Childhood Cancer & the Environment

A project to educate and activate health professionals to address environmental influences on childhood cancer

WESTERN STATES PEHSU
Pediatric Environmental Health Specialty Unit

Childhood Cancer Prevention

CHE Alaska Webinar

April 24th, 2025

Mark Miller, MD, MPH

Director Emeritus, Western States Pediatric Environmental Health Specialty Unit
University of California, San Francisco

Lead, Childhood Cancer and the Environment Program, National PEHSU Network

Former Director, Children's Environmental Health Center, CalEPA

Catherine Metayer, MD, PhD

Adjunct Professor of Epidemiology/Biostatistics

Director of the Center for Integrative Research on Childhood Leukemia and the Environment

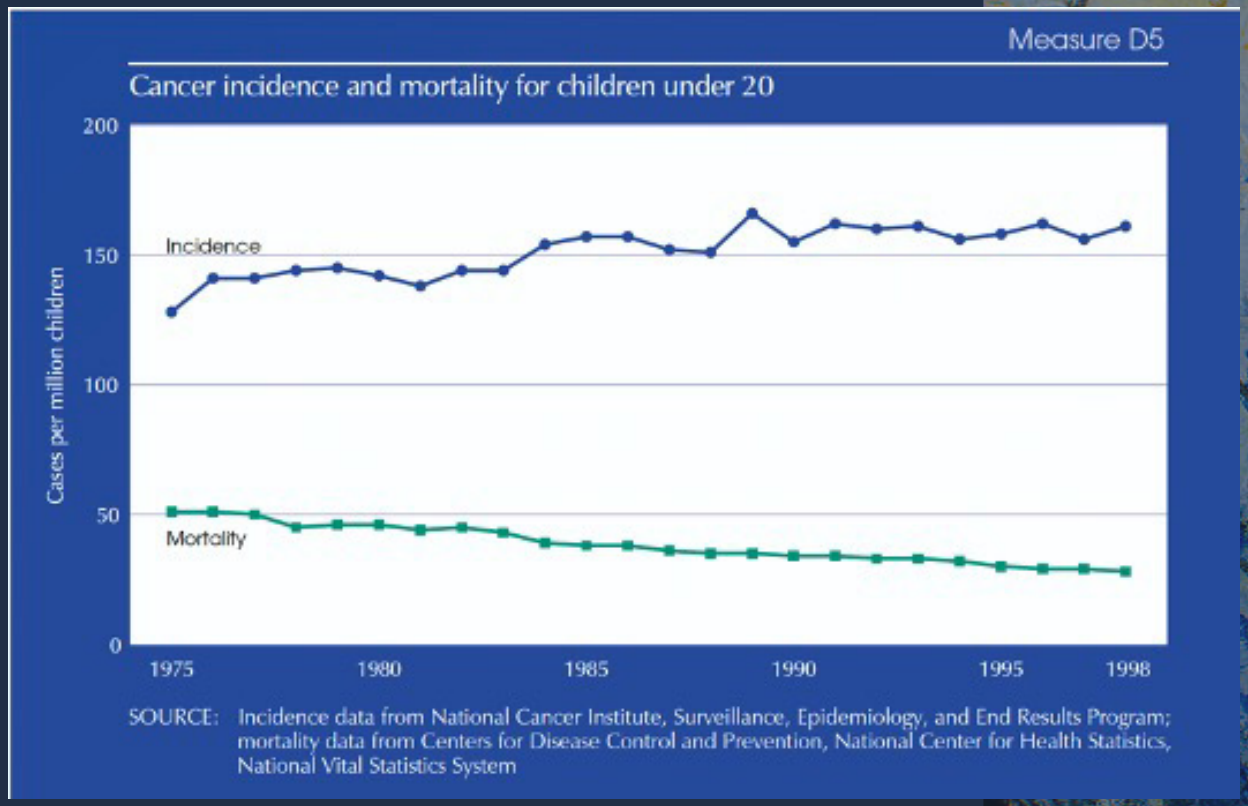
University of California, Berkeley Berkeley Public Health

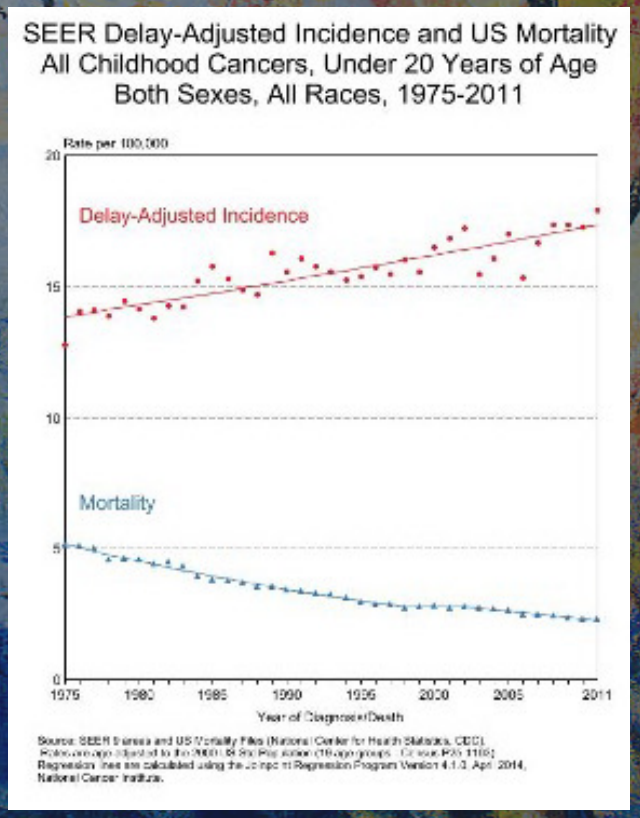
No disclosures

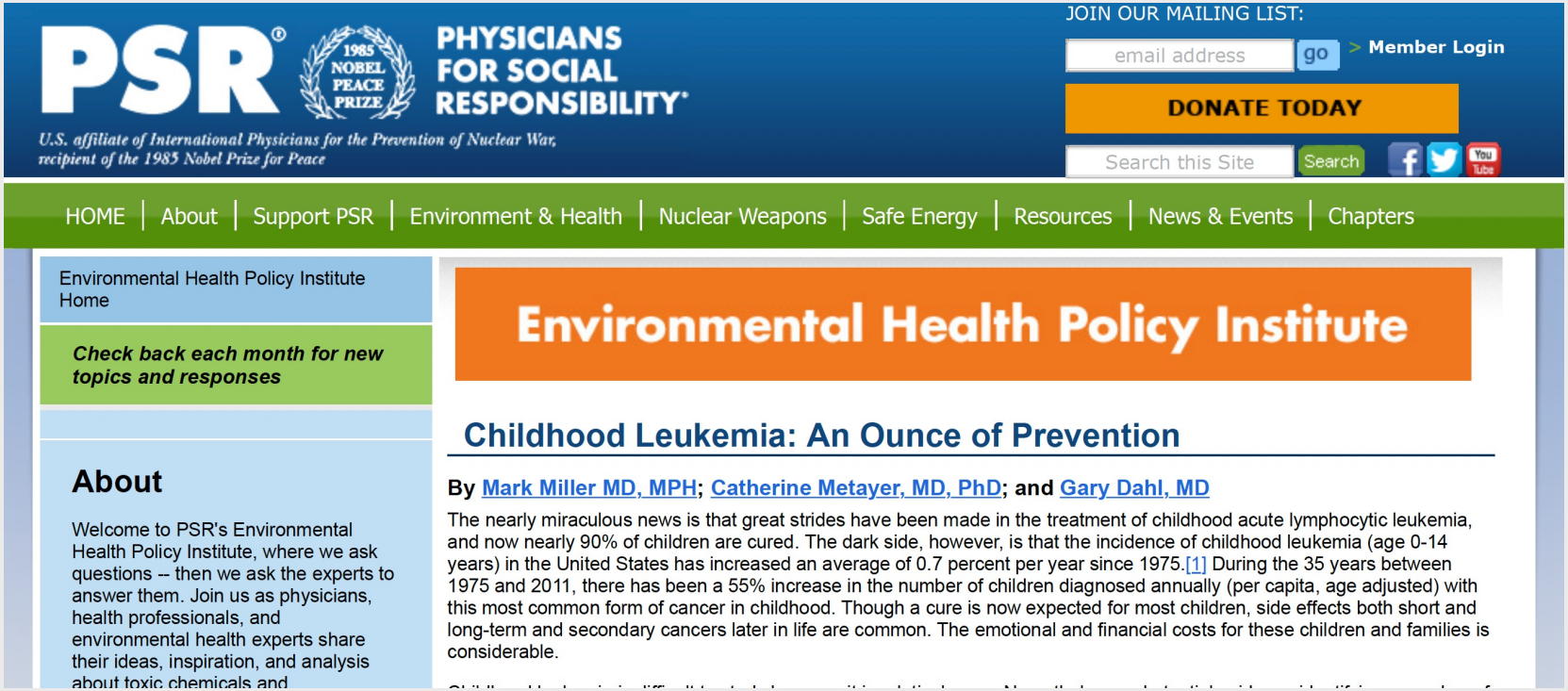
This presentation was supported by cooperative agreement FAIN: NU61TS000356 from the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry (CDC/ATSDR). The U.S. Environmental Protection Agency (EPA) provided support through Inter-Agency Agreement 24TSS2400078 with CDC/ATSDR. The Public Health Institute supports the Pediatric Environmental Health Specialty Units as the National Program Office. The findings and conclusions in this presentation have not been formally disseminated by CDC/ATSDR or EPA and should not be construed to represent any agency determination or policy. Use of trade names that may be mentioned is for identification only and does not imply endorsement by the CDC/ATSDR or EPA.

Data presented have been funded wholly or in part by the United States National Institutes of Health and the EPA. The contents of this presentation do not necessarily reflect the views and policies of the NIH and EPA.

The annual incidence of childhood cancer increased from 1975 until about 1990. The frequency of the disease appears to have become fairly stable overall since 1990. America's Children and the Environment 2003, US EPA







"Although the causative role of cigarette smoking in deaths from coronary disease is not proven, the Committee considers it more prudent from the public health viewpoint to assume that the established association has causative meaning than to suspend judgment until no uncertainty remains."

