiene
CHEMICALS
and biological agents
RADIATION
ultraviolet and ionizing
COMMUNITY NOISE
OCCUPATIONAL RISKS
AGRICULTURAL PRACTICES
including pesticide-use, waste-water reuse
BUILT ENVIRONMENTS
including housing and roads
CLIMATE CHANGE
World Health Organization
#EnvironmentalHealth

History of the Field and Accumulation of Evidence

Cases in History – More Evidence

Minamata Disease

London Fog

Landrigan, P., Miodovnik, A.

Children are not little adults

Giotto, National Gallery, Washington DC

The Unique Vulnerabilities of Children

- Critical Windows of Vulnerability
- Changing Physical Environments
- Normal Behaviors and Stages of Development

- Physiologic Features in the Context of Environment
  - Absorption
  - Distribution
  - Metabolism
  - Chronicity

Critical Windows of Vulnerability

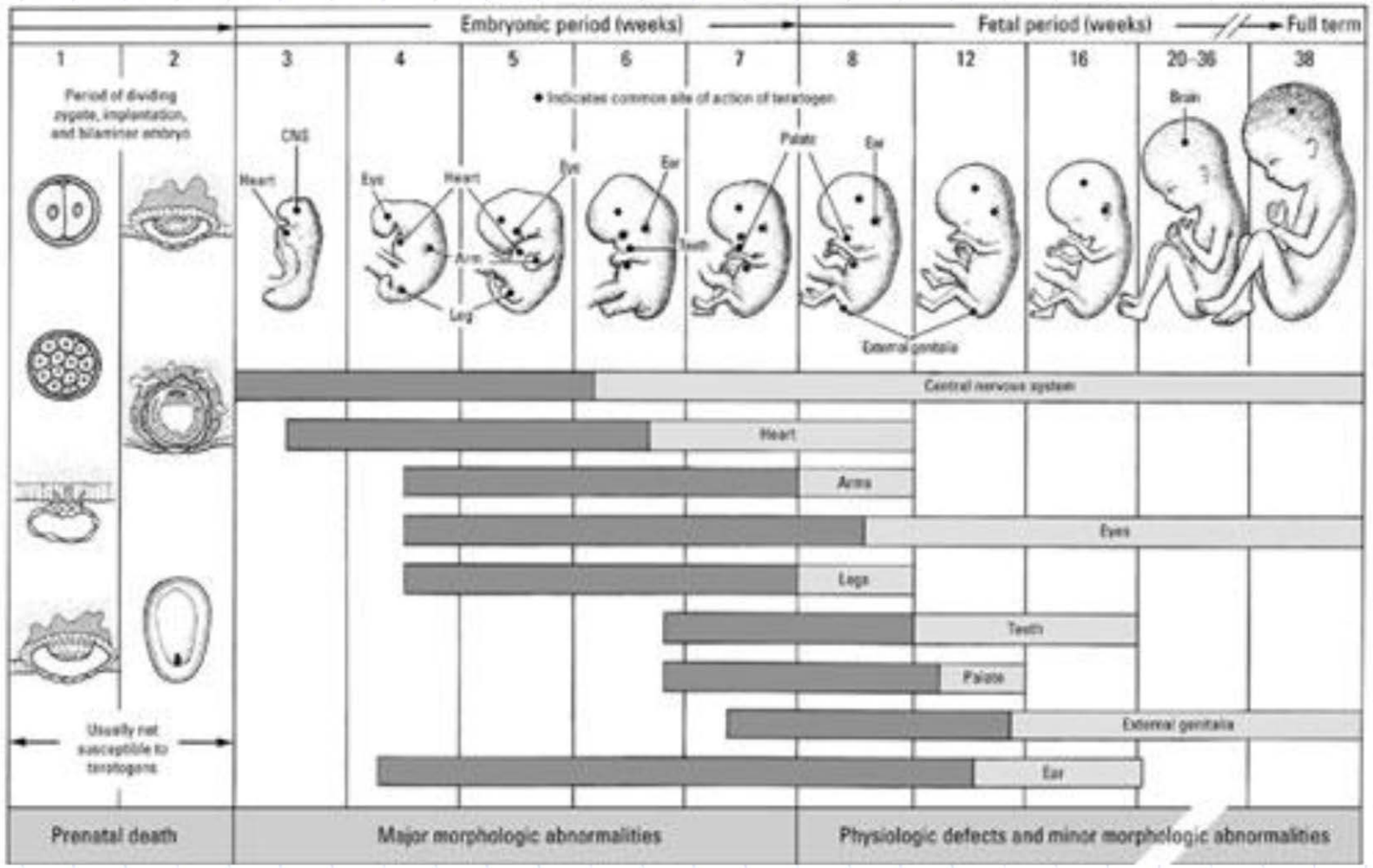


Figure 3. Schematic illustration of the sensitive or critical periods in human development. Dark gray denotes highly sensitive periods; light gray indicates stages that are less sensitive to teratogens. Reprinted with permission of W.B. Saunders Co. [(*3*); first published in 1973].

Fetuses and infants have windows of time during which they are uniquely vulnerable to the adverse effects of drugs, and chemical toxicants.

Unique Susceptibilities of Children

Behaviors & Stages of Development

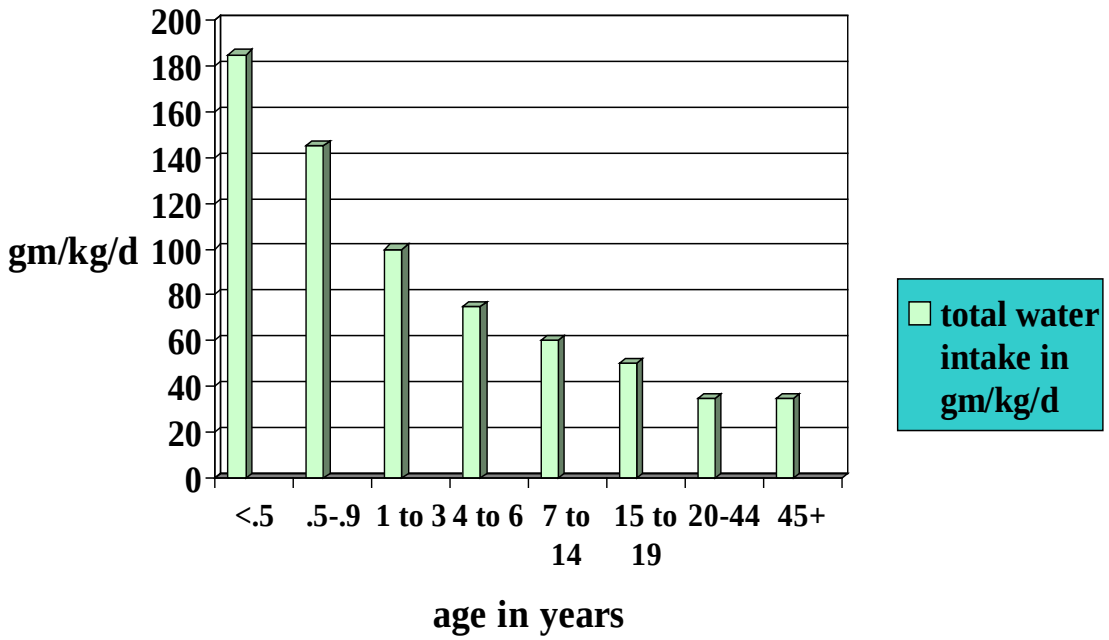
Infants – exploring, crawling, floor & ground, mouthing, restricted diet, daycare

School aged children – playground equipment, outdoors, school

Teens – work, hobbies, high risk behaviors

Water Intake – a key physiologic difference

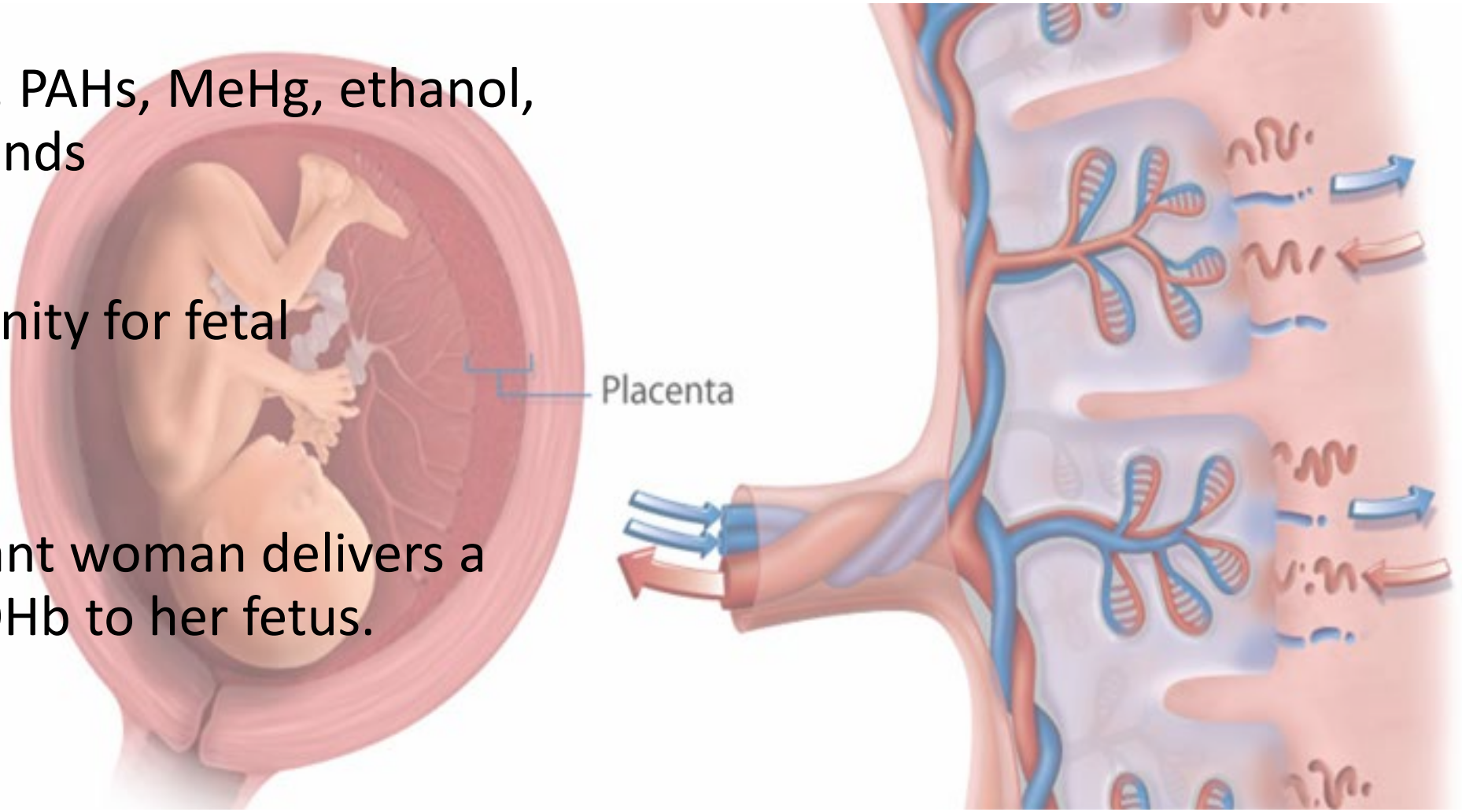
Mean Water Intake



Miller M et al., Intl J.Tox 2002

Transplacental absorption

- Examples: CO, Pb, PAHs, MeHg, ethanol, lipophilic compounds
- CO has higher affinity for fetal hemoglobin.
- A smoking pregnant woman delivers a higher dose of COHb to her fetus.



