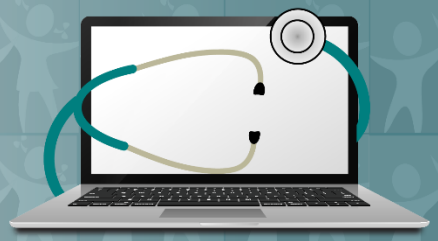
PEHSU NATIONAL CLASSROOM

Pediatric Environmental Health Specialty Units



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Webinars

- Series of scientific webinars that provide a forum for discourse on scientific issues.
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- Fact sheets, journal publications, reports, and other resources for parents, community members, patients and healthcare professionals
- Topics included:
  Air Quality, Pesticides, Natural Disasters, BPA, Mold, Lead, Mercury

Acknowledgements

This material was supported by the American Academy of Pediatrics (AAP) and funded (in part) by the cooperative agreement FAIN: 5 NU61TS000237-05 along with the American College of Medical Toxicology and funded (in part) by the cooperative agreement FAIN: 5U61TS000238-05 from the Agency for Toxic Substances and Disease Registry (ATSDR).

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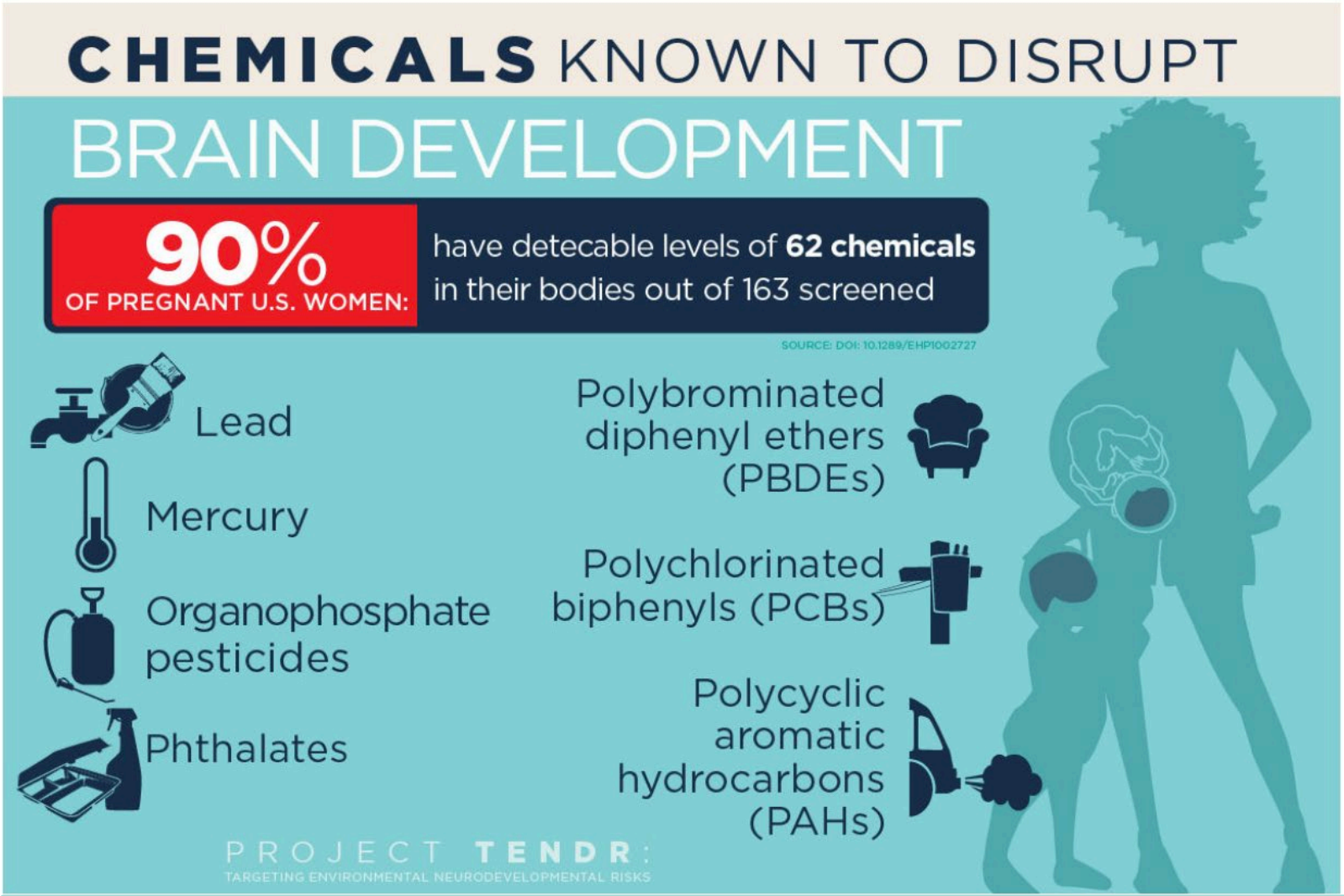
Dr. Laura Anderko PhD RN