Surgeon General's Report on Smoking and Health 1964

Roadblocks Facing Childhood Cancer Prevention

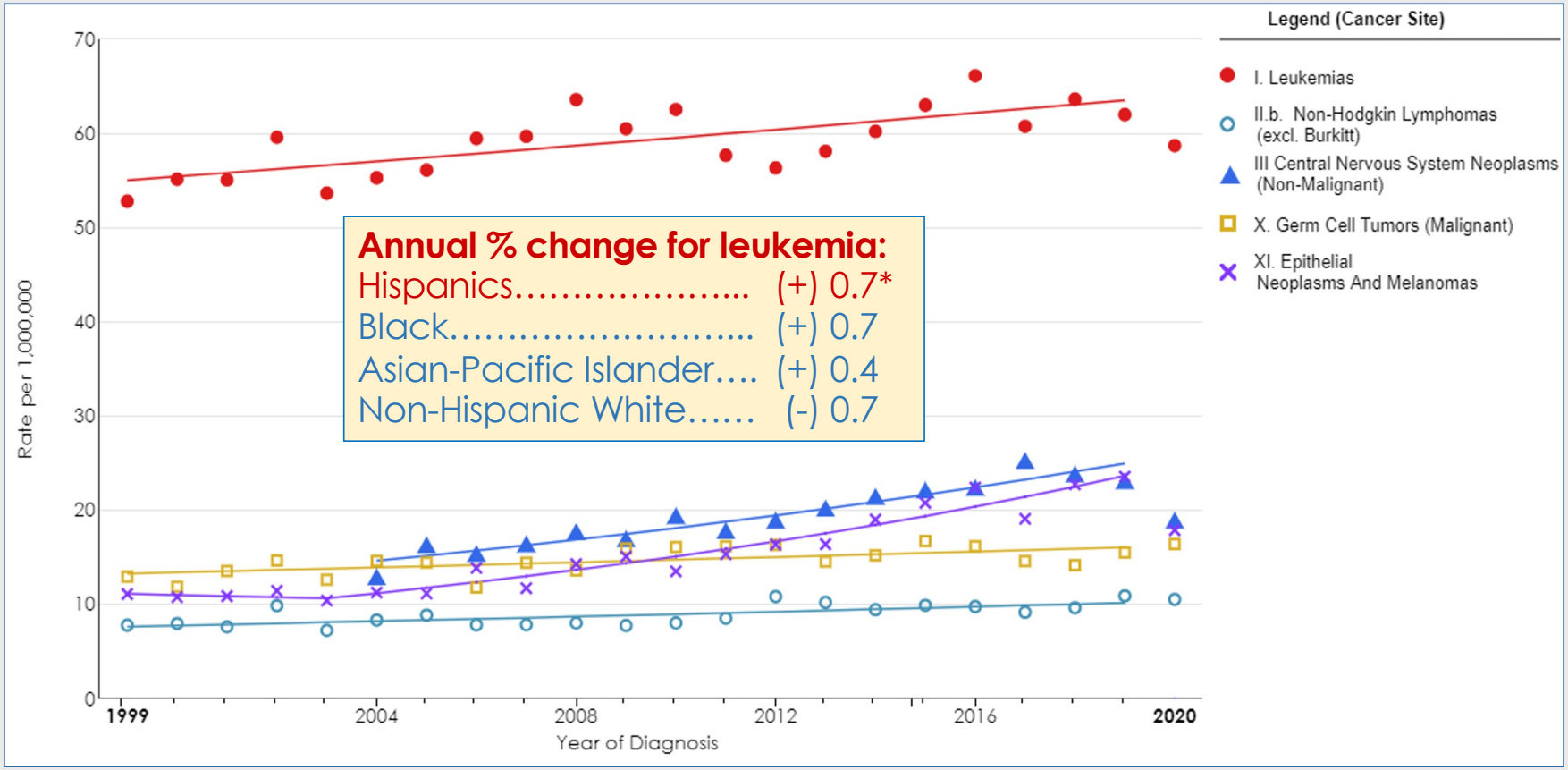
> Most childhood cancers are caused by DNA changes (mutations) that happen early in the child's life, sometimes even before birth. Because of this, there are not many known risk factors or ways to prevent childhood cancers.

American Cancer Society

- Factors that are believed to increase the risk of childhood cancer include:
  - Radiation exposure
  - Secondhand smoke
  - Certain inherited syndromes

https://www.cancer.org/cancer/childhood-cancer/causes-risk-factors-prevention.html

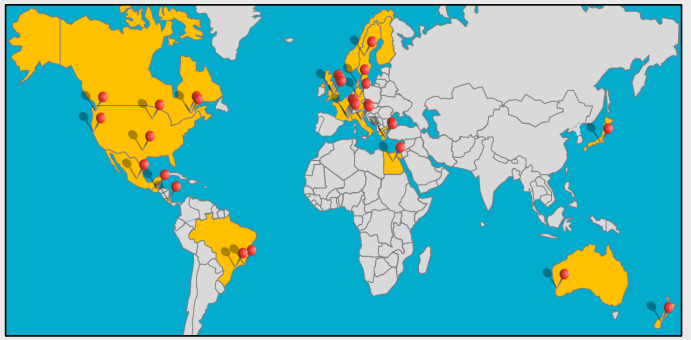
Incidence Trends in the US



Source: US National Childhood Cancer Registry

Methodological Challenges

Childhood Cancer & Leukemia International Consortium



Childhood cancers are rare compared to adults

Need for large studies

Case-control design is most efficient

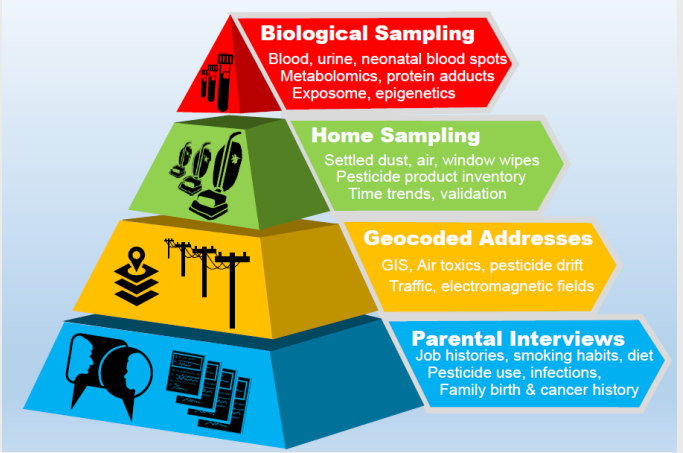
Retrospective assessment of exposure

Biomarkers studies are sparse

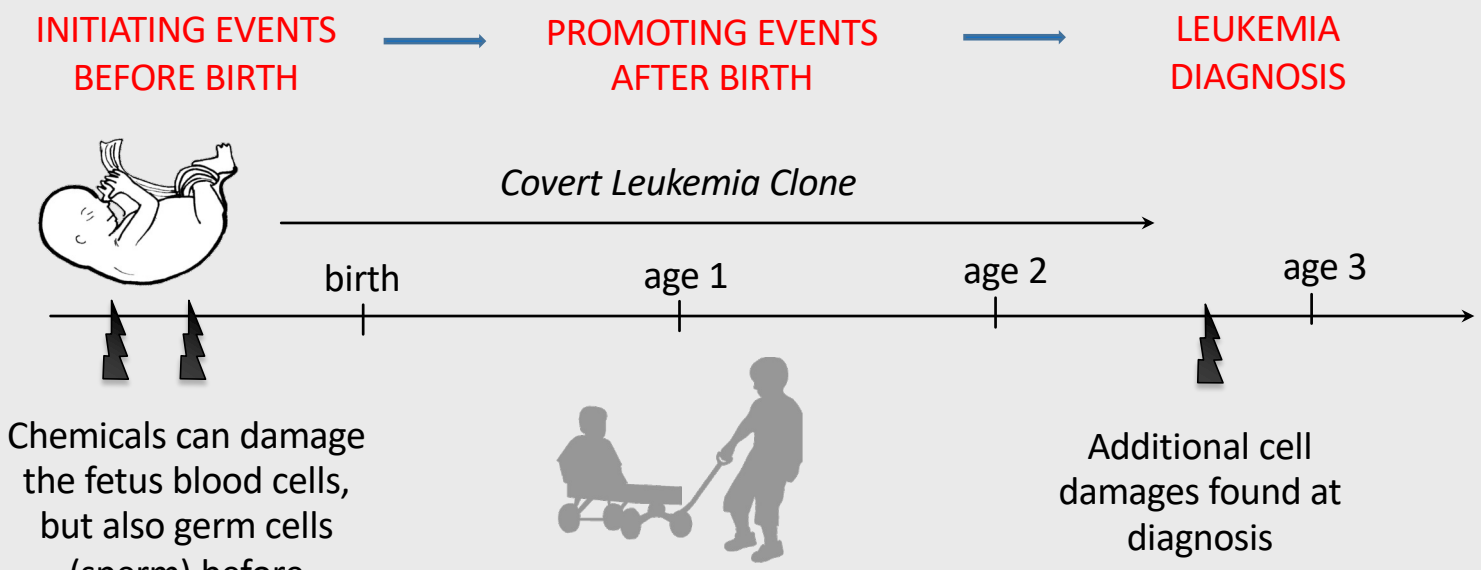
Challenges in accessing biospecimen

Most childhood cancers have a fetal origin

Need for prenatal/neonatal specimens



Natural History of Childhood Leukemia



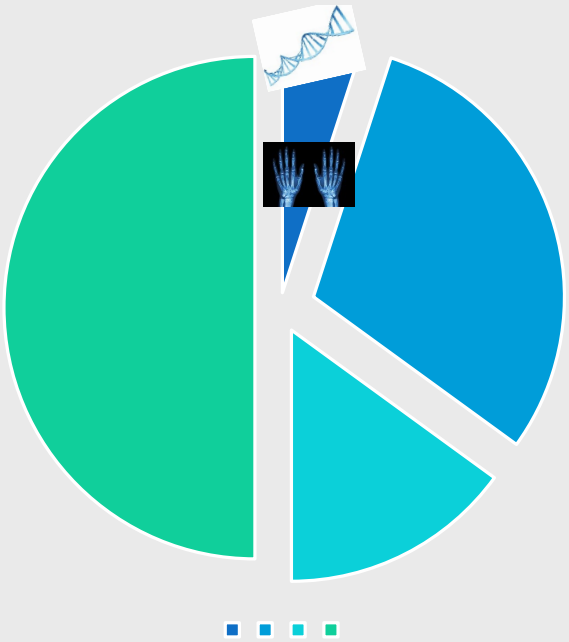
ETV6-RUNX1
RUNX1-MTG8
PML-RARA
CBFB-MYH11