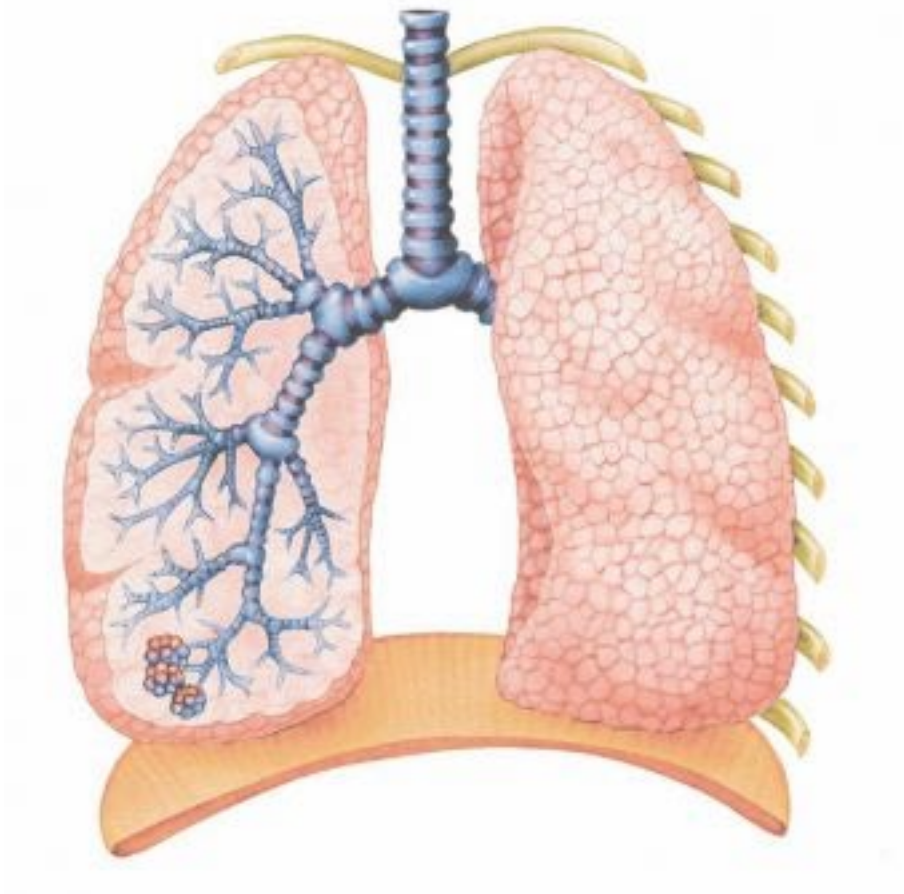
Percutaneous absorption

- Newborn skin: Permeability
- No protective keratin layer
  - Keratin develops during first weeks

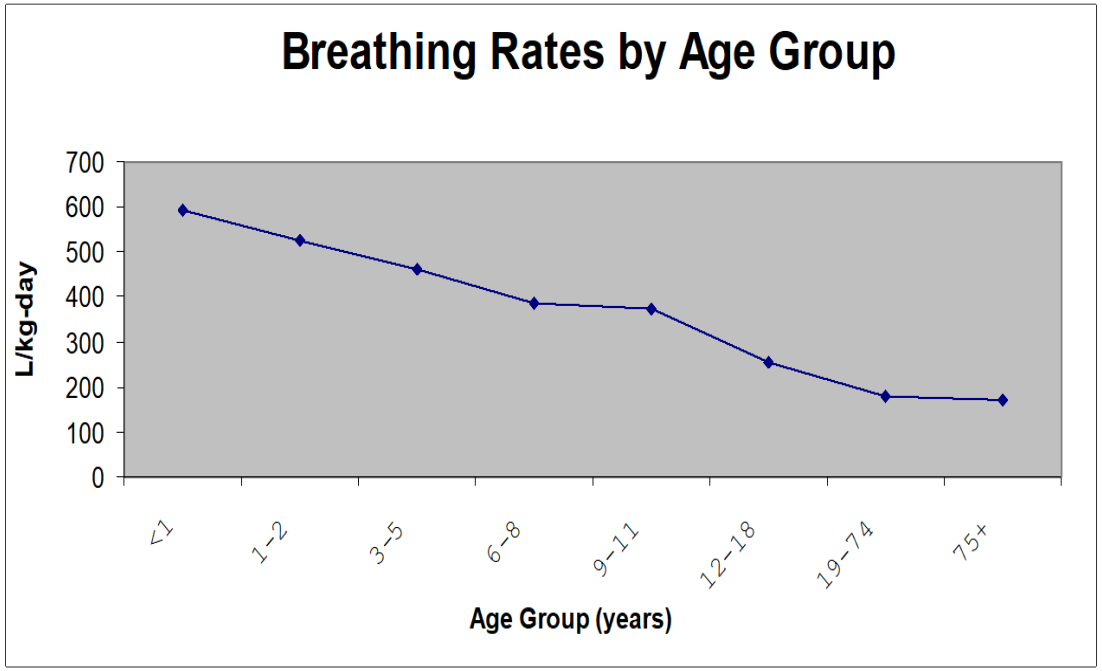
- Newborn: 3x
- Child 2x surface area to mass ratio of adult

  → Absorption of topicals 2-3 times > adult

Absorption – Respiratory



Increased Exposure from Inhalation

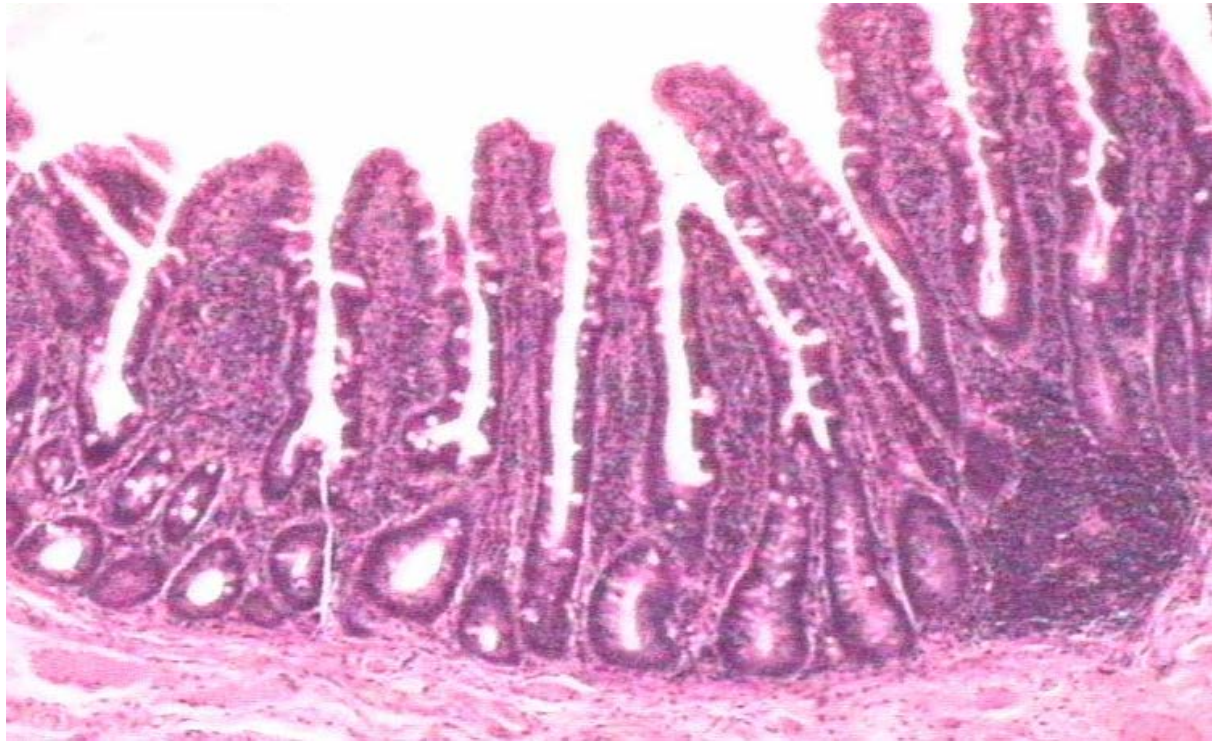


Higher minute ventilation

- Newborn 400 ml/min/kg
- Adult 150 ml/min/kg

Absorption – GI

- Changes during development affect transport of nutrients, and/or noxious agents.



Absorption

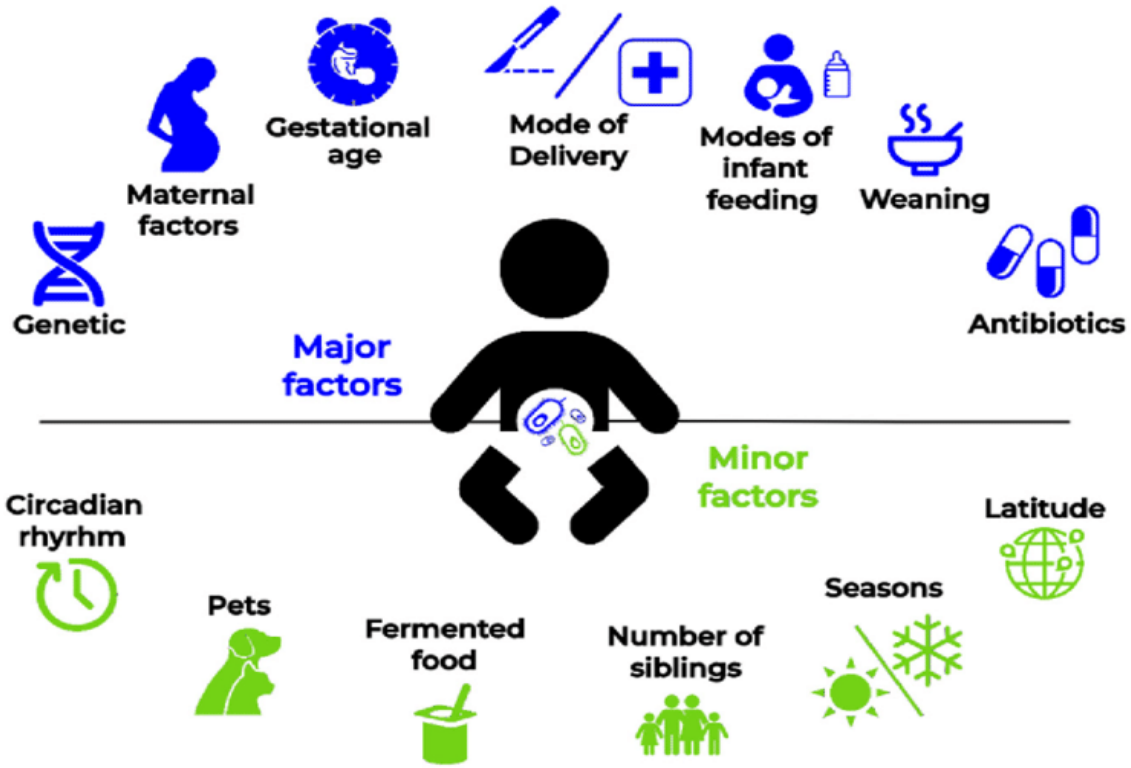
THERE'S NOTHIN' WRONG WITH OUR WELL WATER— IN FACT, JUNIOR'S GROWN ANOTHER FOOT SINCE WE MOVED IN !!
DAN BOUSQUET

Distribution

- Tissue distribution of chemicals varies with development
- Blood brain barrier still forming in young infants.
- Liver function & kidney filtration mature over 5 years

Metabolism

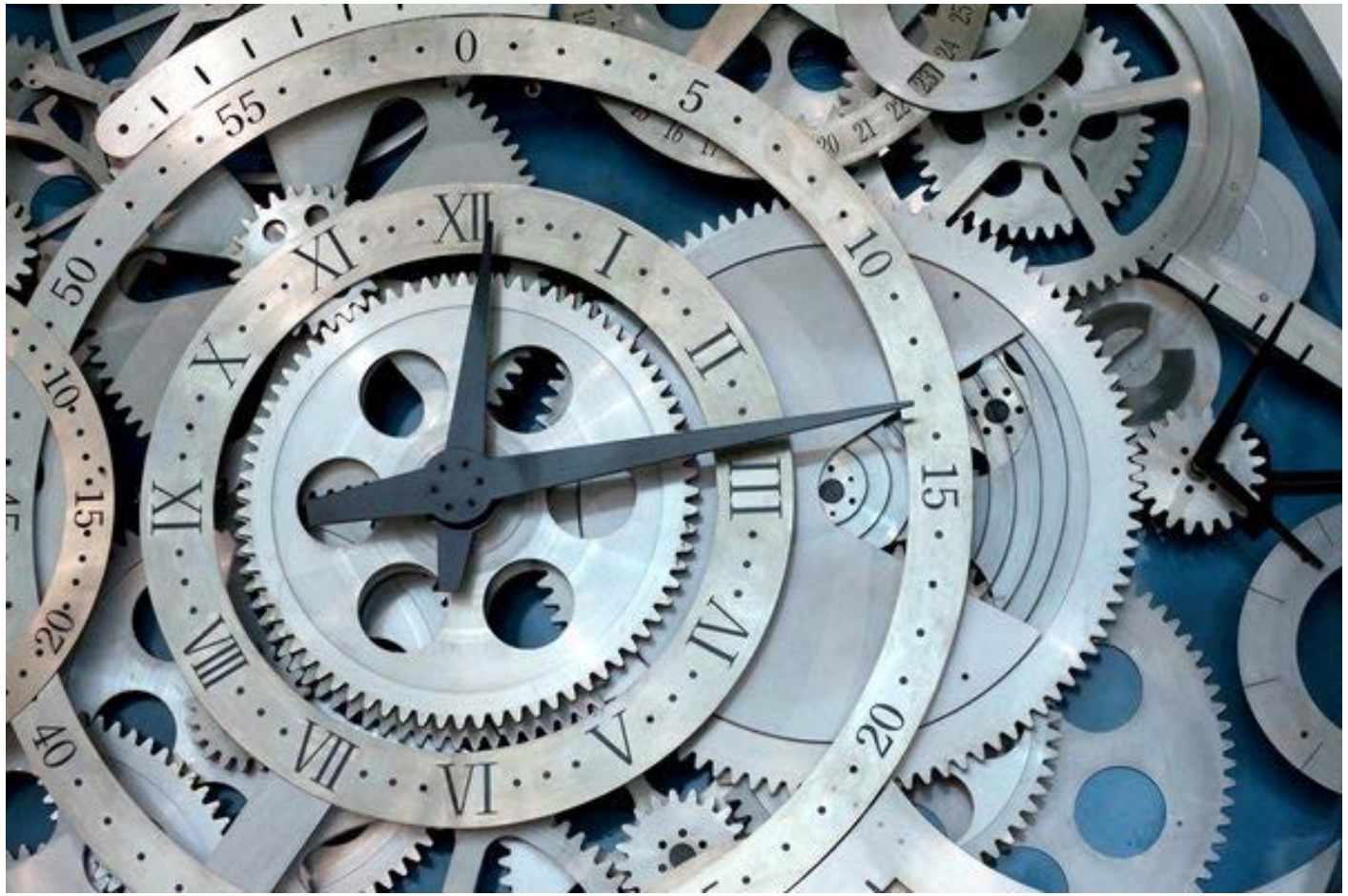
- Enzyme activity varies w/ development
  - CYP450
  - Microbiotia development
- Protective or harmful
  - Acetaminophen metabolism



Target Organ Susceptibility

- Organs differentiate throughout development
- Processes can be disrupted or altered by environmental hazards.
- Environmental agents may mimic hormones.
- Brain & Lungs: vulnerable to toxins during postnatal development.