Region 3 PEHSU: The Mid-Atlantic Center for Children's Health and the Environment

PEHSU
Pediatric Environmental Health Specialty Units

A National Alliance of Scientists, Health Professionals and Environmental Health Advocates.

Co-Founded & Co-Directed by Maureen Swanson, Learning Disabilities Association, and Dr. Irva Hertz-Picciotto, UC Davis



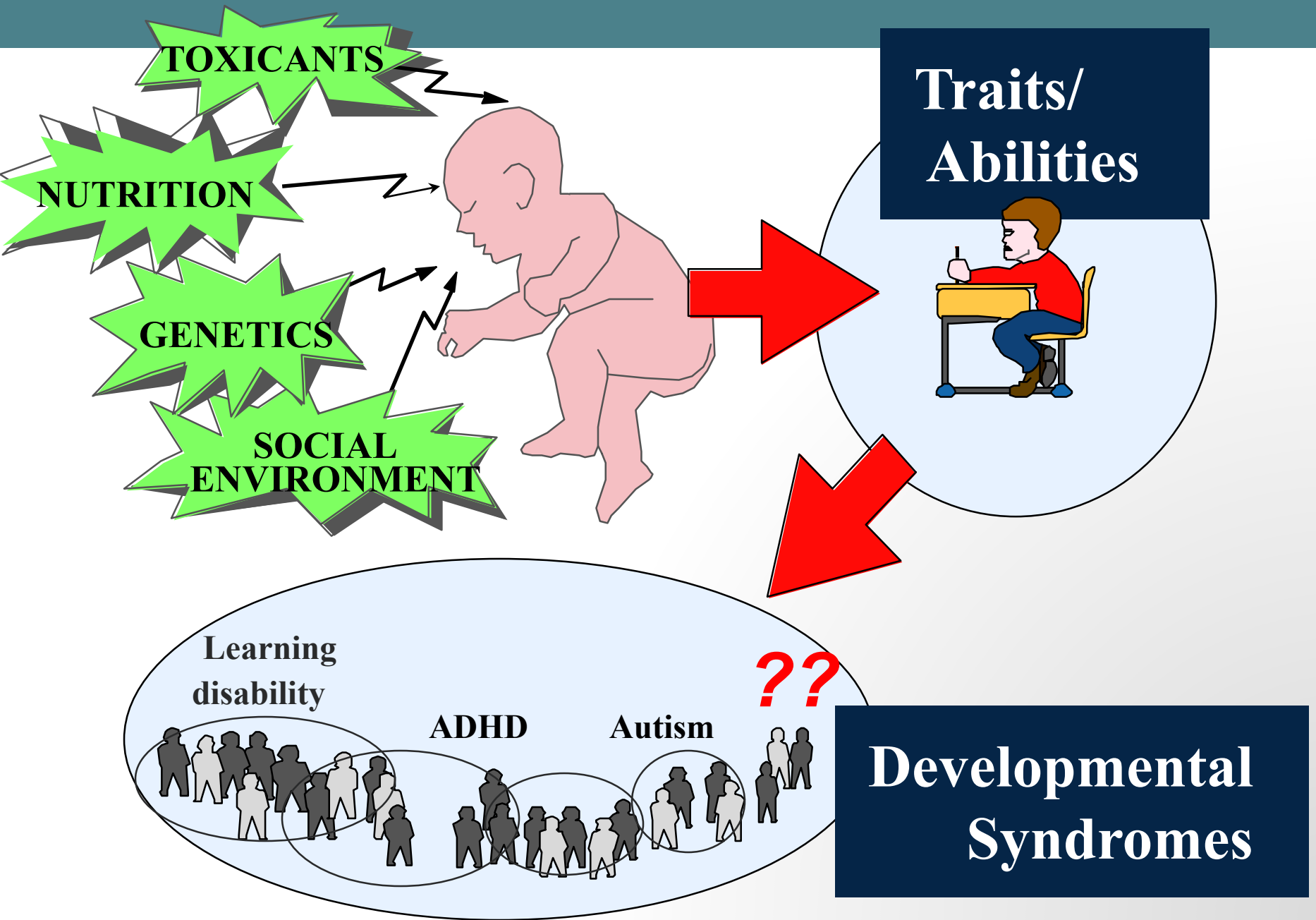
TENDR graphic

Exposure widespread. Reduction of levels is feasible.

Scientific evidence at a tipping point

- Toxic chemicals play a role in neurodevelopmental disorders.
- Learning, developmental, intellectual disabilities affect 1 in 6 children in U.S.
- Increasing prevalence of autism spectrum disorder, ADHD.

Framework for Understanding



Project TENDR Mission

To protect pregnant women and children from toxic chemicals and pollutants that harm brain development,

- **by joining scientific evidence with advocacy** to inform and empower change makers **to create policies**
- **to ensure that no child is exposed to chemicals and pollutants that contribute to neurodevelopmental disorders.**

Two pronged approach

- Target a short list of neurotoxic chemicals that highlight the larger problem of toxicants in the environment.
- Address systemic problems in chemical regulatory policies and implementation.

Published a Consensus Statement July 1st 2016 in *Environmental Health Perspectives*, covered in New York Times, CNN, NPR, 100s of smaller media outlets.

A Section 508–conformant HTML version of this article is available at http://dx.doi.org/10.1289/EHP358.

Project TENDR: Targeting Environmental Neuro-Developmental Risks. The TENDR Consensus Statement

http://dx.doi.org/10.1289/EHP358

Summary: Children in America today are at an unacceptably high risk of developing neurodevelopmental disorders that affect the brain and nervous system including autism, attention deficit hyperactivity disorder, intellectual disabilities, and other learning and behavioral disabilities. These are complex disorders with