ETV6-RUNX1
RUNX1-MTG8
PML-RARA
CBFB-MYH11

30 years ago

Known risk factors accounted for <10% of all childhood leukemia

genetic syndromes & x-rays

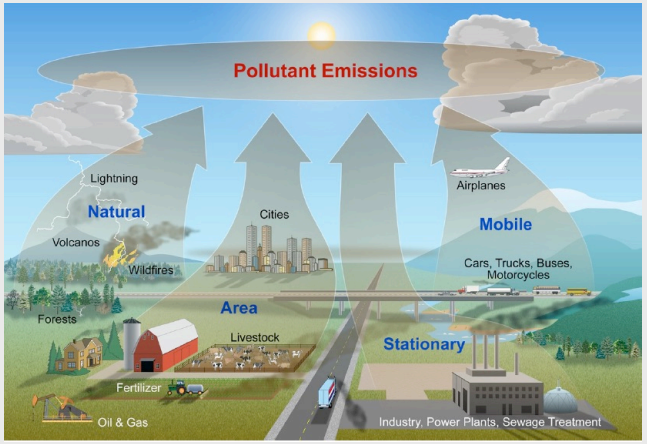


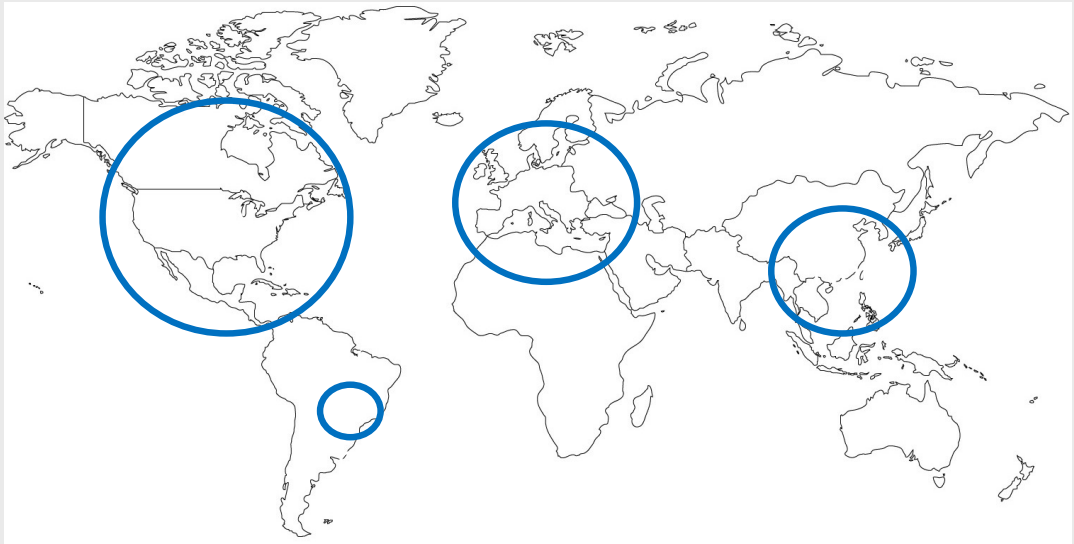
Childhood leukemia & other cancers

- Immune regulation/infections
- Fetal growth
- Environmental exposures
  - At home & work
    - Smoking
    - Paints
    - Solvents
    - Pesticides
    - PCBs/PBDEs
  - Indoor/outdoor pollution
- Dietary patterns (mother and child)
- Genetics
- Epigenetics

Many chemicals are known to cause cancer in adults

Air Pollution





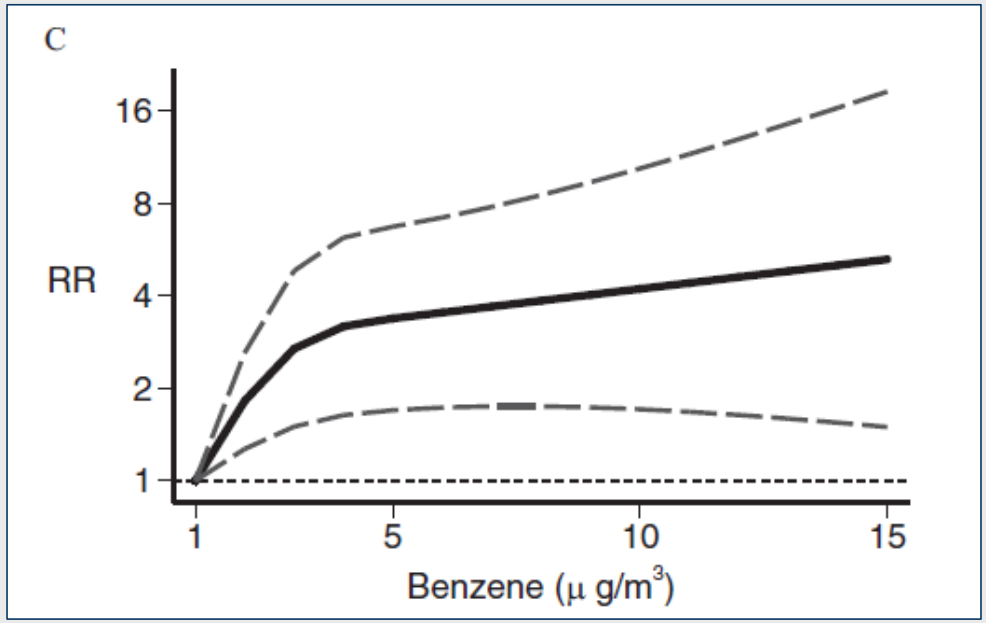
Epidemiologic results vary

- Cancer subtype
- Age at exposure
- Region and period
- Exposure assessment method
  - *traffic density*
  - *proximity to industrial sources*
  - *air monitors*

Leukemia: Meta-analysis of Air Monitor Data

	Benzene *7 studies max*	**1,2 Butadiene** *2 studies max*
Leukemia type		
Lymphoid (ALL)	No association	↑ risk
Myeloid (AML)	↑ risk	↑ risk
Age at diagnosis		
0-5 years	↑ risk	↑ risk
6+ years	No association	n/a
Window of exposure		
Prenatal	↑ risk	↑ risk
After birth	↑ risk	n/a

Acute myeloid leukemia



Source: adapted from Filippini et al.. Association between Outdoor Air Pollution and Childhood Leukemia: A Systematic Review and Dose-Response Meta-Analysis. Environ Health Perspect. 2019 Apr;127(4):46002.

Hazardous Air Pollutants

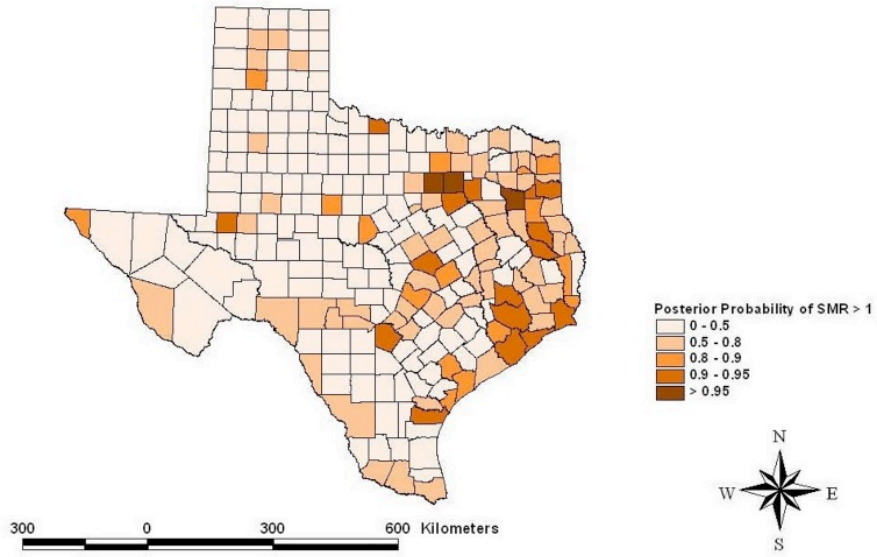


Figure 8
Spatial risks for hepatic tumors by county.

- **Spatial risk analysis in Texas (1990-2002)**
- "*The study supports the increase of childhood hepatic cancer risk [..and not other cancer sites] in areas of intense HAP release.* ***The standard morbidity ratio (SMR) for hepatic tumors was 1.87 (0.95, 3.98)*** *for county-years with greater than 100 tons of HAP releases.*"

Source (with permission): Thompson JA, Carozza SE, Zhu L. Geographic risk modeling of childhood cancer relative to county-level crops, hazardous air pollutants and population density characteristics in Texas. Environ Health. 2008 Sep 25;7:45. doi: 10.1186/1476-069X-7-45

Oil & Gas - Fracking

- Chemical & radiological contamination of air & water
- **Study in Pennsylvania 2007-2012**
  - Living within a 2km buffer of the birth address anytime from preconception to one-year prior diagnosis => 70% INCREASED RISK OF ACUTE LYMPHOBLASTIC LEUKEMIA
  - Higher risk during the perinatal period

Source: Deziel et al., Environ Health Perspect., 2022 Aug;130(8):87001. doi: 10.1289/EHP11092

Paternal Occupational Exposures to Organic Compounds & Childhood ALL

CALIFORNIA CHILDHOOD LEUKEMIA STUDY

Latino Fathers only

Expert exposure assessment	Cases	Controls	OR*	95% CI
Any organic compounds	**107**	**102**	**1.72**	**(1.22-2.44)**
-- Benzene	30	20	2.03	(1.11-3.70)
-- Chlorinated hydrocarbons	31	17	2.53	(1.36-4.71)
Combustion exhaust/PAHs	**64**	**56**	**1.70**	**(1.16-2.57)**

* OR adjusted for child's age at diagnosis/reference date, sex, maternal race, and household annual income

Metayer, Env Research (2016)

Home Use of **Paints** & Childhood ALL

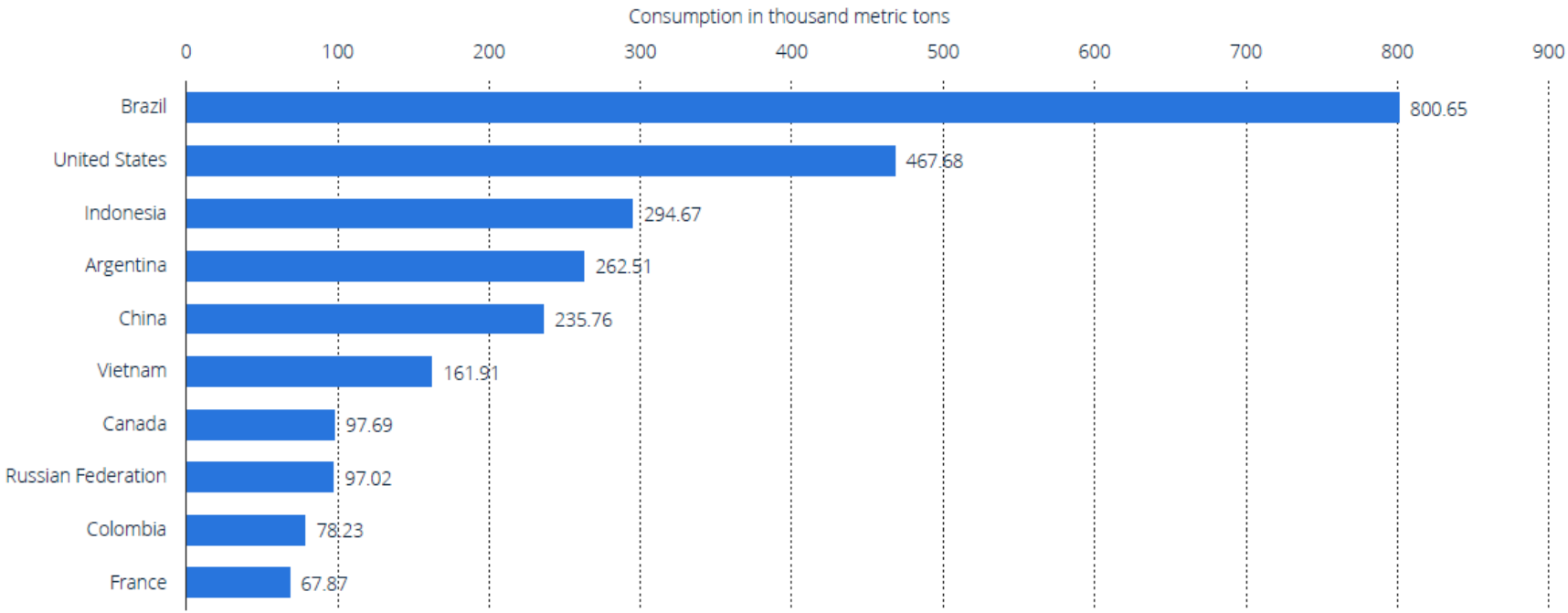
Time window	Exposure	# Cases	OR*	95% CI
Before conception	Any paints	3,000	1.42	(0.92-2.19)
	Water-based paints	1,146	0.87	(0.72-1.04)
	Oil-based paints	**1,146**	**1.27**	**(1.03-1.57)**
	Professional	**608**	**1.53**	**(1.03-2.26)**
Pregnancy	Any paints	1,962	3.91	(1.54-9.90)
	Water-based paints	1,387	0.96	(0.80-1.15)
	Oil-based paints	**1,387**	**1.22**	**(0.98-1.53)**
	Professional	**1,305**	**1.66**	**(1.21-2.28)**
After birth	Any paints	35	1.12	(1.07-1.39)
	Water-based paints	1,157	1.01	(0.83-1.23)
	Oil-based paints	1,157	1.17	(0.94-1.45)
	Professional	**928**	**1.46**	**(1.18-1.80)**

* OR adjusted for child's age at diagnosis/reference date, sex, maternal race, and household annual income

Bailey, Cancer Causes Control

Leading countries in agricultural consumption of pesticides worldwide in 2022 (in 1,000 metric tons)

Global pesticide agricultural use 2022, by leading country



Note(s): Worldwide; 2022

Further information regarding this statistic can be found on page 8.