Increased Risk of Chronicity



Review

Fetuses and children are vulnerable.

Because…

- Physical environment
- Physiology
- Absorption
- Metabolism
- Ongoing development
- Organ formation and maturation

Changing Patterns of Pediatric Diseases

- Neurodevelopmental disorders
- Asthma
- Obesity
- Cancer

Landrigan, P., Miodovnik, A.
Cohen ML. Changing patterns of infectious disease. Nature. 2000 Aug 17;406(6797):762-7. doi: 10.1038/35021206. PMID: 10963605.

Background information

- Chemicals in the US (TSCA)
- CDC's 4th National Report on Human Exposure
- Precautionary Principle

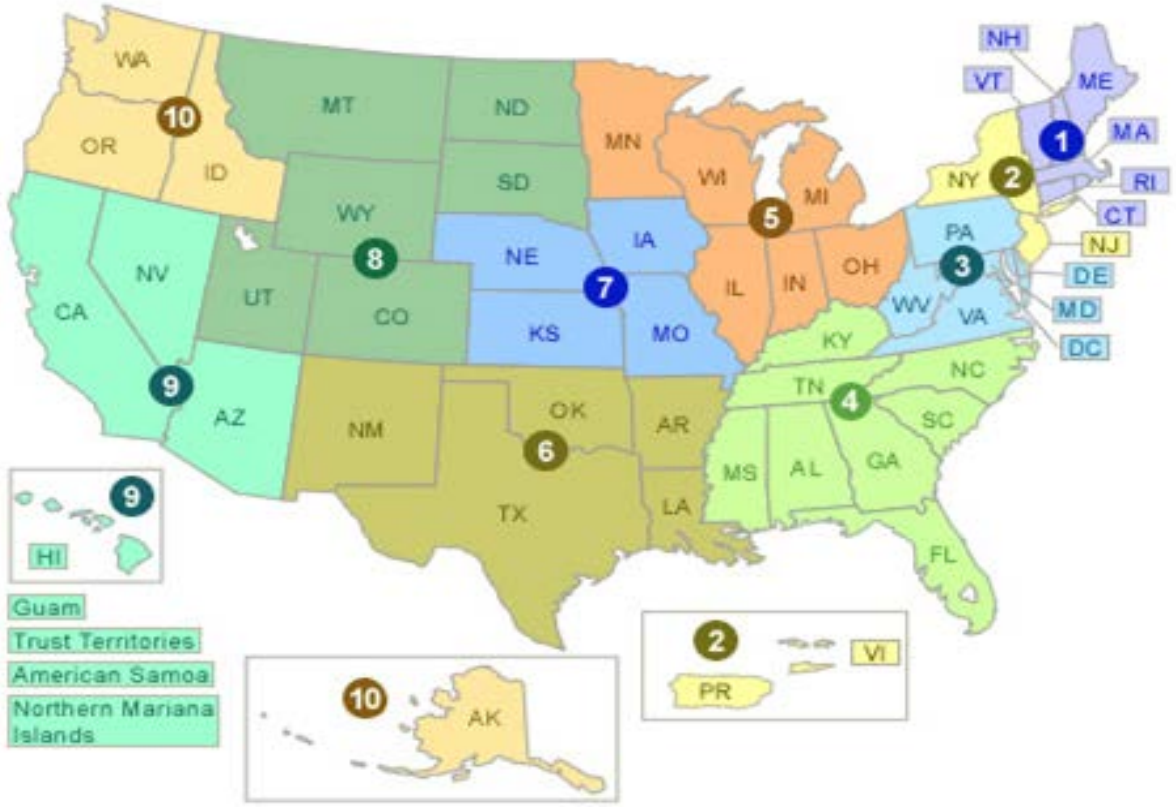
It is the work of an instructed mind to rest satisfied with the degree of precision the topic supports and not to insist on an exactness when only an approximation is feasible.

Aristotle

MAPEHSU

MID-AMERICA PEDIATRIC ENVIRONMENTAL HEALTH SPECIALTY UNIT

- HHS/EPA funded network of interdisciplinary pediatric EH specialists based at academic medical centers
- R7-PEHSU at Children's Mercy Hospital, Kansas City, MO
- Provide free consultation, referral, outreach and education
  - Public Health Departments
  - Clinicians
  - Public health and medical trainees
  - Communities
  - Families



PEHSU: 1-800-421-9916
mapehsu@cmh.edu
www.pehsu.net

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PEHSU Consultation

En vivo – cellular, molecular changes indicative of health effects

+

En vitro – cellular, molecular changes indicative of health effects

+

Epidemiologic studies (exposure + health)

+

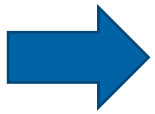
Exposure assessments

+

Risk assessments

+

Case studies



Application of Sum of Studies

Problem Solving at the Clinical & Population Level

Environmental Health at Children's Mercy

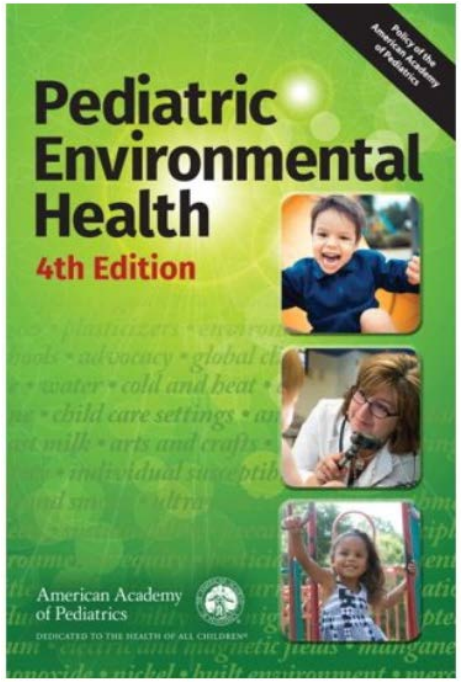
- Healthy Homes
  - Lead
  - Asthma
  - Complex Medical Cases (developing)
- Healthy Schools
  - Industrial hygiene services for children in schools rather than adults at work (i.e. OEM)
  - COVID-19
- Healthy Homes/Schools Training Programs
  - Services to CHWs, Public health departments, etc.

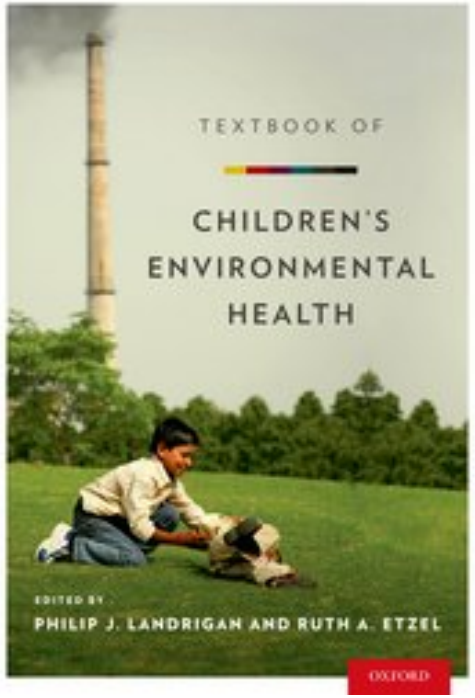
Great Lakes Center for Children's Environmental Health

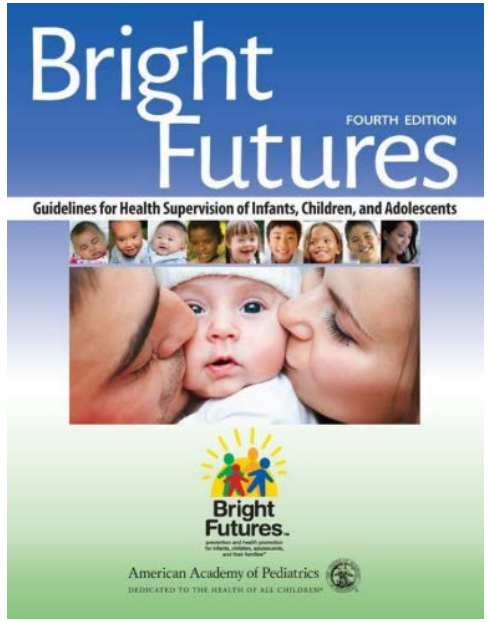
New York State Children's Environmental Health Centers

DENVER HEALTH
est. 1860
FOR LIFE'S JOURNEY

Western States PEHSU
Pediatric Environmental Health Specialty Unit







National Environmental Education Foundation

Knowledge to live by

Children's Mercy KANSAS CITY

Resources for Healthcare Providers

National PEHSU - links to CDC, FDA, etc. regarding a variety of pediatric environmental health care concerns. Note many regional PEHSUs have their own collection of useful materials.

Region 7 Website: **http://www.childrensmercy.org/mapehsu;** E-mail: **mapehsu@cmh.edu**

Agency for Toxic Substances and Disease Registry - provides technical information to health professionals on the effects of hazardous substances, also provides CME and other educational opportunities.

Children's Health Protection – EPA department – link to health topic indeces, based on location (environment), toxic exposures and general health topics

NIEHS Kids Page - Fun stuff for kids.

TOXNET – Database with information on emergency handling procedures, environmental data, regulatory status and human exposure

General Resources

- Environmental Working Group – Consumer product reference
- National Sanitation Foundation – Organization that establishes health and safety standards for consumer products, including water filters, appliances, and food equipment
- Environmental Health News – Collection of news reports from publications around the world
- Children's Environmental Health Network – National and multidisciplinary network that makes news, resources and events available for health professionals, childcare professionals, as well as families and other child health advocates

Intermission:

Pediatric Environmental Health – Part II
Annual NE AAP Conference 2020

Elizabeth Friedman, MD, MPH

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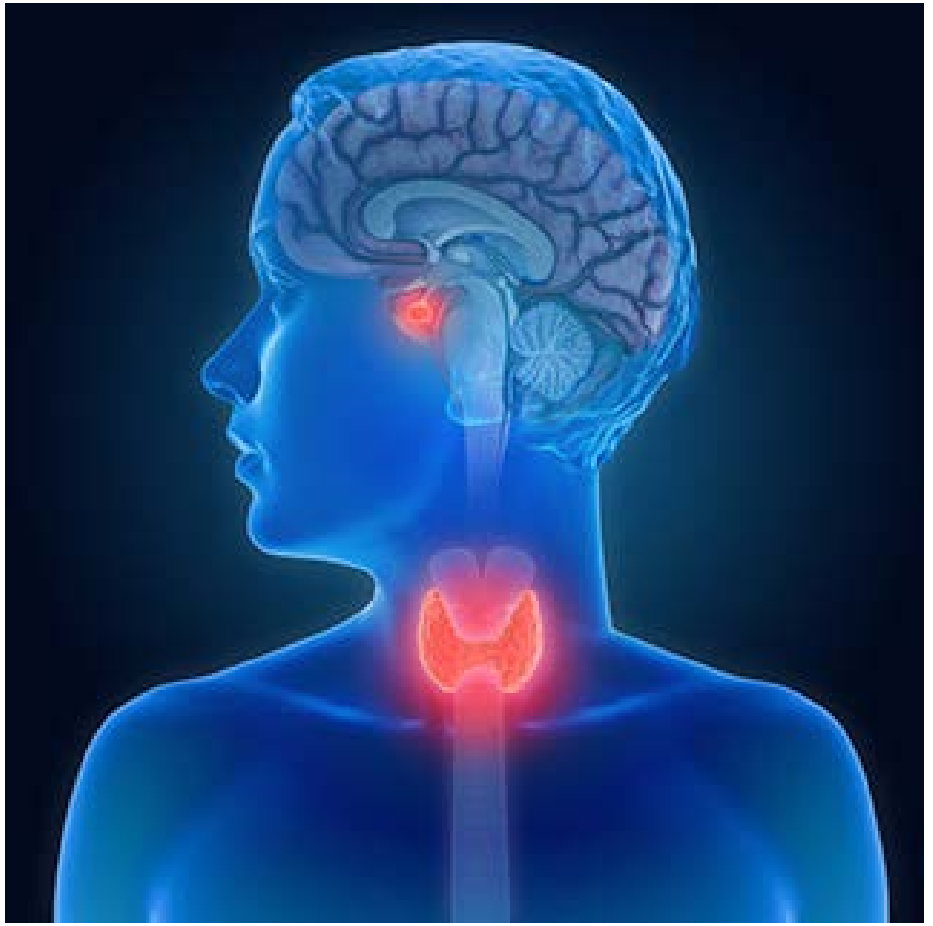
Endocrine Disruptors – Application in Clinical Practice