multiple causes—genetic, social, and environmental. The contribution of toxic chemicals to these disorders can be prevented. **Approach:** Leading scientific and medical experts, along with children's health advocates, came together in 2015 under the auspices of Project TENDR: Targeting Environmental Neuro-Developmental Risks to issue a call to action to reduce widespread exposures to chemicals that interfere with fetal and children's brain development. Based on the available scientific evidence, the TENDR authors have identified prime examples of toxic chemicals and pollutants that increase children's risks for neurodevelopmental disorders. These include chemicals that are used extensively in consumer products and that have become widespread in the environment. Some are chemicals to which children and pregnant women are regularly exposed, and they are detected in the bodies of virtually all Americans in national surveys conducted by the U.S. Centers for Disease Control and Prevention. The vast majority of chemicals in industrial and consumer products undergo almost no testing for developmental neurotoxicity or other health effects. **Conclusion:** Based on these findings, we assert that the current system in the United States for evaluating scientific evidence and making health-based decisions about environmental chemicals is fundamentally broken. To help reduce the unacceptably high prevalence of neurodevelopmental disorders in our children, we must eliminate or significantly reduce exposures to chemicals that contribute to these conditions. We must adopt a new framework for assessing chemicals that have the potential to disrupt brain development and prevent the use of those that may pose a risk. This consensus statement lays the foundation for developing recommendations to monitor, assess, and reduce exposures to neurotoxic chemicals. These measures are urgently needed if we are to protect healthy brain development so that current and future generations can reach their fullest potential.