Source(s): FAO; ID 1263069

Childhood Cancer & Leukemia International Consortium

Parents at work

- **~8,000 ALL cases | 14,000 controls**
- Pesticide exposure based on job exposure matrix using occupational and industry codes, and data from industrial hygienists for a subset
- Paternal exposure during periconception: **OR=1.20 (1.06-1.38)**
- Maternal exposure during pregnancy: **OR=1.01 (0.78-1.30)**

Bailey et al., Int J Cancer, 2014

Parents & children at home

Time period	Acute Lymphoblastic Leukemia (ALL)		Acute Myeloid Leukemia (AML)	
	# Cases	OR (95% CI)	# Cases	OR (95% CI)
Before conception	2785	1.4 (1.2,1.5)	173	1.5 (1.0, 2.2)
During pregnancy	5055	1.4 (1.3, 1.5)	345	1.5 (1.2, 2.0)
After birth	4162	1.4 (1.2, 1.5)	198	1.1 (0.8, 1.5)

Adjusted for age, sex, birth year group, ethnicity, highest level of education for either parent +/- birth order.

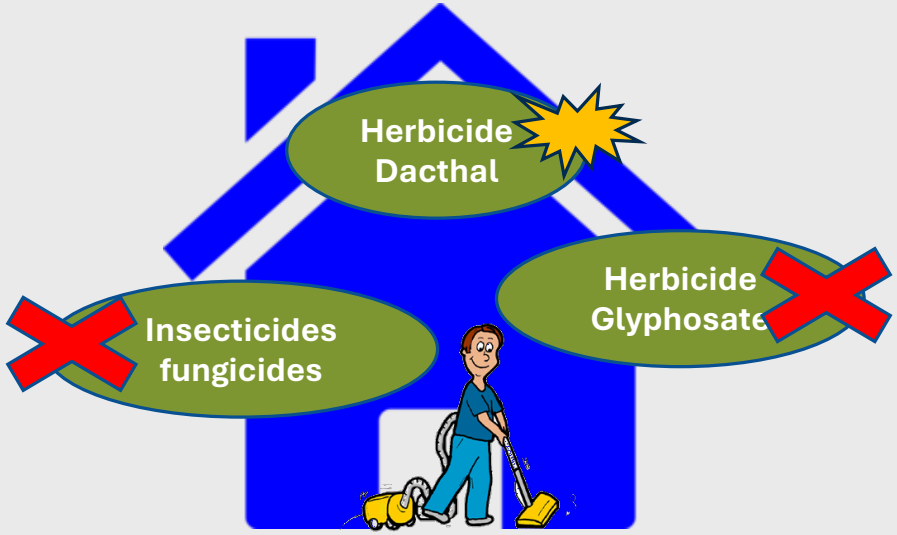
Source: Adapted from Bailey et al, IJE, 2015

Pesticides in **Home Dust**

- Dust is a reservoir of chemicals
- Young children are exposed via
  - Ingestion
  - Inhalation
  - Skin contact

- **Measured chemicals ~ 500 homes**

CALIFORNIA CHILDHOOD LEUKEMIA STUDY

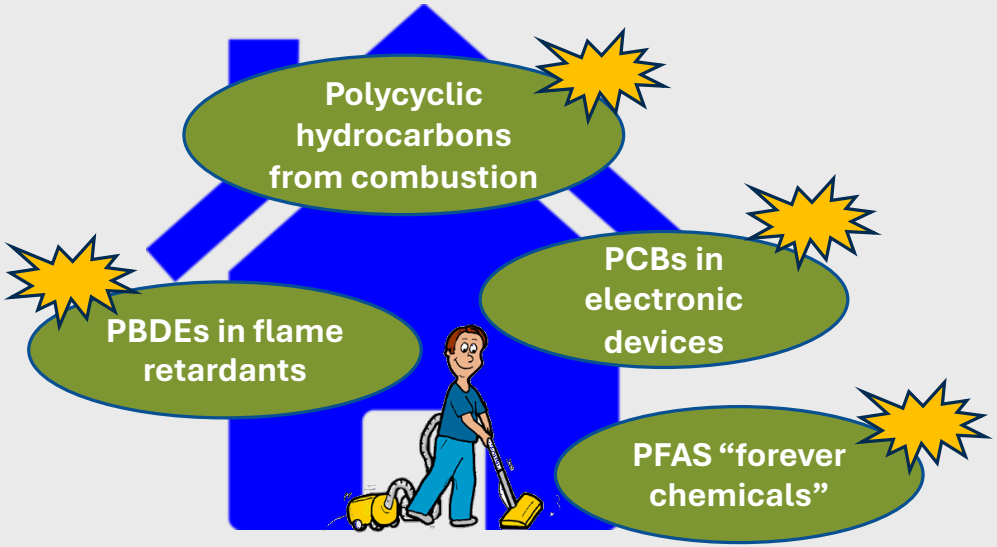


Metayer, JESEE, 2013

Madrigal, Environ Res, 2021

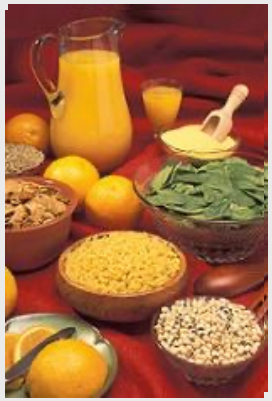
Ward, EHP, 2023

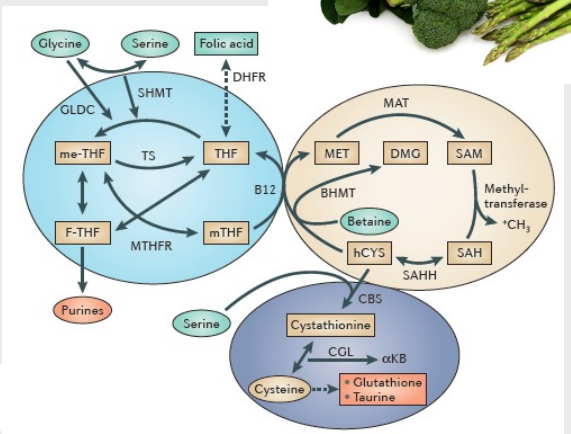
Other Chemicals in **Homes**

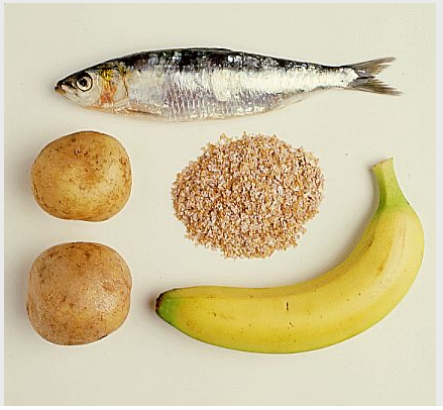


Deziel et al., Environ Res 2014
Ward et al., EHP 2013 & 2009
Metayer et al., IJE 2025

Sources of One Carbon (Folate) Metabolism Nutrients







Prenatal Vitamin and Folate supplementation and Risk of Childhood Leukemia

	Vitamins (Any Time)						Folic Acid (Any Time)					
	No. Studies	No. Exposed		OR	(95% CI)[a]	Test for Interaction	No. Studies	No. Exposed		OR	(95% CI)[a]	Test for Interaction
		Controls	Cases					Controls	Cases			
Parental education[c]												
Overall[b]	12	6640	4336	0.85	(0.78–0.92)		8	2164	1228	0.80	(0.71–0.89)	
None/Primary	12	873	447	0.72	(0.60–0.88)	$P = 0.14$[d]	8	352	132	0.47	(0.33–0.68)	$P = 0.01$[d]
Secondary	12	2649	1879	0.78	(0.68–0.88)		8	660	410	0.73	(0.59–0.90)	
Tertiary	12	3118	2010	0.97	(0.86–1.09)		8	1152	686	0.96	(0.82–1.12)	

[a]Adjusted for age, sex, ethnicity, parental education, and study. OR for parental education is adjusted for age, sex, ethnicity, and study

Metayer, Epidemiology, 2014

Prenatal vitamin intake and childhood ALL

Singer, Cancer Causes Control, 2016

Intake	Latina mothers 234 cases, 296 controls	Non-Latina whites 265 cases, 374 controls
None	Ref.	Ref.
Moderate intake	1.12 (0.44-2.84)	1.25 (0.75-2.07)
High intake	0.36 (0.17-0.74)	0.76 (0.50-1.16)

Conditional logistic models adjusted for father's education, mother's education, household income, maternal age at child's birth, and nutrient intake from food. N= number of discordant pairs/triplets *For folic acid, moderate intake is >0 & <600 µg and high intake is ≥600 µg. For vitamins B12, B6, and riboflavin, moderate intake is >0 & <5 µg B12 and <1.5 mg B6 and riboflavin, and high intake is ≥5 µg B12 and ≥1.5 mg B6 and riboflavin.