- Definition
- Examples
- Sources

Examples of Endocrine Disruptors

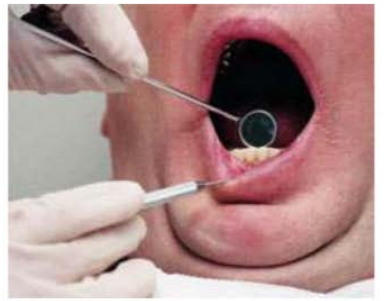
- Plasticizers / plastics *
- Pesticides
- Organohalogens
- Heavy metals (i.e. Pb+)



https://www.niehs.nih.gov/health/topics/agents/endocrine/index.cfm Accessed: October 2020

Phthalates

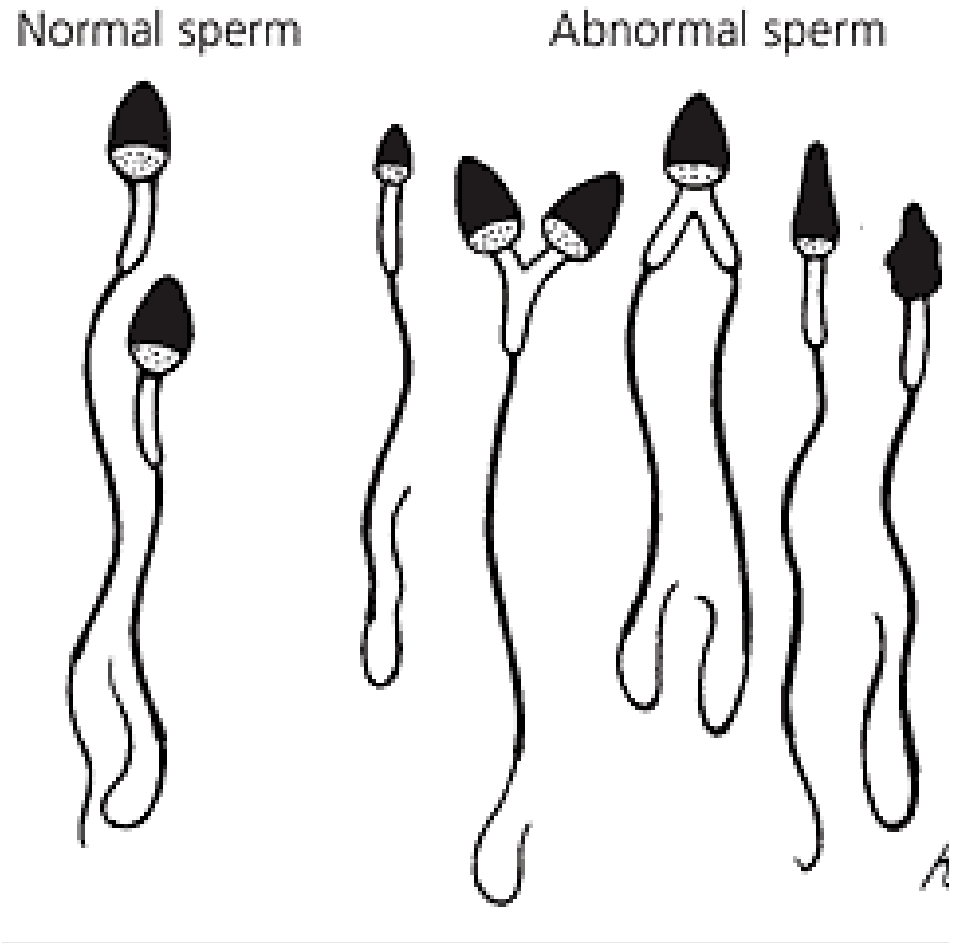
Bisphenol A



What’s our exposure to these plasticizers?

- Pathway: ingestion of food (including breast milk), mouthing of products, inhaled dust, direct skin contact, IV tubing
- High temperature promotes leaching
- Short half-lives
- No clinical references
- Exposure is ubiquitous amongst people in the US

Phthalates are anti-androgenic



Bisphenol-A is a weak estrogen

Legislation

- Europe: ban on **phthalates** [2005].
- United States: voluntary ban on **phthalates** [2002].
- California: 1st state to ban six **phthalates** from toys for children <3 years [2009].
- Canada: ban on **BPA** in baby bottles, formula cans and infant food packages [2008].
- New York: 1st **BPA** legislation in US [2009].
- Baby bottles: Avent, Disney, Evenflow, Gerber, Playtex and Dr. Brown withdrawn **BPA**

Alternatives

Addressing Patients' Concerns

It is easy to reduce exposure to BPA and phthalates.

Check the symbol on the bottom of plastic items.

Choose safer plastics:

1	2	4	5
PETE	HDPE	LDPE	PP
Polyethylene terephthalate	High-density polyethylene	Low-density polyethylene	Polypropylene

Plastics to avoid:

3	6	7
V	PS	Other
PVC or vinyl can contain phthalates	Polystyrene Foam	Can contain Bisphenol A Polycarbonate

Avoid heating plastic containers.

Avoid #3, 6, and 7 plastics and products labeled vinyl or PVC. Choose stainless steel or glass.

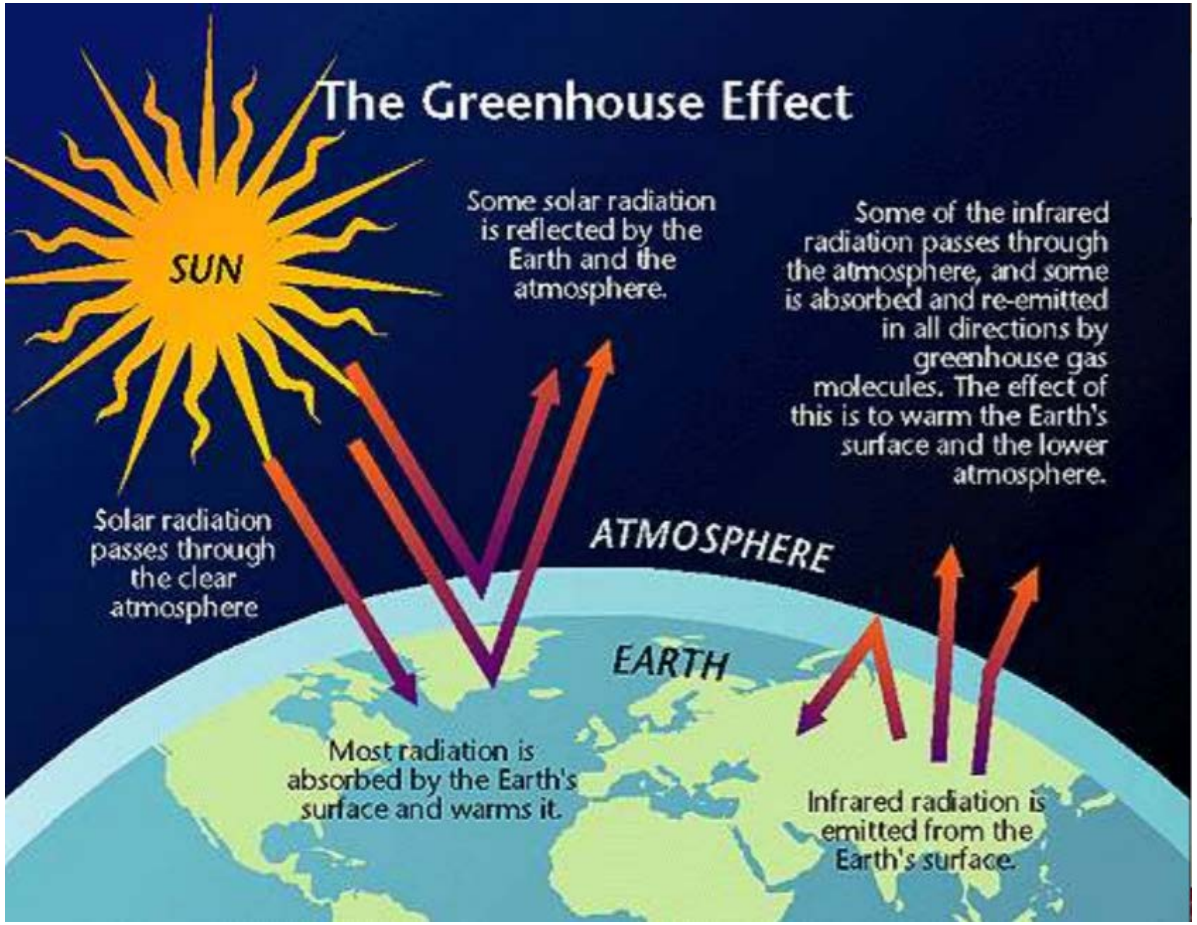
Choose fragrance-free products.

Avoid canned, processed or packaged foods. Choose fresh or frozen.

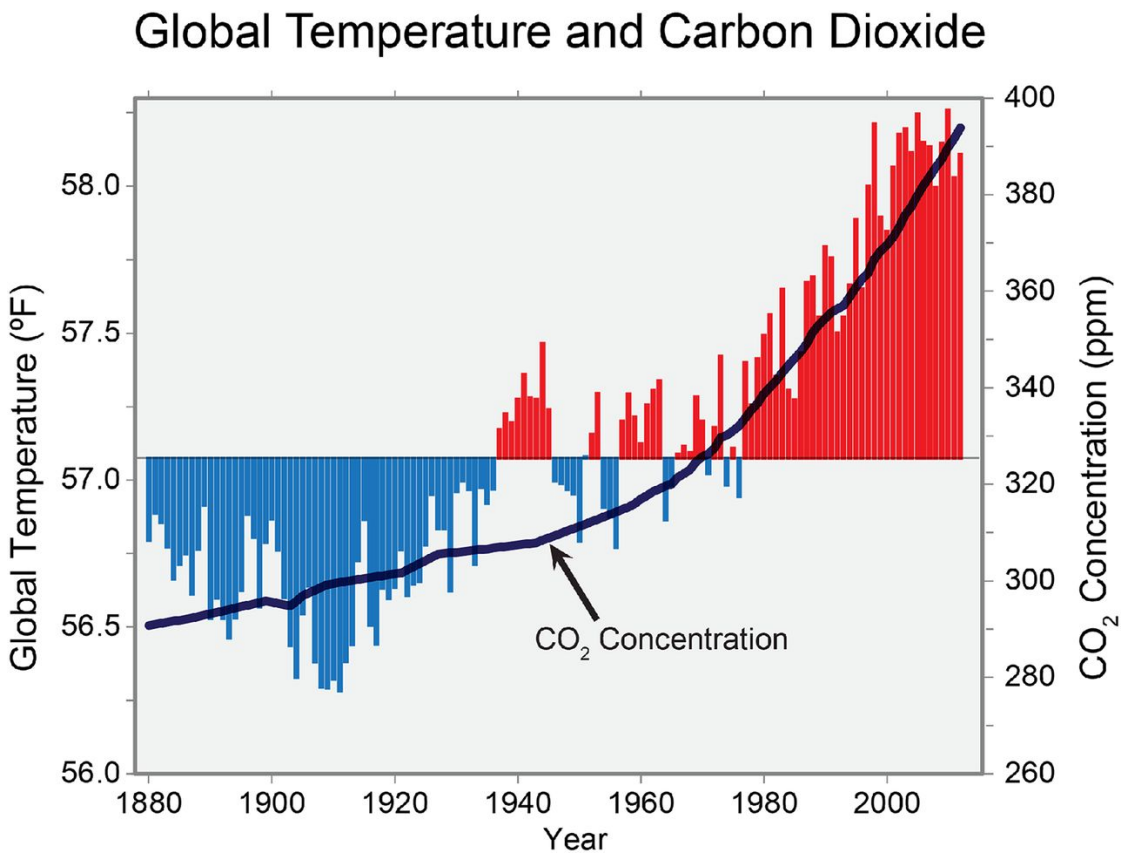
Opt for e-receipts instead of paper.