A Call to Action

The TENDR Consensus Statement is a call to action to reduce exposures to toxic chemicals that can contribute to the prevalence of neurodevelopmental disabilities in America's children. The TENDR authors agree that widespread exposures to toxic chemicals in our air, water, food, soil, and consumer products can increase the risks for cognitive, behavioral, or social impairment, as well as specific neurodevelopmental disorders such as autism and attention deficit hyperactivity disorder (ADHD) (Di Renzo et al. 2015; Gore et al. 2015; Lanphear 2015; Council on Environmental Health 2011). This preventable threat results from a failure of our industrial and consumer markets and regulatory systems to protect the developing brain from toxic chemicals. To lower children's risks for developing neurodevelopmental disorders, policies and actions are urgently needed to eliminate or significantly reduce exposures to these chemicals. Further, if we are to protect children, we must overhaul how government agencies and business assess risks to human health from chemical exposures, how chemicals in commerce are regulated, and how scientific evidence informs decision making by government and the private sector.

Trends in Neurodevelopmental Disorders

We are witnessing an alarming increase in learning and behavioral problems in children. Parents report that 1 in 6 children in the United States, 17% more than a decade ago, have a developmental disability, including learning disabilities, ADHD, autism, and other developmental delays (Boyle et al. 2011). As of 2012, 1 in 10 (> 5.9 million) children in the United States are estimated to have ADHD (Bloom et al. 2013). As of 2014, 1 in 68 children in the United States has an autism spectrum disorder (based on 2010 reporting data) (CDC 2014).

The economic costs associated with neurodevelopmental disorders are staggering. On average, it costs twice as much in the United States to educate a child who has a learning or developmental disability as it costs for a child who does not (Chambers et al. 2004). A recent study in the European Union found that costs associated with lost IQ points and intellectual disability arising from two categories of chemicals—polybrominated diphenyl ether flame retardants (PBDEs) and organophosphate (OP) pesticides—are estimated at 155.44 billion euros ($169.43 billion dollars) annually (Bellanger et al. 2015). A 2009 analysis in the United States found that for every $1 spent to reduce exposures to lead, a potent neurotoxicant, society would benefit by $17–$221 (Gould 2009).

Vulnerability of the Developing Brain to Chemicals

Many toxic chemicals can interfere with healthy brain development, some at extremely low levels of exposure (Adamkiewicz et al. 2011; Bellinger 2008; Committee on Improving Analysis Approaches Used by the U.S. EPA 2009; Zoeller et al. 2012). Research in the neurosciences has identified "critical windows of vulnerability" during embryonic and fetal development, infancy, early childhood and adolescence (Lanphear 2015; Lyall et al. 2014; Rice and Barone 2000). During these windows of development, toxic chemical exposures may cause lasting harm to the brain that interferes with a child's ability to reach his or her full potential.

The developing fetus is continuously exposed to a mixture of environmental chemicals (Mitro et al. 2015). A 2011 analysis of the U.S. Centers for Disease Control and Prevention's (CDC) biomonitoring data found that 90% of pregnant women in the United States have detectable levels of 62 chemicals in their bodies, out of 163 chemicals for which the women were screened (Woodruff et al. 2011). Among the chemicals found in the vast majority of pregnant women are PBDEs, polycyclic aromatic hydrocarbons (PAHS), phthalates, perfluorinated compounds, polychlorinated biphenyls (PCBs), perchlorate, lead and mercury (Woodruff et al. 2011). Many of these chemicals can cross the placenta during pregnancy and are routinely detected in cord blood or other fetal tissues (ATSDR 2011; Brent 2010; Chen et al. 2013; Lien et al. 2011).

Prime Examples of Neurodevelopmentally Toxic Chemicals

The following list provides prime examples of toxic chemicals that can contribute to learning, behavioral, or intellectual impairment, as well as specific neurodevelopmental disorders such as ADHD or autism spectrum disorder:

- Organophosphate (OP) pesticides (Eskenazi et al. 2007; Fortenberry et al. 2014; Furlong et al. 2014; Marks et al. 2010; Rauh et al. 2006; Shelton et al. 2014).
- PBDE flame retardants (Chen et al. 2014; Cowell et al. 2015; Eskenazi et al. 2013; Herbstman et al. 2010).
- Combustion-related air pollutants, which generally include PAHs, nitrogen dioxide and particulate matter, and other air pollutants for which nitrogen dioxide and particulate matter are markers (Becerra et al. 2013; Clifford et al. 2016; Jedrychowski

Consensus Statement

The TENDR Consensus Statement is published in the journal *Environmental Health Perspectives* as of July 1, 2016. The consensus statement is available here (pdf) or you can view the HTML version online.