Gonseth, Epigenetics, 2015; 10(12):1166-76

Methylation marker of prenatal folate intake

Reduced maternal folate intake around conception was associated with increased methylation and, in turn, decreased gene expression at 3 loci of folate-associated genes:

- *TFAP2A*, a gene critical for neural crest development
- *STX11*, a gene implicated in acute myeloid leukemia
- *CYS1*, a candidate gene for cystic kidney disease

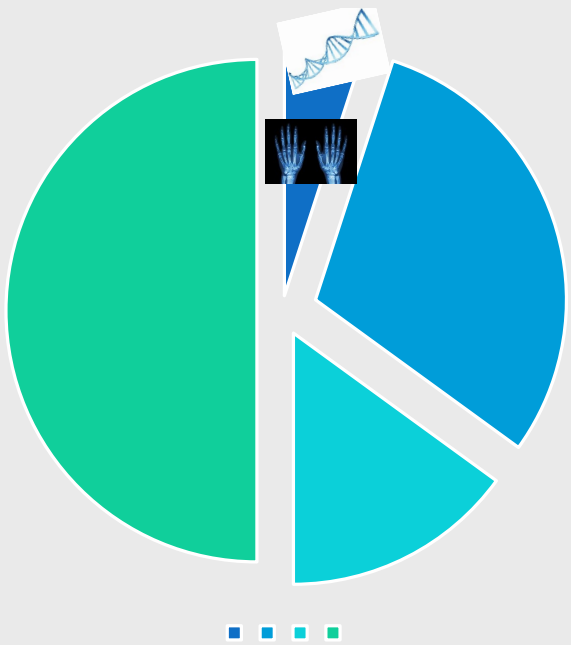
CLIC consortium meta-analyses:
Breastfeeding reduces the risk of childhood lymphoblastic leukemia

	% (case:control)	Pooled analysis	
		Crude OR (95% CI)[a]	Adjusted OR (95% CI)[b]
Breastfeeding duration[c] (N = 10 782 cases; N = 16 588 controls)			
Never	35.4:34.5	1.00	1.00
<4 mo	27.2:26.9	0.96 (0.90-1.02)	0.98 (0.92-1.04)
4-6 mo	12.8:13.7	0.87 (0.80-0.94)	0.88 (0.81-0.96)
7-12 mo	24.6:24.8	0.86 (0.80-0.92)	0.85 (0.79-0.92)
Exclusive breastfeeding duration[d] (N = 3278 cases; N = 7072 controls)			
Never	45.8:44.2	1.00	1.00
<4 mo	36.8:38.8	0.88 (0.80-0.97)	0.91 (0.83-1.01)
4-6 mo	14.1:13.7	0.72 (0.63-0.83)	0.73 (0.63-0.85)
7-12 mo	3.4:3.3	0.70 (0.55-0.89)	0.70 (0.53-0.92)

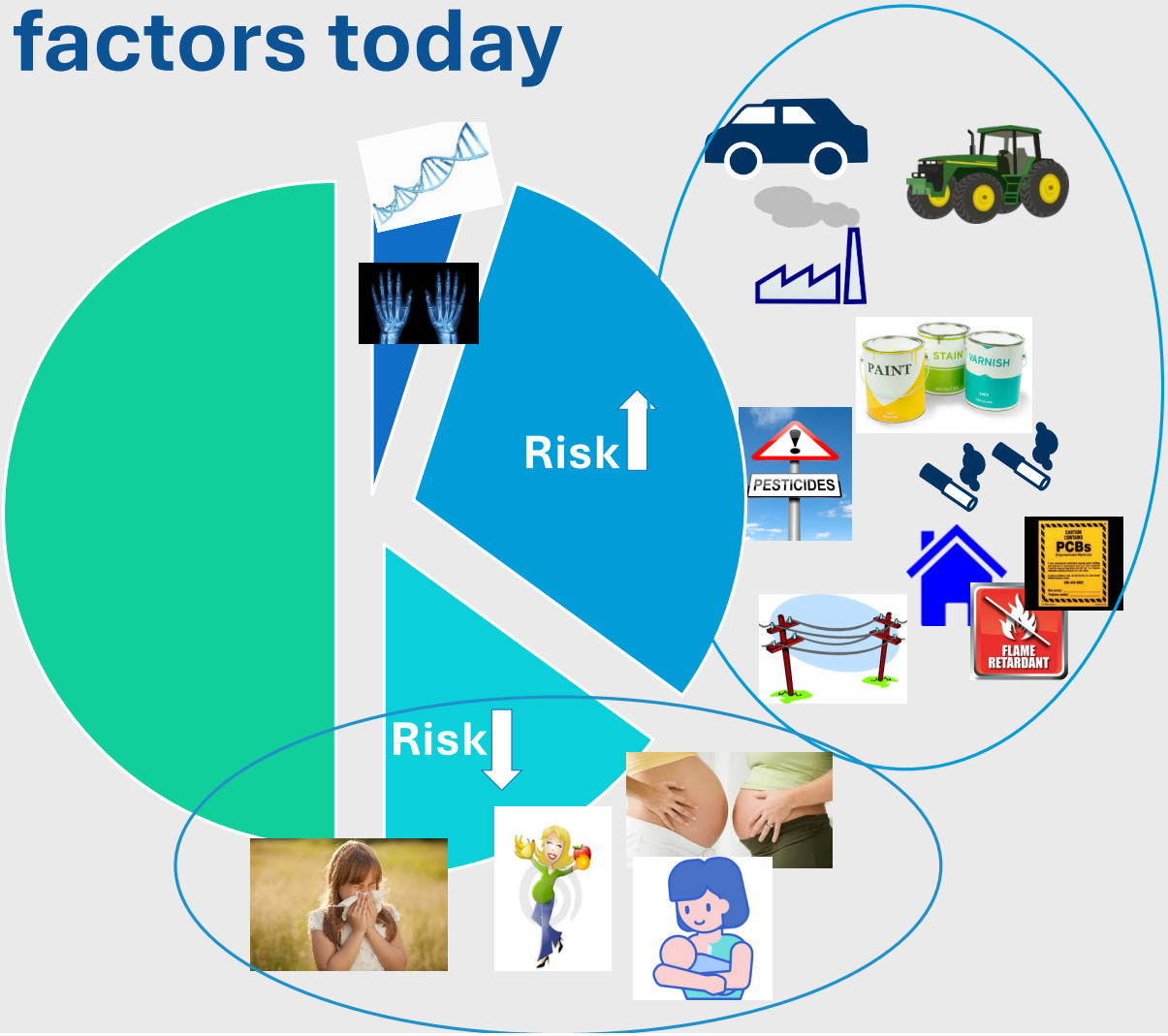
Schraw, IJC, 2022

30 years ago

Known risk factors accounted for <10% of all childhood leukemia



Known risk factors today



Cumulative Impact

International Journal of *Molecular Sciences*

MDPI

Int J Mol Sci. 2024 Mar 14;25(6):3284

Review

Environmental Pollution and Risk of Childhood Cancer: A Scoping Review of Evidence from the Last Decade

María del Pilar Navarrete-Meneses [1], Consuelo Salas-Labadía [1], Fernando Gómez-Chávez [2] and Patricia Pérez-Vera [1,*]

Overview of the etiology of childhood cancer and future directions

Thanh T. Hoang[a,b,c], Michael E. Scheurer[a,b,c] and Philip J. Lupo[a,b,c]

Curr Opin Pediatr. 2025 Feb 1;37(1):59-66

	Air Pollution	Tobacco	Pesticides	Vitamins/BF
Leukemias	√√	√√	√√	√√
Lymphomas	√√		√√	
Brain tumors	√	√	√	√√
Neuroblastoma	√	√√	√	
Retinoblastoma	√√	√√	√	
Wilms tumor	√√		√	
Hepatoblastoma		√√		

Take-away

Data support associations between certain chemicals and **increased** risks of several childhood cancers

Data support association between dietary factors and **decreased** risks of several childhood cancers

Assessment in epidemiologic studies can be imprecise and may underestimate true associations.

Exposomic studies are ongoing to better understand existing and novel etiologic pathways

Ripples

1 CIRCLE/ WSPEHSU *(focus region 9)*

a) Outreach to Latino communities/ young adults

b) Outreach to clinical community

2 Funding for work by CDC "Trevor's law"

a) Expansion to full country and beyond

b) Train PEHSU Champions and early practice clinicians

c) Expand developed material

d) Partner with CEHN

3 Develop consultative service

a) Baylor Medical College/Texas Children's Hospital

b) Mercy Children's Hospital, Kansas City

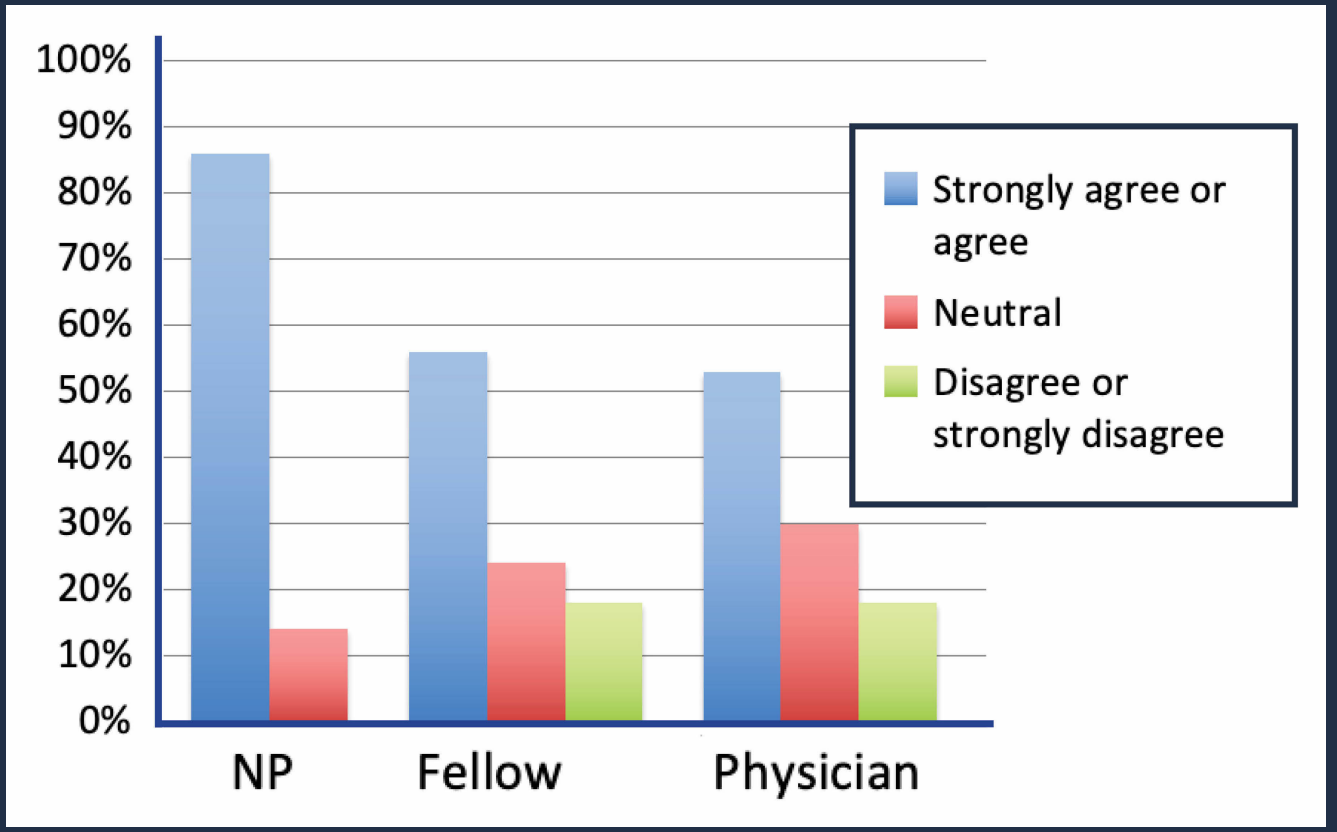
4 Collaboration with Prep 4 Gold and other foundations

a) Help develop Childhood Cancer Prevention Conference

b) Developing collaborative network

Survey of Pediatric Oncology Fellows, Attendings, and Nurse Practitioners.