Reduce dust by wet mopping or vacuuming with a HEPA filtered vacuum.

Climate Change – Why it Matters in Pediatric Practice



State of the Science – Global Temperature



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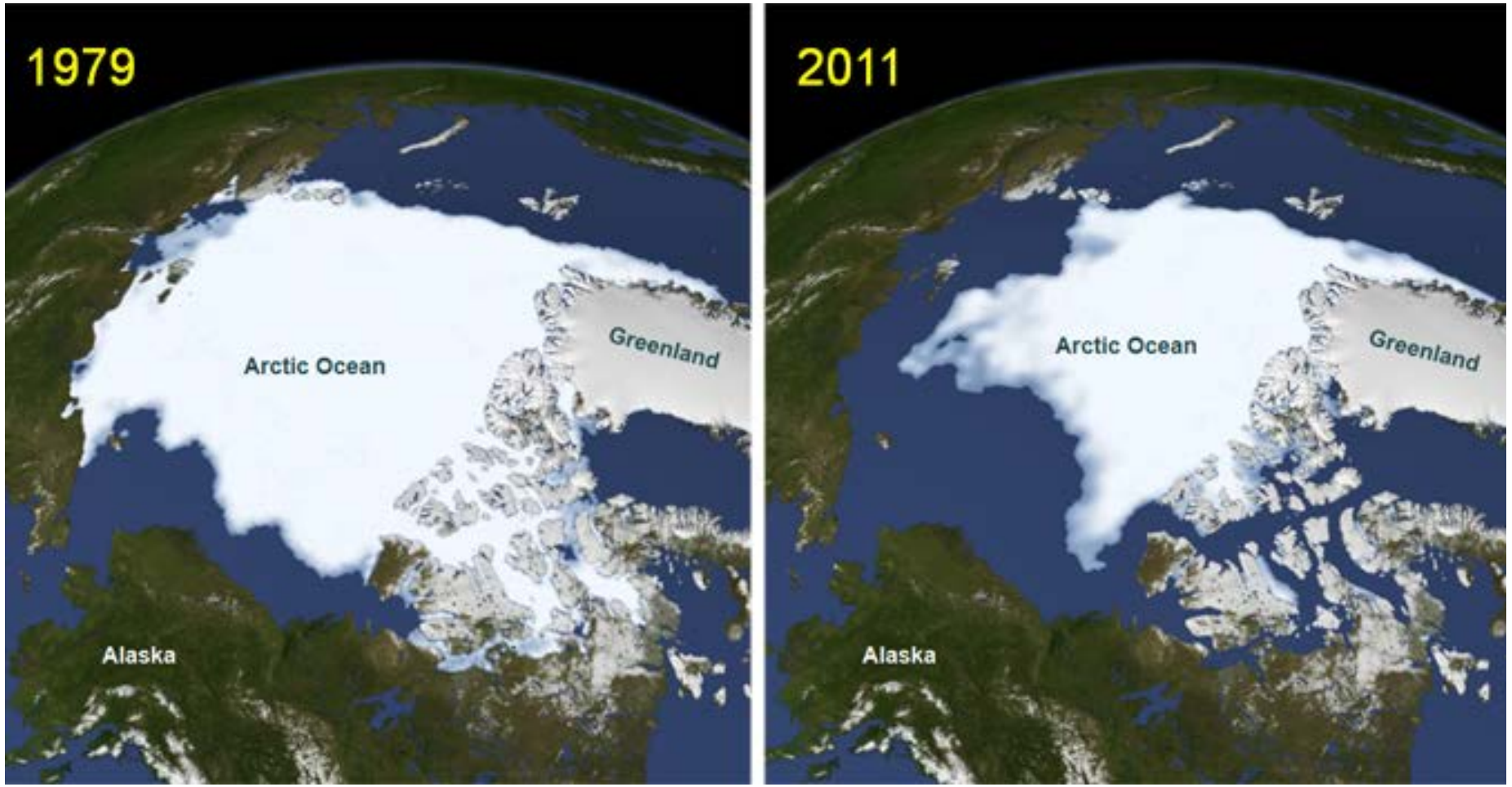
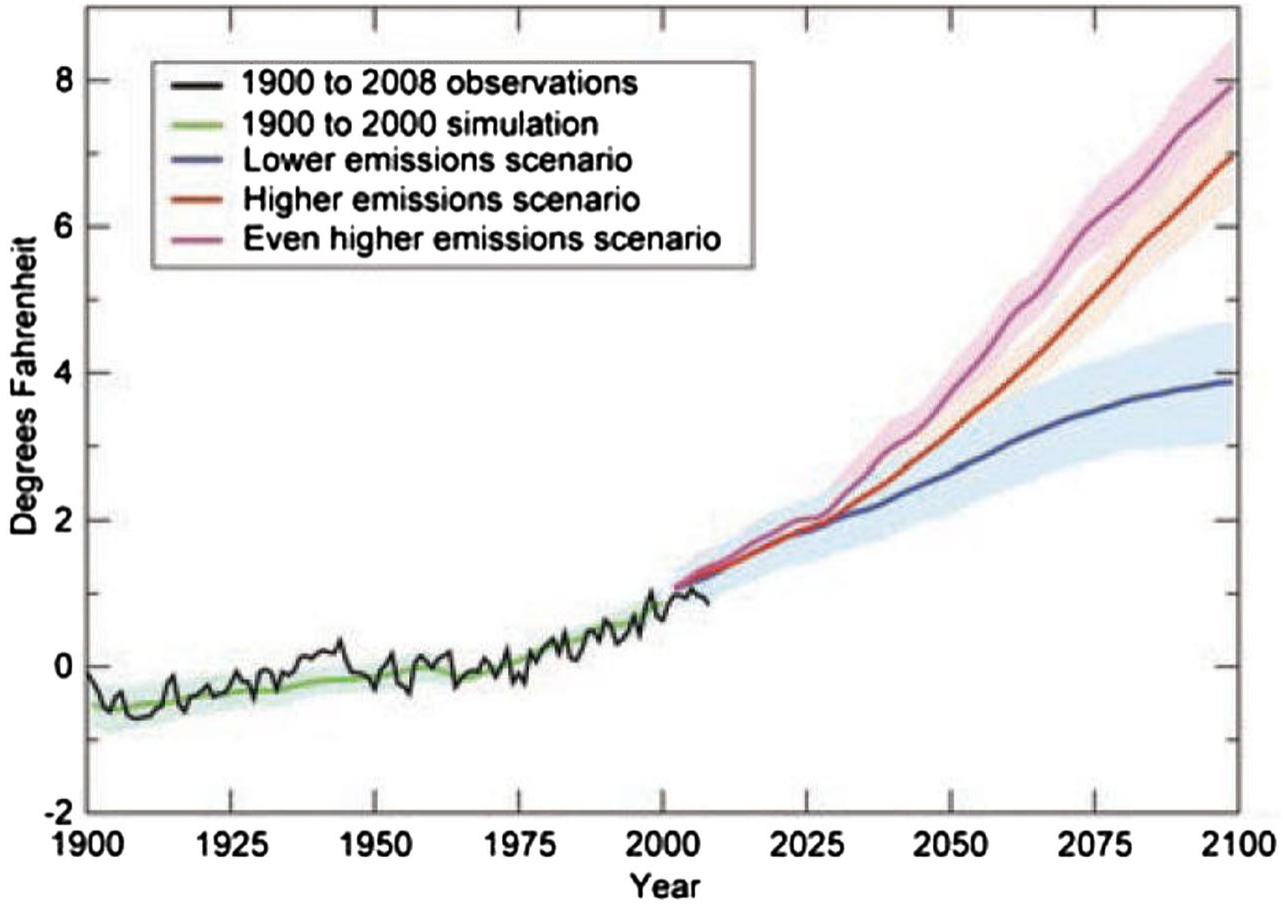
Samantha Ahdoot et al. Pediatrics 2015;136:e1468-e1484

State of the Science –



https://www.nasa.gov/topics/earth/features/ocean-bloom-briefing.html

Scientists have modelled future temperature changes based on a variety of greenhouse gas emissions scenarios.



PEDIATRICS

Samantha Ahdoot et al. Pediatrics 2015;136:e1468-e1484

©2015 by American Academy of Pediatrics

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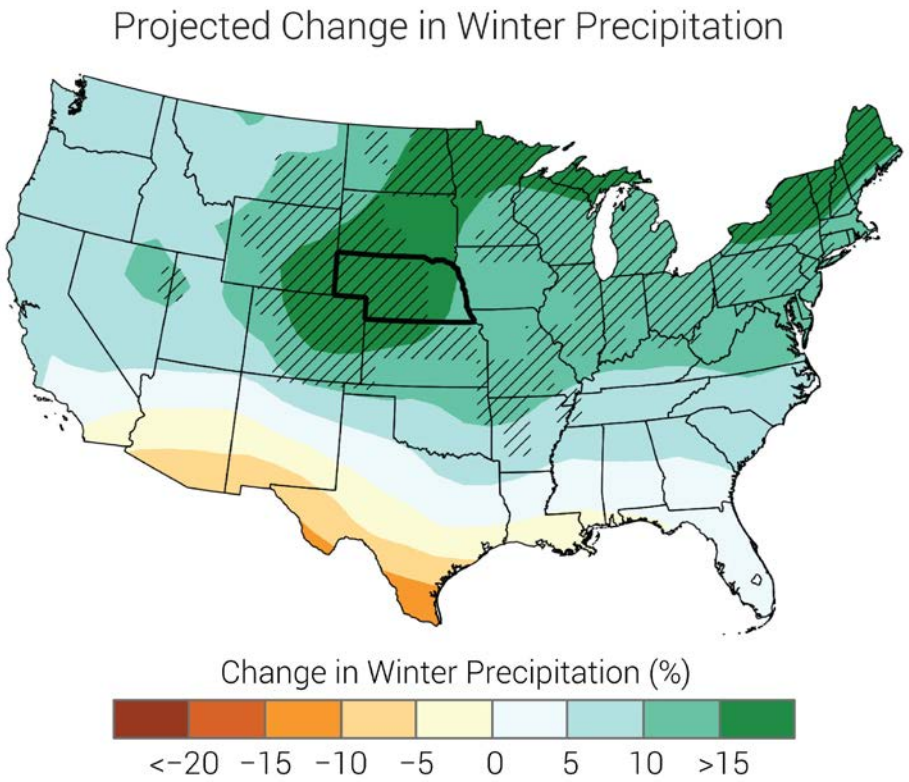
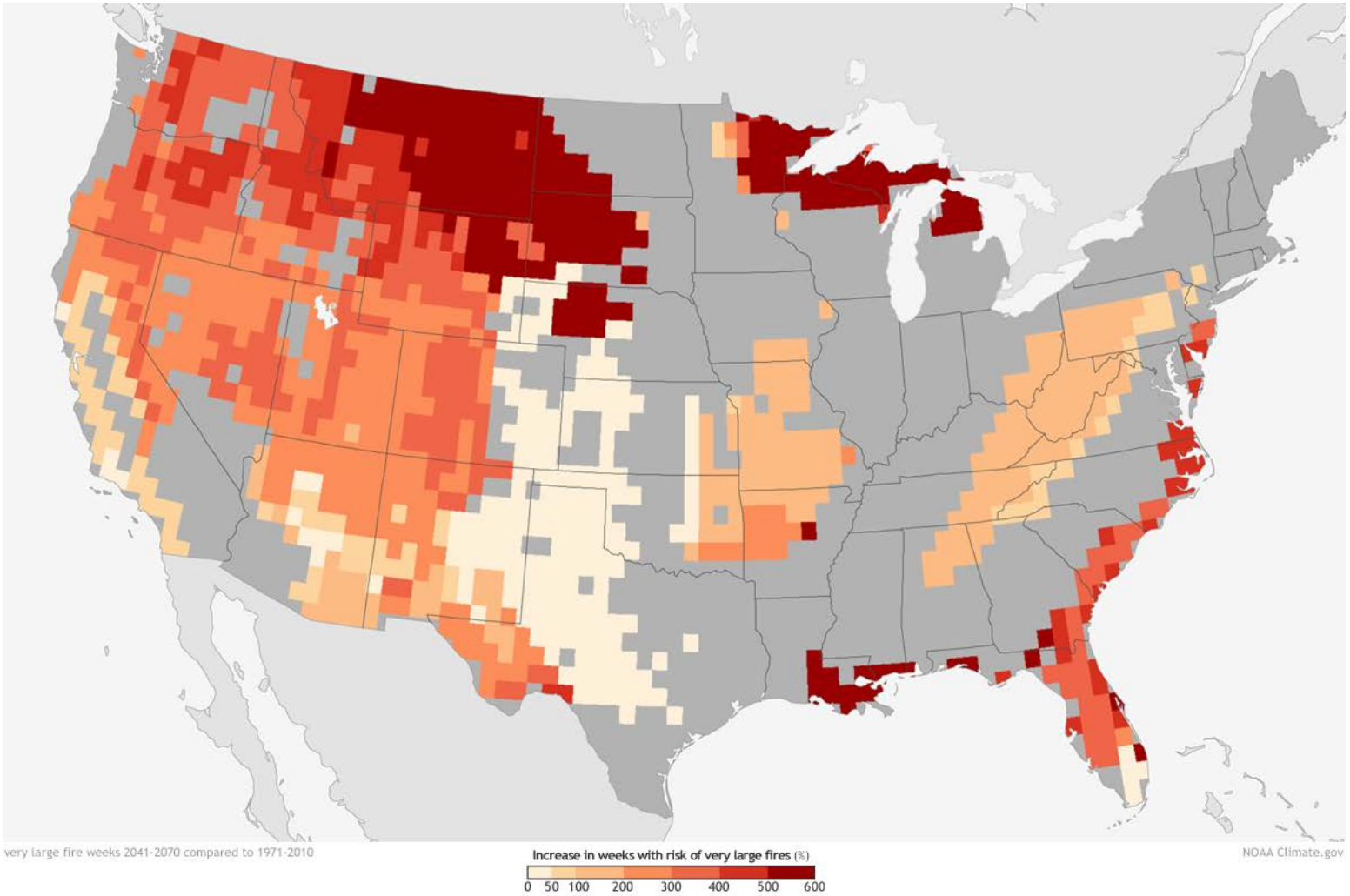
Predictions for Our Region