In your opinion, are environmental exposures important contributors to childhood cancer?



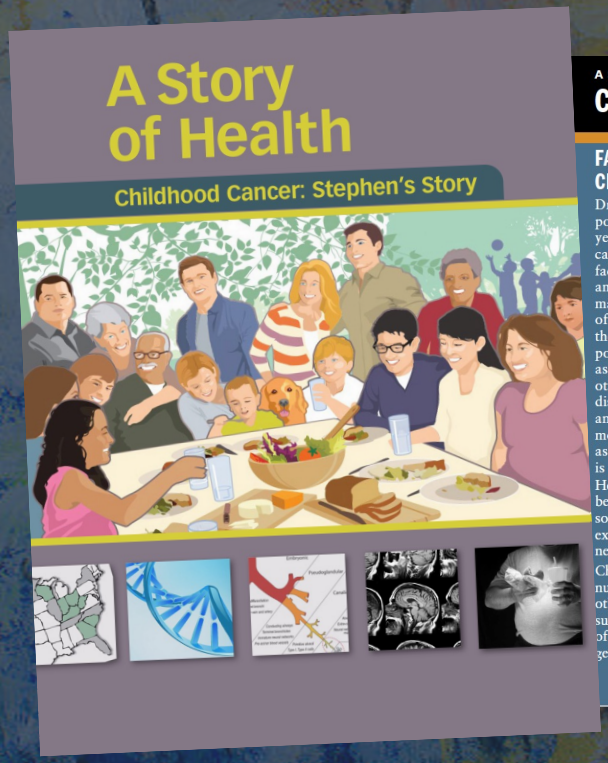
Zachek et al. J Pediatr Hematol Oncol 2015

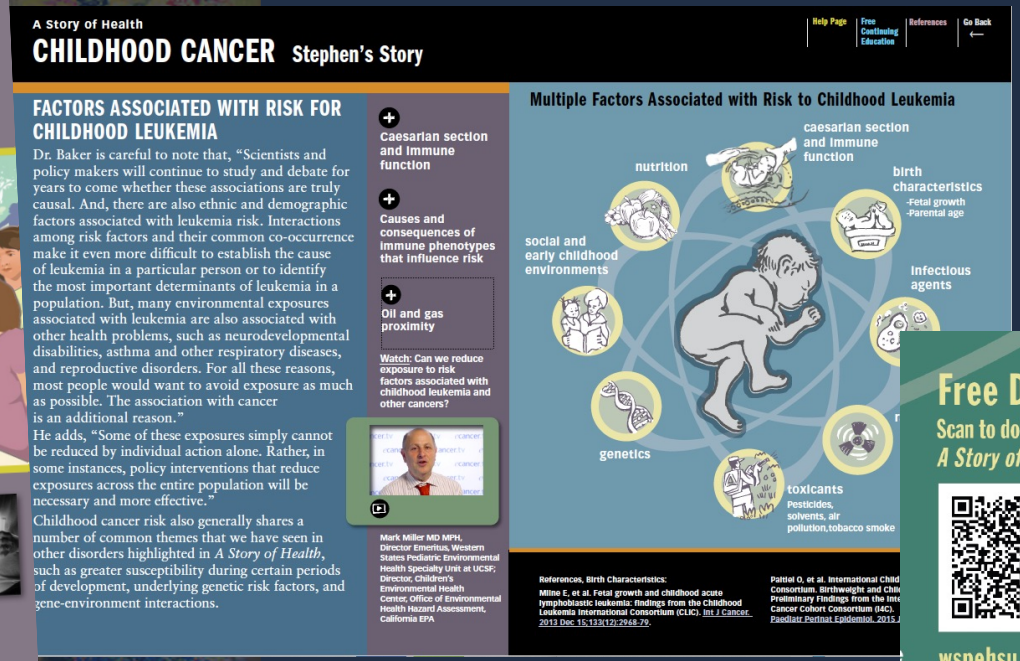
Knowledge Gap

- 89% report getting questions from families
- ~ ½ uncomfortable discussing environmental exposures
- 92% would find it helpful to have information about environmental exposures

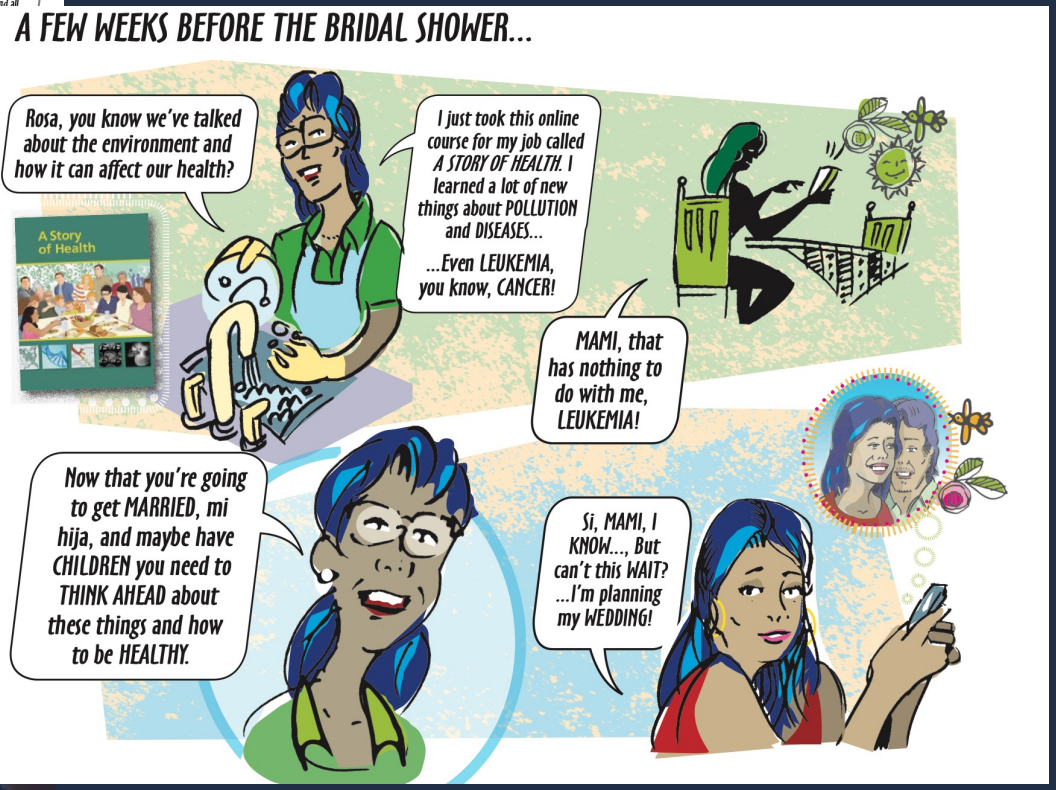
Zachek et al. J Pediatr Hematol Oncol 2015

Story of Health eBook
Stephen's Story – Childhood Cancer





Comic book



[Improving Environmental Health Literacy of Young Adults]

Ripples

1 CIRCLE/ WSPEHSU *(focus region 9)*

a) Outreach to Latino communities/ young adults

b) Outreach to clinical community

2 Funding for work by CDC "Trevor's law"

a) Expansion to full country and beyond

b) Train PEHSU Champions and early practice clinicians

c) Expand developed material

d) Partner with CEHN

3 Develop consultative service

a) Baylor Medical College/Texas Children's Hospital

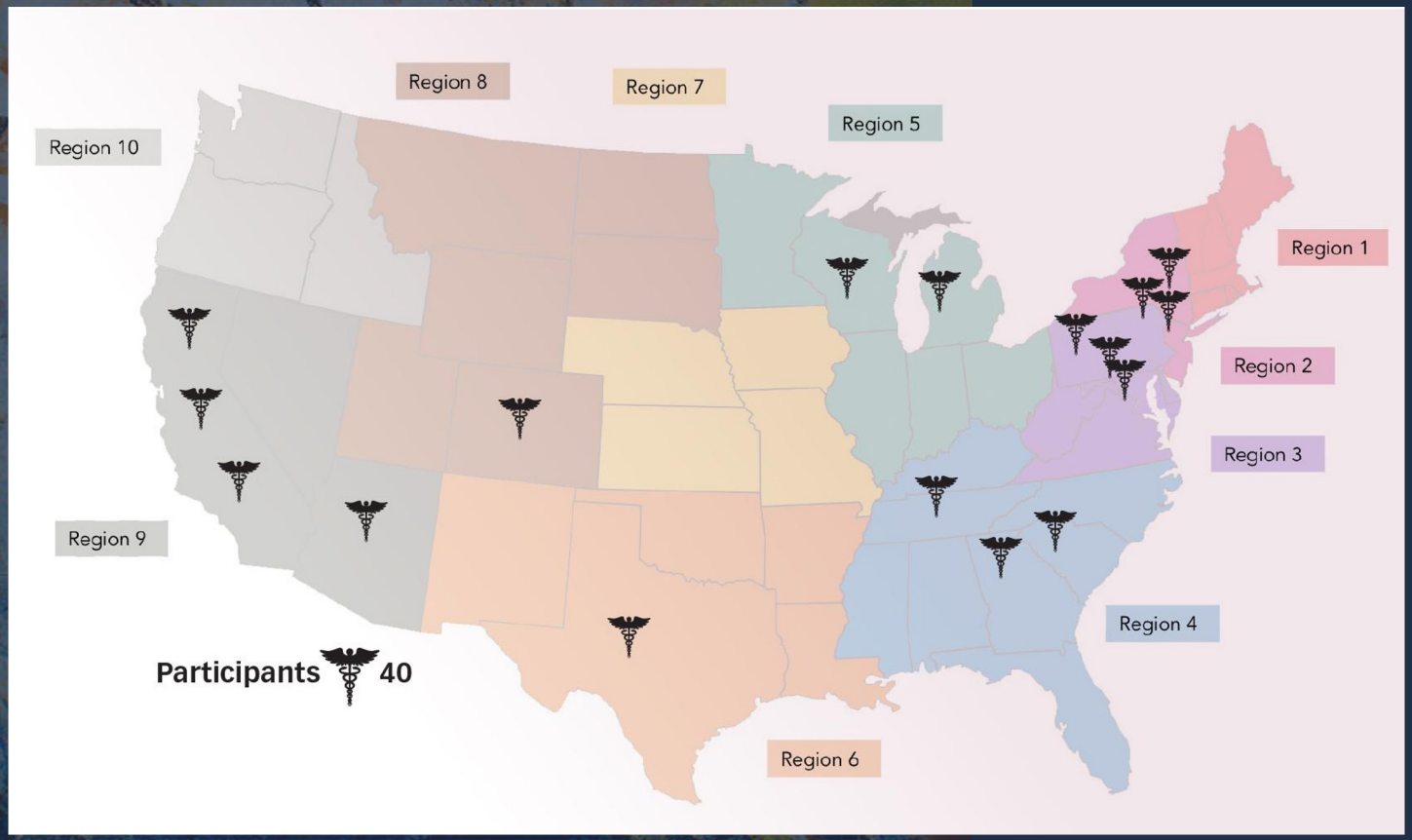
b) Mercy Children's Hospital, Kansas City

4 Collaboration with Prep 4 Gold and other foundations

a) Help develop Childhood Cancer Prevention Conference

b) Developing collaborative network

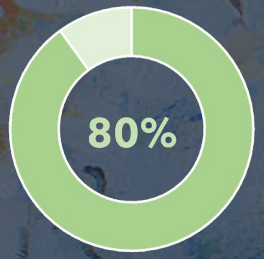
Workshop participants – Pediatric Oncology Fellows and NPs



Topics covered:

- Introduction to Env. Health
- Trends in childhood cancer
- The science on potential environmental influences on childhood cancer
- Investigating unusual patterns of cancer
- Cancer and environmental equity
- Communications strategies
- Taking an environmental history
- Ways to reduce exposures related to childhood cancer risk

Three months post-workshop surveys revealed:



80% of attendees said that they made changes to their clinical practice and had shared workshop information with colleagues.