- More extreme weather
  - Fewer frosts
  - Increase in heavy precipitation events → flooding
  - Fewer summer rains → more droughts
- Increased temperatures
  - Hotter summers (and just warmer all around)
- Ecosystem disruption
  - Resource changes and re-distribution



Frankson, R., Kunkel, K, Stevens L, Shulski M, 2017: Nebraska State Climate Summary. NOAA Technical Report NESDIS 149-NE, 4 pp. Electronic Reference https://statesummaries.ncics.org/chapter/ne/
Frankson, R., K. Kunkel, S. Champion and B. Stewart, 2017: Missouri State Climate Summary. NOAA Technical Report NESDIS 149-MO, 4 pp. Electronic Reference:https://statesummaries.ncics.org/
Frankson, R., K. Kunkel, L. Stevens, D. Easterling, X. Lin, and M. Shulski, 2017: Kansas State Climate Summary. *NOAA Technical Report NESDIS 149-KS*, 4 pp.

Anticipated Risk of Fires (mid-century)

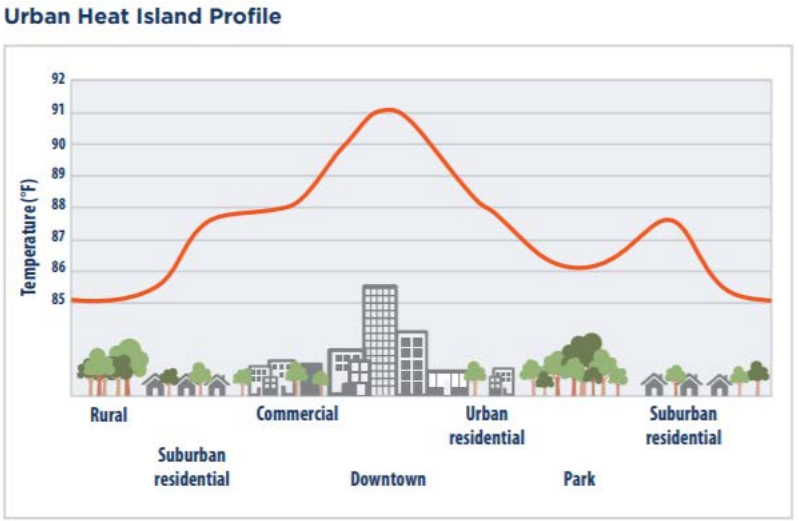


Climate Change and Children's Health

Air Pollution

https://www.coloradoindependent.com/2020/05/26/denver-improved-air-quality-pandemic-public-health/

Heat



This diagram represents how an urban heat island can increase local air temperatures by several degrees. Source: U.S. EPA, 2006[16]

https://www.cdc.gov/climateandhealth/pubs/extreme-heat-guidebook.pdf

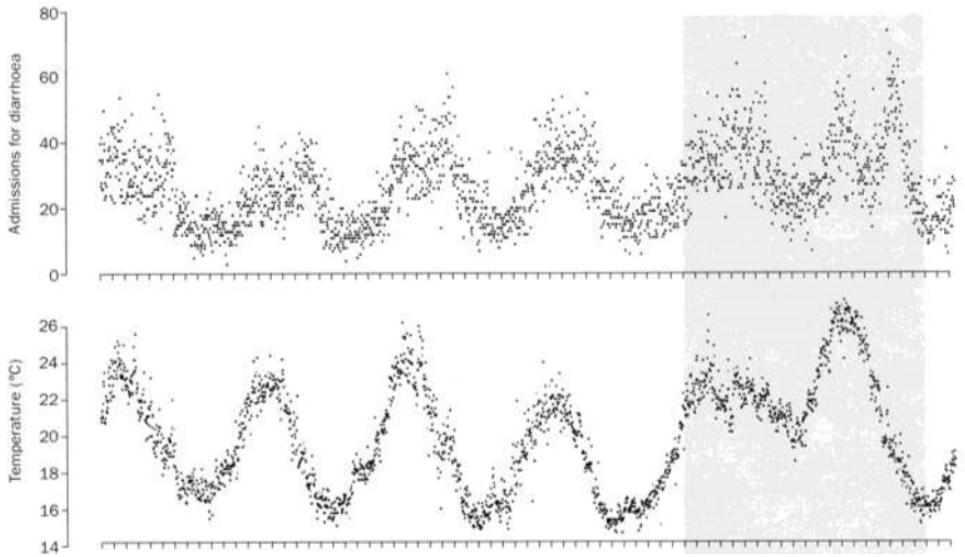
Severe Weather

Am J Respir Crit Care Med 1998; 158(2):538-46;
Séguin J 2008. Human Health in a Changing Climate. Health Canada
Samantha Ahdoot et al. Pediatrics 2015;136:e1468-e1484
https://www.spc.noaa.gov/faq/tornado/torscans.htm

Vector Borne Diseases

https://www.cdc.gov/ncezid/dvbd/media/stopmosquitoes.html

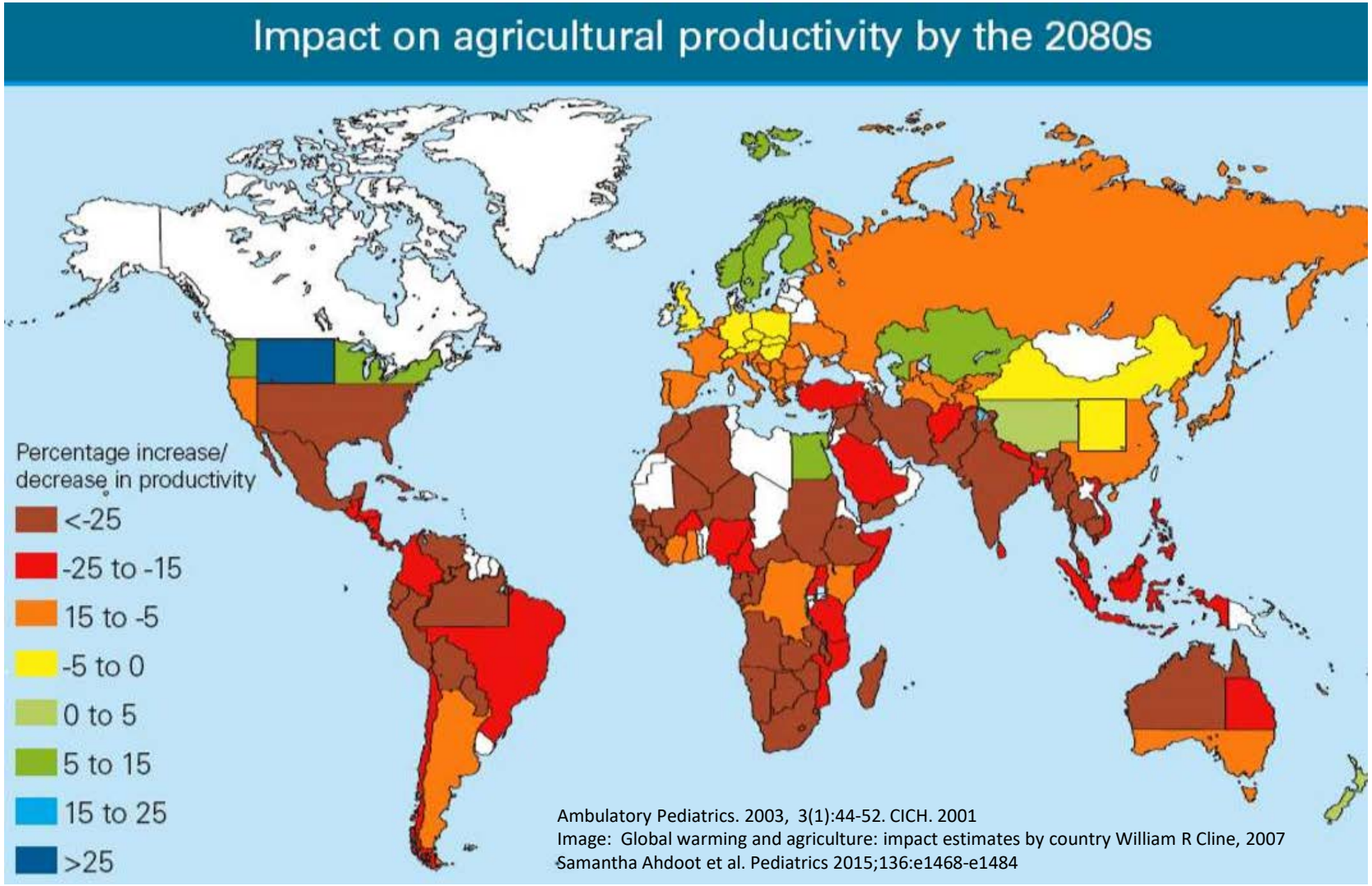
Waterborne Diseases



Daily diarrhea admissions

Daily temperature

Food



Ambulatory Pediatrics. 2003, 3(1):44-52. CICH. 2001
Image: Global warming and agriculture: impact estimates by country William R Cline, 2007
Samantha Ahdoot et al. Pediatrics 2015;136:e1468-e1484

Health Disparities Expected to Worsen

- Difficulty to replace lost items, including housing
- Difficulty to relocate
- Lack of A/C → greater risk for heat related diseases
- Increased food insecurity associated with decreasing crop yield

Effects Seen in Nebraska

Rising temperatures put heat on Nebraska's $7 billion corn industry

SOPHIA SVANDA For the Lincoln Journal Star Sep 28, 2020 Updated Oct 12, 2020 5 min to read

SALE! Subscribe for $1/mo.

With experts predicting that average temperatures will continue to climb across Nebraska over future decades, the state's corn crop could be at risk. Temperatures above 90 degrees can make pollen sterile, resulting in corn cobs that look like they badly lost a fight, only with missing kernels instead of missing teeth.

Journal Star file photo

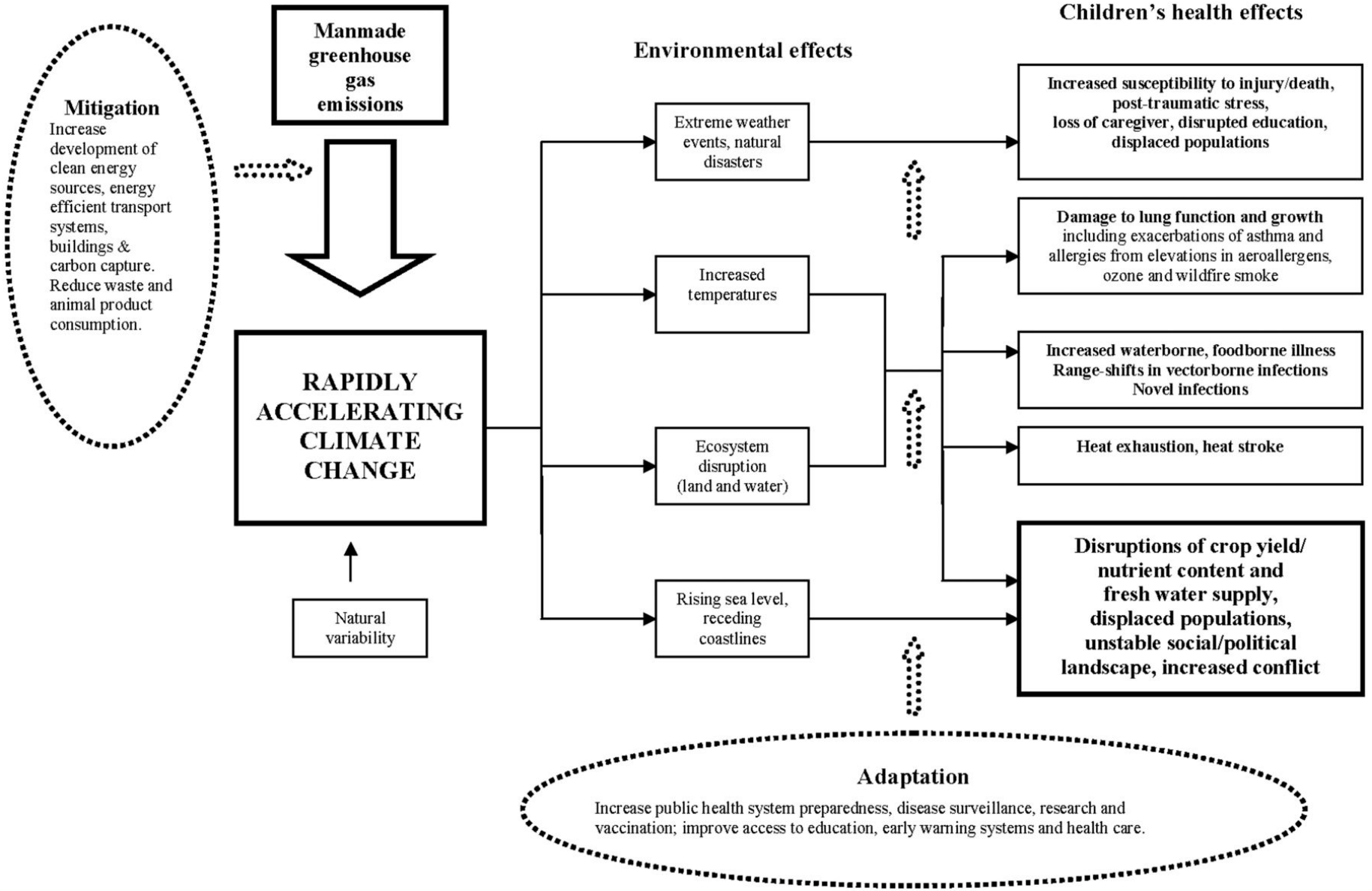
Dept. of Health urges citizens to test wells for contamination

Telegraph staff reports Mar 19, 2019 0

tetson Freeman/Staff

d soybean farmer Chad Christianson looks at the erosion of his cornfield from the flooding of Maple Creek, on April 2 in Fremont, a. Many parts of the state flooded after heavy rains hit frozen, saturated ground.

A century-old irrigation tunnel that collapsed near Fort Laramie, Wyo., has left fields of hundreds of farmers parched. Theo Stroomer for The New York Times



Samantha Ahdoot et al. Pediatrics 2015;136:e1468-e1484

Pediatric Lead Screening – a brief review of lead and child health and an update on guidelines

Who should receive a blood test for lead exposure?

Does the child have any of the following <u>risk factors</u>?

- Lives in or regularly visits home built before 1978.
- From a low-income family - federal law mandates BLL testing for all children in Head Start or covered by Medicaid.
- Has a sibling or frequent playmate with elevated BLL.
- In foster care, a recent immigrant, refugee, or a foreign adoptee.
- Has a parent or caregiver working professionally or recreationally with lead.
- Uses traditional, folk or ethnic remedies or cosmetics.
- Eats wild game such as deer or waterfowl that has been shot with lead bullets.
- Lives in one of the high risk zip codes (annually defined by NE DHHS)

Nebraska DHHS Division of Public Health/Childhood Lead Poisoning Prevention Program

Statewide Blood Lead Risk Assessment/Blood Lead Testing Plan

Three Criteria for Testing a Child for Lead Poisoning	Specifics for Each Criterion
CRITERION 1 **GEOGRAPHY** All Children Living in One of Nebraska's Targeted Communities for Lead Assessment/Testing	Alliance – 69301 Beatrice – 68310 Central City – 68826 Columbus - 68601 Fairbury - 68352 Fremont – 68025 Grand Island – 68801, 68803 Hastings – 68901 Lincoln – 68502, 68503, 68504, 68507, 68508, 68510, 68521 Nebraska City – 68410 Norfolk - 68701 Omaha – 68102, 68104, 68105, 68106, 68107, 68108, 68110, 68111, 68112, 68131, 68132 Schuyler - 68661 Scottsbluff – 69361 York - 68467 DHHS strongly recommends that all children living in these communities be tested for lead poisoning at 12 and 24 months of age. Children between 25 and 72 months of age need to be tested as soon as possible, if not previously tested. *Please note that targeted communities may change as more blood lead data is obtained. Zip codes will be re-evaluated annually and posted at www.dhhs.ne.gov/lead.*
CRITERION 2 **MEDICAID AND WIC** *Medicaid:* ALL CHILDREN INSURED BY MEDICAID MUST BE TESTED—NO EXCEPTIONS OR WAIVERS EXIST.	***Medicaid:*** CMS (Centers for Medicare and Medicaid Services) requires that all children receive a screening blood lead test at 12 months and 24 months of age. Children between the ages of 36 months and 72 months of age must receive a screening blood lead test if they have not been previously screened for lead poisoning. A blood lead test must be used when screening Medicaid-eligible children. (http://www.cms.gov/MedicaidEarlyPeriodicScrn/) (http://www.sos.ne.gov/rules-and-regs/regsearch/Rules/Health_and_Human_Services_System/Title-471/Chapter-33.pdf)
WIC: Federal Policy (MPSF:WC-01-05-P) requires that upon enrollment of a child, the parent must be asked if the child has had a blood lead test. If the child has not had a test, they must be referred to programs where they can obtain such a test	***WIC:*** For every child age 12 months and older, during the Nutrition Risk Assessment, WIC staff will ask the question "Has your child had a blood lead test done in the past 12 months?" Document the Yes or No response. If a child has not had a blood lead test done, staff make and document a referral for a blood lead test back to their healthcare provider or to a lead screening program.
CRITERION 3 **QUESTIONNAIRE** **For** **Children NOT Enrolled in Medicaid or WIC** **And** **Children NOT Residing within a Target Community** The child's parents/guardians should be asked specific exposure questions (see questions at right) to determine each child's risk. If the response to any of the exposure questions is "yes" or "don't know," the child should be tested.	**QUESTIONNAIRE** 1) Does the child live in or often visit a house, daycare, preschool, home of a relative, etc., built before 1950? 2) Does the child live in or often visit a house built before 1978 that has been remodeled within the last year? 3) Does the child have a brother, sister or playmate with lead poisoning? 4) Does the child live with an adult whose job or hobby involves lead? 5) Does the child's family use any home remedies or cultural practices that may contain or use lead? 6) Is the child included in a special population group, i.e., foreign adoptee, refugee, migrant, immigrant, foster care child? *For additional information, i.e. jobs, hobbies, home remedies, cultural practices that include lead, visit dhhs.ne.gov/lead*

11/2015

Children's Mercy KANSAS CITY

Consider testing additional children per clinical judgement, such as:

- Children whose parents have concerns or request lead testing (including older children)
- Children living within a kilometer of lead emitting industry such as a current or former mining or smelter site or an airport
- Children with pica behavior
- Children with neurodevelopmental disabilities or conditions such as autism, ADHD and learning delays

Lead Exposures and Pathways

Potential Exposure Sources

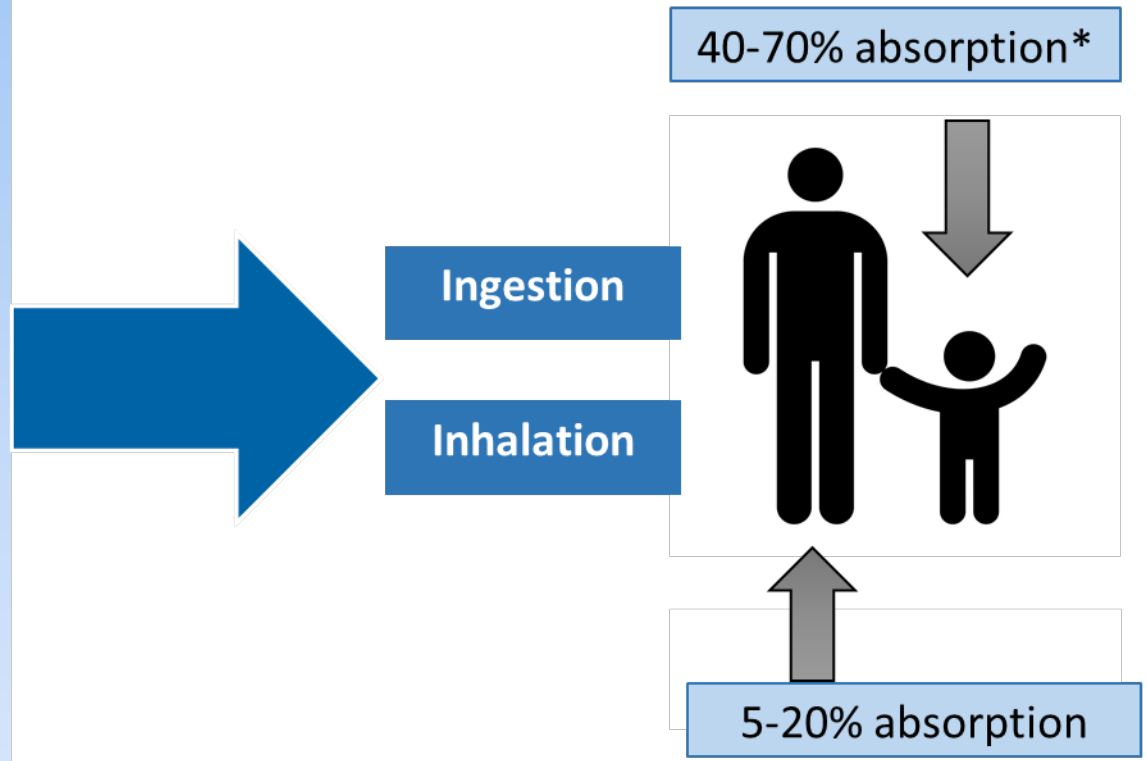
- Paint dust from buildings built before 1978
- Contaminated soil or dirt (including from above)
- Contaminated water
- Burning lead contaminated wood

Parental occupations or hobbies

- Remodeling and demolition
- Chemical preparation
- Visiting gun range
- Mining, smelting, battery recycling
- Making lead fishing weights or ammunition
- Staining glass
- Soldering and welding
- Radiator repair

Use of consumer products

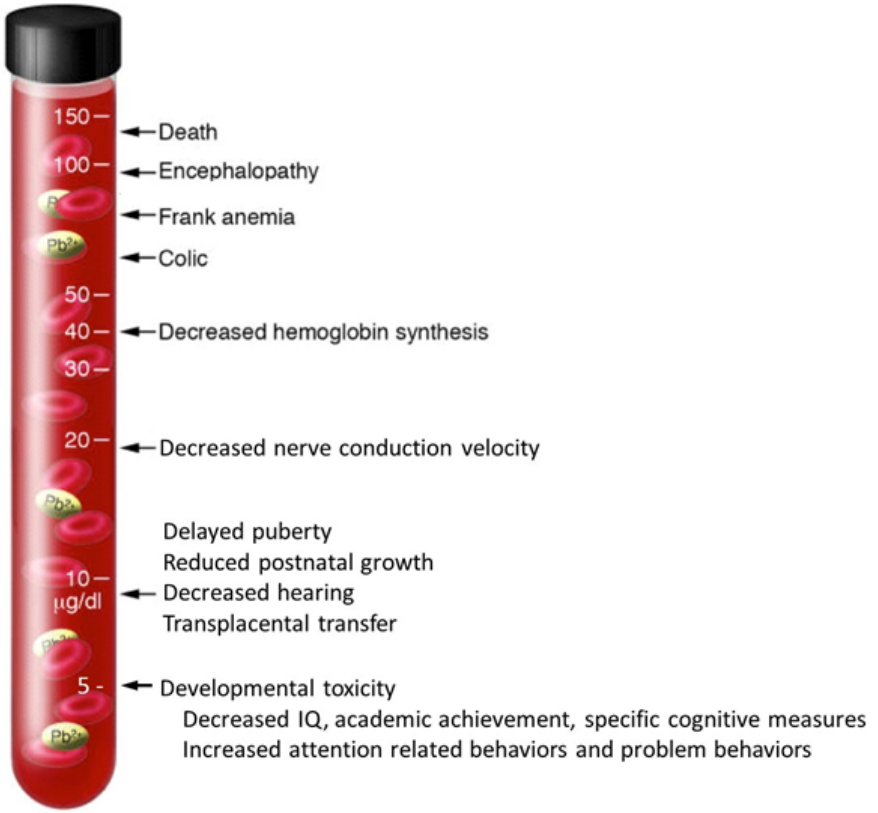
- Pottery or porcelain with lead glaze
- Imported food, candy, spices
- Antique furniture, toys
- Imported cosmetics
- Inexpensive and costume jewelry



* Rates for ingested lead only, ATSDR

Key Pediatric Health Concerns

- May be asymptomatic
- <u>Possible symptoms:</u> constipation, fatigue, anemia, headaches.
- <u>Serious health consequences:</u> neurological disorders, fatal lead encephalopathy
- Acute and high dose exposures are rare, but possible
- Most lead toxicity in US children is “subclinical” necessitates blood test to determine exposure.