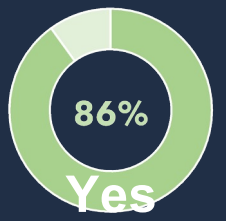
55% shared information with patients.

Over 80% said approach to answering family's questions had changed.

Attendees

Three months post training comments

- **Have your perceptions of environmental risks changed?**
  - "Completely ignorant before".
  - "I have a lot more respect and consideration for parental concerns about environmental factors"



- **Key take away**
  - "There is a lot that is known about the link between childhood cancer and the environment that is never discussed in formal medical education"
  - "That the environment does indeed play a role in ALL."
  - "Increasing disease burden in childhood cancer is related to environmental impact at various stages of development as early as fetal."

childhood cancer factsheet

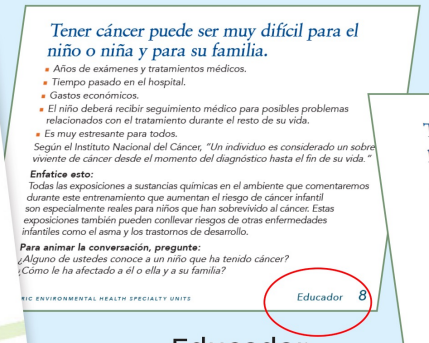
Children's Cancer & the Environment

childhood cancer and the environment resource guide

Resource materials

Major Outreach to Community Health Workers

Flipbook: Una herramienta para los promotores de salud



Educador

Aprendiz

Ripples

1 CIRCLE/ WSPEHSU *(focus region 9)*

a) Outreach to Latino communities/ young adults

b) Outreach to clinical community

2 Funding for work by CDC "Trevor's law"

a) Expansion to full country and beyond

b) Train PEHSU Champions and early practice clinicians

c) Expand developed material

d) Partner with CEHN

3 Develop consultative service

a) Baylor Medical College/Texas Children's Hospital

b) Mercy Children's Hospital, Kansas City

4 Collaboration with Prep 4 Gold and other foundations

a) Help develop Childhood Cancer Prevention Conference

b) Developing collaborative network

Creating a Pediatric Cancer and the Environment Consultative Service

- When our daughter was diagnosed with Wilms' Tumor, a kidney cancer, … there was no one on staff at our hospital – one of the top cancer facilities in the country – who asked questions about home environment at intake, or gave us any specific environmental advice during or after active treatment. I was left to do my own research. Exhausted patients and caregivers rely on our doctors, nurses, child life specialists—and more—to guide us through this unique hell. I would vastly have preferred to collaborate on her care—as we were able to in every other realm—rather than arrive at my own environmental health conclusions."

help many families."

Alexandra Zissu, Environmental Health Journalist, Editor, Environmental Health Advocate

Environmental Exposures Impact Childhood Cancer Survivors

Exposure to $PM_{2.5}$ in children treated with chemotherapy doubled risk for respiratory disease hospitalization

PM associated with increase in CNS and lymphoma mortality at 5 and 10 years

Photo: Story of Health

Ou JY, et al.. Int J Environ Res Public Health. 2019 Mar 26;16(6):1081; Phillips NS, et. al., JAMA Netw Open. 2023;6(5); Carceles-.Ivareza A, et al., Env. Research, 2019; Cancer Epidemiol Biomarkers Prev 2020, 29:1929

Choose Outdoor Time Carefully

WWW.AirNow.gov

- Adjust activities on the basis of degree of ambient air pollution.
  - The Air Quality Index (AQI), provides a tool for this.
  - On the basis of local air quality at any particular time, individuals can make decisions to reduce time spent in physical activities outside or elect to do indoor activities.

https://weather.gc.ca/airquality/pages/index_e.html

AQI Basics for Ozone and Particle Pollution

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

ee the **Activity Guides** to learn ways to protect your health when the AQI reaches unhealthy levels.

Corsi-Rosenthal Box: An inexpensive, effective air filter

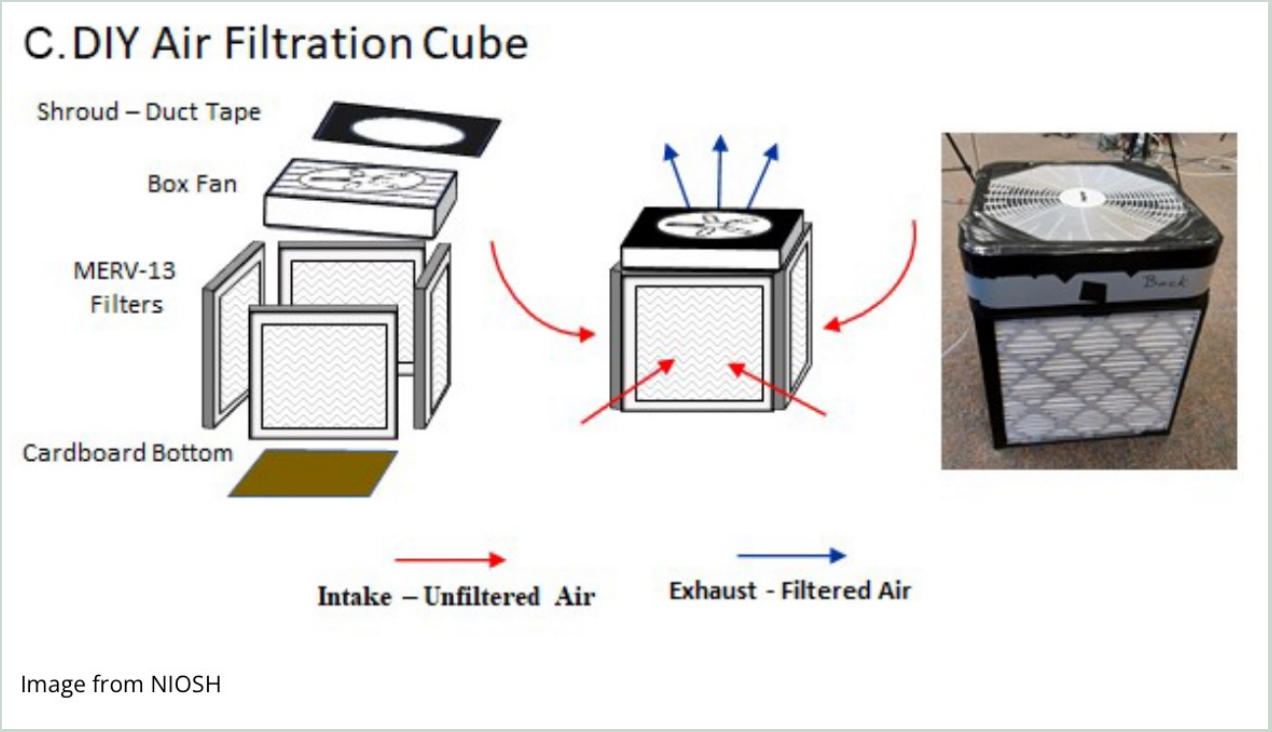
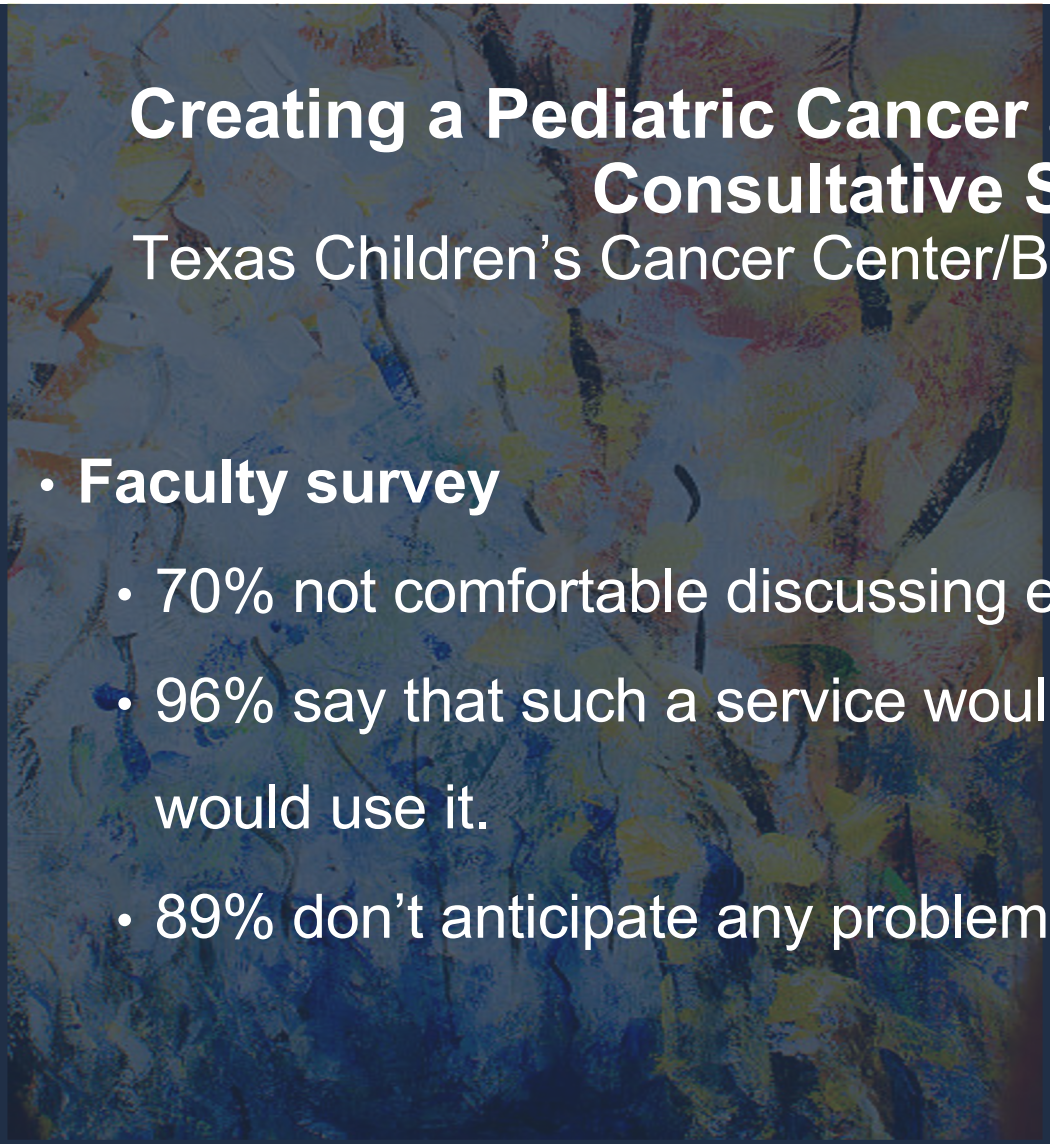