WHO. Childhood Lead Poisoning. 2010.

We have sufficient evidence for the following low-level health effects:

Neurological Effects

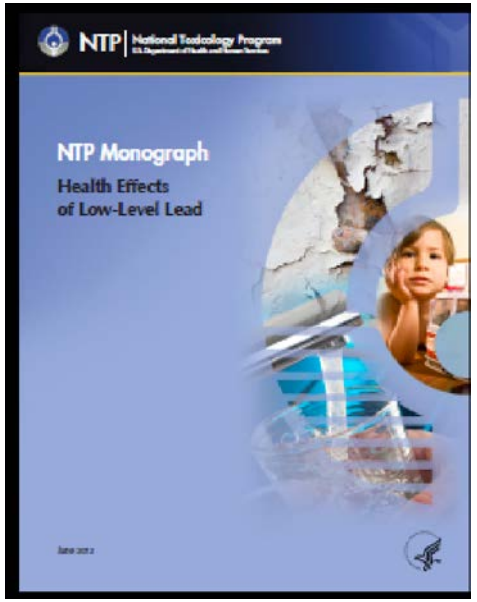
- Attention related problems
- Anti social behavior
- Criminal Behavior
- Decreased cognitive ability
- Decreased academic achievement
- Decreased Hearing

Reproductive Effects

- Reduced fetal growth
- Adverse changes in sperm parameters; increased time to pregnancy

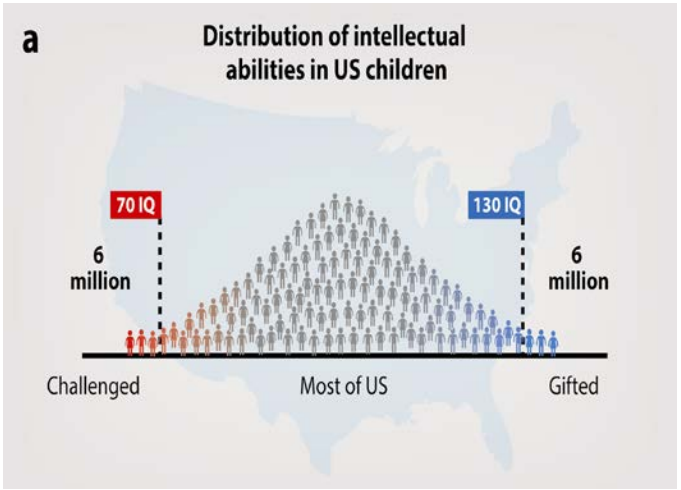
Other Effects

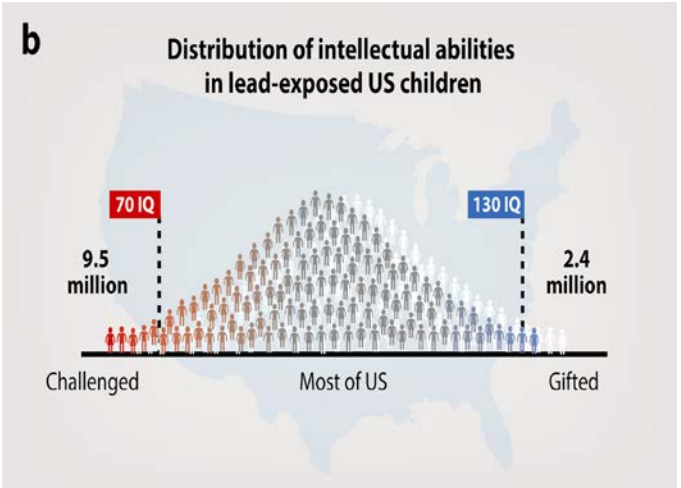
- Decreased postnatal growth
- Delayed puberty

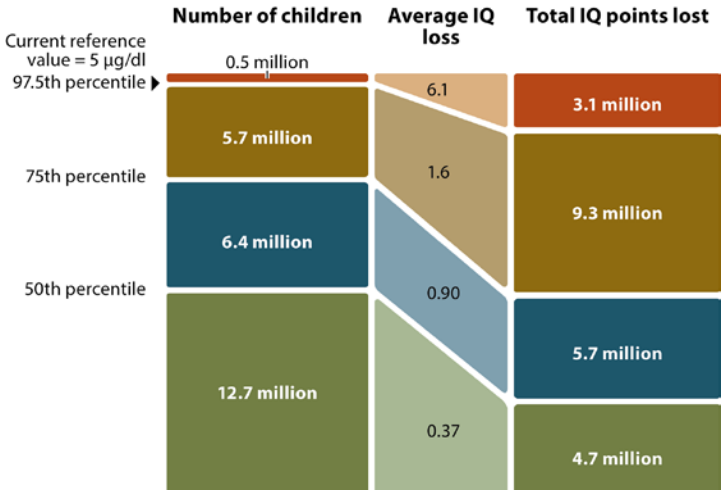


National Toxicology Program 2012

The Significance of a 5 Point IQ Reduction







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Evens, A., Hryhorczuk, D., Lanphear, B.P. et al. The impact of low-level lead toxicity on school performance among children in the Chicago Public Schools: a population-based retrospective cohort study. Environ Health 14, 21 (2015). https://doi.org/10.1186/s12940-015-0008-9

Summary: why address lead exposure in pediatric patients?

- There is no threshold – potential harm exists even at low levels.
- Lead exposure to children is common
- Detecting elevated BLLs leads to investigation and elimination of the source.

Common Barriers to BLL testing

- Belief among clinicians that their patients are not at risk for lead exposure and would be symptomatic if they were exposed
- Blood testing was off site from clinic location.
- Parents want to limit the frequency of blood testing at time of vaccines.
- Parents unaware of importance of testing.
- Remoteness of residence.
- Language barriers

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Federal Rules

- Federal law mandates lead testing test for all children covered by Medicaid at 12 and 24 months.

- **HEDIS Measure** for Lead Screening in Children:

  Number of children 2 years of age who had one or more blood tests for lead poisoning by their second birthday.

Testing Requirements for Children in NE

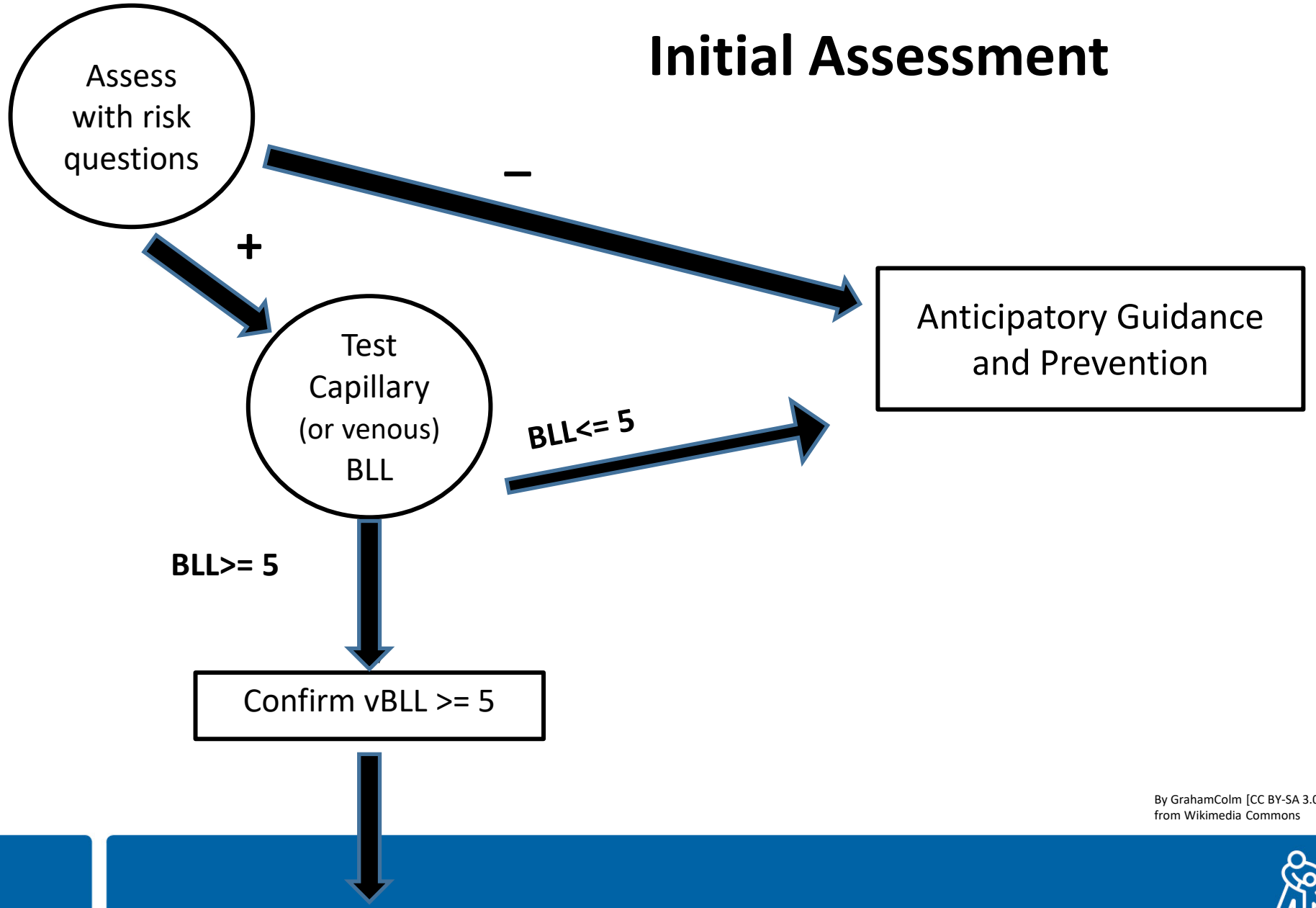
NE Medicaid Children

- Blood test at 12 and 24 months
- One blood test between ages of 12 and 72 months if no previous test
- Screen annually until the age of six
  - Blood lead test for a positive response to questions on HCY screening tool
- **Annual blood lead test for high risk areas until age of six (list published annually)

All Children in NE

- Blood test annually for *high risk areas* until the age of six (list published annually)
- Screen annually until the age of six
  - Blood lead test for a positive response to questions on screening tool

Initial Assessment



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Responding to abnormal BLLs

Timeline

Identify Risk Factors

↓

Obtain BLL and confirm ≥5 with vBLL

↓

Lab (or clinic) reports all BLLs at all levels to state within <7 days

↓

State reports to County Public Health

↓

Public Health Response

↓

Clinician monitors BLL
BLLs continue to be tracked

Work-Up and Clinical Management of Lead Exposed Children

For 5 << BLL << 44 mcg/dL

- Labs: CBC, iron, ferritin, CRP
- Consider abdominal X-ray
- Consult specialist if > 20 mcg/dL
- Monitoring repeat BLLs
- Conduct exposure history
- Ensure good nutrition
- Promote healthy neurocognitive development
  - ***Consider referring for educational enrichment***

Addressing Lead Exposure Sources – Methods for removing lead from the home

- Frequent wet dusting and wet mopping
- Frequent hand washing
- Remove shoes at domicile
- Wash produce
- Keep painted surfaces dust-free
- Clean surfaces weekly
- Lead Safe Certified renovation firms

Promoting Healthy Neurocognitive Growth - including Anticipatory Guidance

- Speaking with parents constructively
- Promote healthy neuro-cognitive development
  - Good nutrition
  - Educational enrichment
  - Physical activity
  - Limited screen time
  - Safe environments
  - Good sleep
- Reduce risk of future exposure (i.e. with home lead reduction opportunities)

Resources

- PEHSU National Fact Sheet: Lead
  - http://www.pehsu.net/_Childhood_Lead_Exposure.html
- AAP: Detection of Lead Poisoning
  - https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/lead-exposure/Pages/Detection-of-Lead-Poisoning.aspx
- US EPA: Lead Sources
  - https://www.epa.gov/lead
- Nebraska Childhood Lead Poisoning Prevention Program
  - Educational Materials: http://dhhs.ne.gov/Pages/Lead-Educational-Materials.aspx
- Protect Your Family from Lead booklet
  - https://www.epa.gov/sites/production/files/2020-04/documents/lead-in-your-home-portrait-color-2020-508.pdf *(available in multiple languages)*
- Fight Lead with a Healthy Diet
  - https://www.epa.gov/sites/production/files/2020-01/documents/fight_lead_poisoning_with_a_healthy_diet_2019.pdf.

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