Image from NIOSH

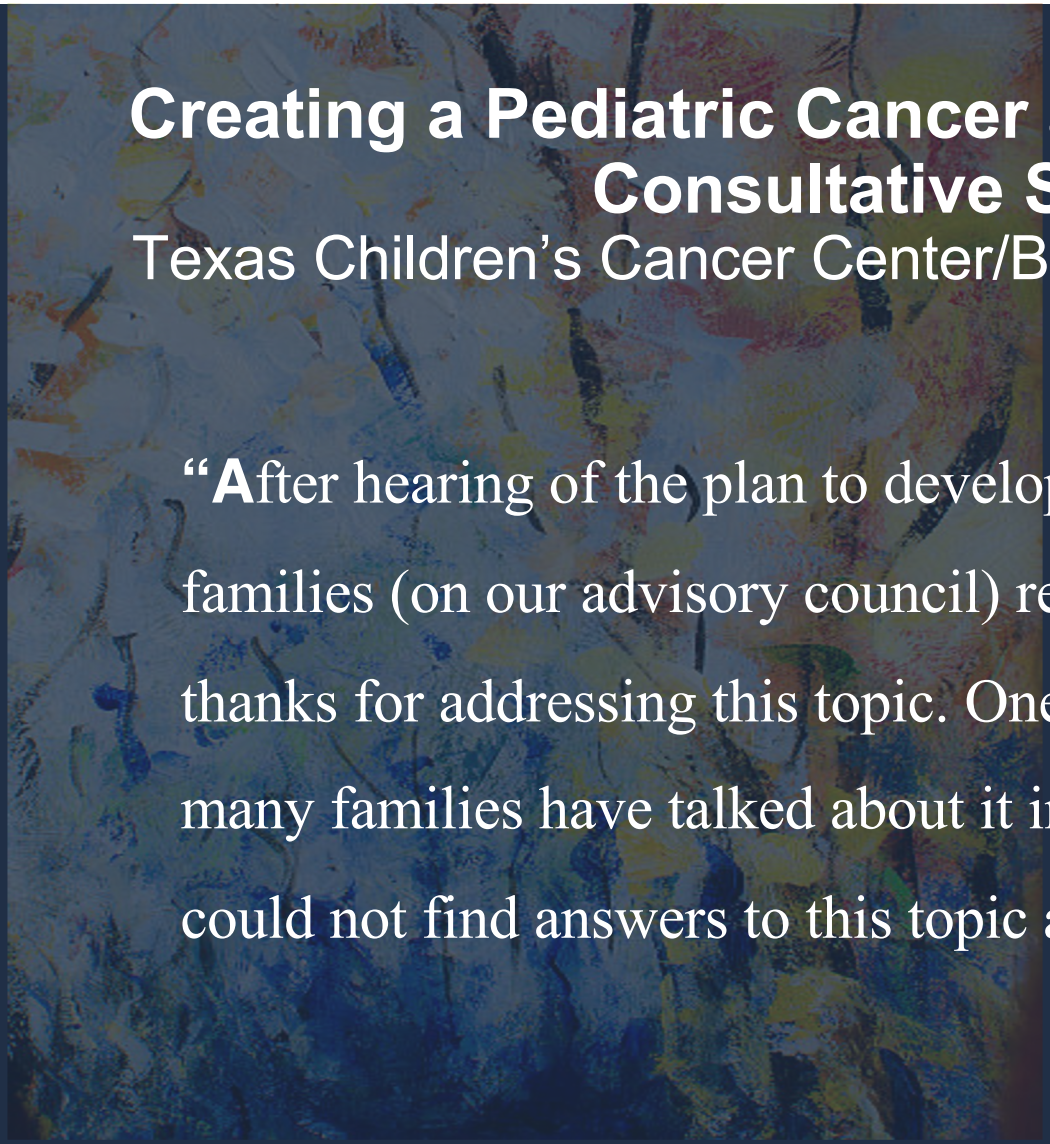
https://blogs.cdc.gov/niosh-science-blog/2023/02/03/diy-filtration/



Creating a Pediatric Cancer and the Environment Consultative Service

Texas Children's Cancer Center/Baylor College of Medicine

- **Faculty survey**
  - 70% not comfortable discussing environmental risk factors
  - 96% say that such a service would be helpful and that they would use it.
  - 89% don't anticipate any problem with such a service.



Creating a Pediatric Cancer and the Environment Consultative Service

Texas Children's Cancer Center/Baylor College of Medicine

"**A**fter hearing of the plan to develop the consultative service, four families (on our advisory council) reached out and expressed thanks for addressing this topic. One family even stated: 'I know many families have talked about it in the halls on the unit, but we could not find answers to this topic anywhere.'"

Ripples

1 CIRCLE/ WSPEHSU *(focus region 9)*

a) Outreach to Latino communities/ young adults

b) Outreach to clinical community

2 Funding for work by CDC "Trevor's law"

a) Expansion to full country and beyond

b) Train PEHSU Champions and early practice clinicians

c) Expand developed material

d) Partner with CEHN

3 Develop consultative service

a) Baylor Medical College/Texas Children's Hospital

b) Mercy Children's Hospital, Kansas City

4 Collaboration with Prep 4 Gold and other foundations

a) Help develop Childhood Cancer Prevention Conference

b) Developing collaborative network

Second Historic

Childhood Cancer Prevention Symposium

Presenting Sponsor:

ANDREW McDONOUGH B+ FOUNDATION
www.BePositive.org

February 10 -13 | Jan and Dan Duncan Neurological Research Institute at Texas Children's Hospital (NRI) | Houston, Texas

Outreach to the public, clinicians, policy makers, advocates, etc.

Podcasts

Ep. 85: Environmental Factors and Childhood Cancer

Episode 2: Childhood Cancer, the Environment and the Role of Community Health Workers with Mark Miller, MD, MPH, and Erica Guerrero MS, MPAS, PA-C.

Help and Hope Happen Here

Jonathan Agin, Gavin Lindberg, and Dr. Mark Miller will talk about the upcoming Childhood Cancer Prevention Symposium which will be taking place in February in Houston, Texas.

Videos

Outdoor and Indoor Air Pollution and Risk of Childhood Cancers

Blogs

POISONING OUR CHILDREN

Mark Miller: Stalwart Defender of Children's Environmental Health.

Jan 26, 2024

GUEST COMMENTARY

Childhood Cancer & the Environment: Opportunities for prevention

January 23, 2025

CHE Collaborative for Health & Environment

Mark Miller, MD, MPH
Lead, Childhood Cancer & the Environment Project, Western States Pediatric Environmental Health Specialty Unit, UCSF

Maria Valenti
Director, Health and Environment Literacy Project, Commonweal

Newsletters

Periconception and Pregnancy Intake of Vitamins and Folate **Reduces** Leukemia Risk

- International study finds:
  - vitamin consumption reduces ALL risk by almost 30%.
  - Folic Acid supplementation reduces risk of ALL by over 50%.

Metayer, Epidemiology, 2014
Singer et al., British Journal of Nutrition, 2016

U.S. women of pregnancy age with sub-optimal RBC folate 2017-18

NHANES survey

- Little change from 2011 – 2016 despite introduction of voluntary fortification of masa

• Non-Hispanic White	15.2%	(9.8, 20.6)
• Hispanic	18.8%	(14.4, 23.2)

Wang A, et al., *Nutrients*. 2021; 13(4):1325

You can start protecting your children's health even before they are conceived, and during pregnancy.

Co-benefits of Reducing Exposures

Traffic: Preterm birth, decreased birth wt., asthma, respiratory development, cardiovascular dis., neurobehavioral disorders

Pesticides: Neurobehavioral disorders, asthma, adverse birth outcomes, adult cancer, reproductive toxicity

Inadequate folate early in pregnancy associated with neural tube defects, increase in autism risk, other birth defects

Tobacco, breast feeding, others

What if we get it right?

Ayana Elizabeth Johnson

What does the change look like?

We must address all of these factors

Can we do primary prevention of cancer?

- SIDS
  - Many wanted to wait
  - Though studies supported a decreased risk they asked, “What is the mechanism?”

AAP technical report SIDS
Moon R. Pediatrics. 2011 Nov;128(5):1030-9. doi: 10.1542/peds.2011-2284

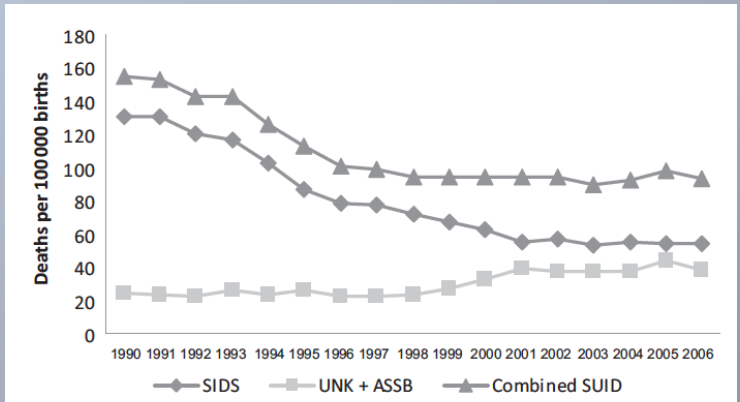


FIGURE 1
Trends in SIDS and other SUID mortality: United States 1990–2006. UNK indicates ill-defined or unspecified deaths.

Real Life Example of Childhood Cancer Prevention
Folic Acid Fortification of Grains 1996-98

Childhood Cancer Incidence Trends in Association With US Folic Acid Fortification (1986–2008)

Linabery et. al., PEDIATRICS Volume 129, Number 6, June 2012

- *Post fortification decreases in Wilm's Tumor (down 20%)*
  and Primitive NeuroEctodermal Tumors (down 40%)

Folic acid food fortification is associated with a 60% decline in neuroblastoma in Ontario Canada

French et al., CLINICAL PHARMACOLOGY & THERAPEUTICS VOLUME 74, NUMBER 3

Thank you

Collaborators, co-developers of material, supporters

- Joe Wiemels PhD, University of Southern California
- Catherine Metayer MD, PhD, UC Berkeley
- Center for Integrative Research on Childhood Leukemia and the Environment
- Childhood Leukemia International Consortium
- Maria Valenti, Vickie Leonard RN,PhD, Steve Burdick from our WSPEHSU Team
- Whitney Sterten-Hall, Omar Shakeel MD, Nicole Wood MD, Hannah Thompson MD MPH, Perry Sheffield MD MPH