Organizations Endorsing or Supporting the TENDR Consensus Statement:

American College of Obstetricians and Gynecologists
American Public Health Association
Alliance of Nurses for Healthy Environments
American Nurses Association
Child Neurology Society
Developmental Neurotoxicology Society
Endocrine Society
International Neurotoxicology Association
International Society for Children's Health and the Environment
International Society for Environmental Epidemiology
National Association of Pediatric Nurse Practitioners
National Council of Asian Pacific Islander Physicians
National Hispanic Medical Association
National Medical Association
Physicians for Social Responsibility

Process: First the evidence

TENDR work group articles

- National Strategy On Lead, 2017, *JAMA Pediatrics*
- Call for Ban on OP pesticides, 2018, *PLoS Medicine*
- Healthy Air, Healthy Minds, 2019, *Am J Pub Health*

Work groups underway: PBDEs and phthalates

New Work Groups in 2019

- Climate change and neurodevelopment
- Disproportionate exposures/health disparities
- Autism & environmental factors

Process: Education and Advocacy

Congressional briefings

Comment letters on federal, state and international policies & proposed rules.

Grand rounds and professional presentations

Op-eds

Providing Expert Testimony on the science

- Federal agency rulings on PBDEs, lead
- State bills on toxic chemicals in children's products, and on neurotoxic pesticides
- Amicus brief in case on federal phthalates rule

Project TENDR is working for a future where all children are no longer exposed to harmful chemicals, eliminating the disproportionate exposure to children of color and low-income children.

Thank you!

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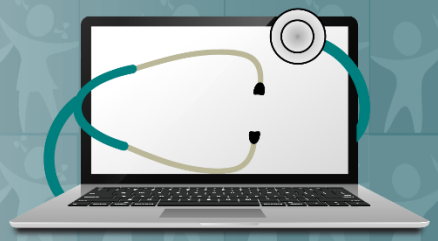

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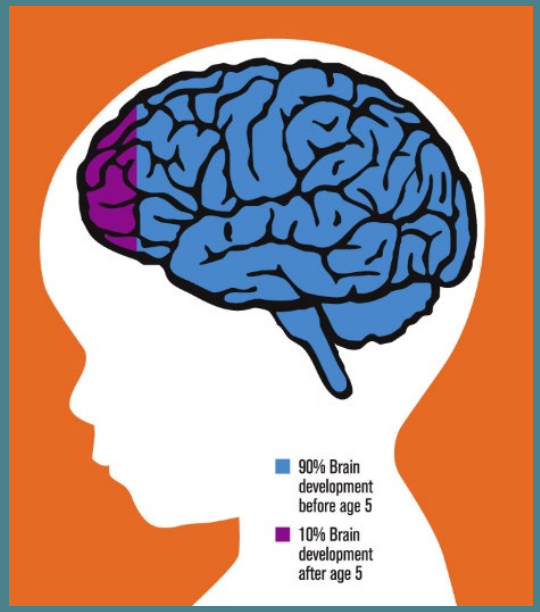
Healthy Air, Healthy Brains: Advancing Air Pollution Policy to Protect Children's Health

Devon Payne-Sturges, DrPH
University of Maryland School of Public Health

PEHSU Annual Meeting
Washington, DC
June 3, 20019



Graphic adapted from Harvard Center for the Developing Child

SCHOOL OF PUBLIC HEALTH

PEHSU Pediatric Environmental Health Specialty Units

American Journal of Public Health 2019

COMMENTARY

Healthy Air, Healthy Brains: Advancing Air Pollution Policy to Protect Children's Health

Evidence is growing on the adverse neurodevelopmental effects of exposure to combustion-related air pollution.

Project TENDR (Targeting Environmental Neurodevelopmental Risks), a unique collaboration of leading scientists, health professionals, and children's and environmental health advocates, has identified combustion-related air pollutants as critical targets for action to protect healthy brain development.

Devon C. Payne-Sturges, DrPH, Melanie A. Marty, PhD, Frederica Perera, DrPH, PhD, Mark D. Miller, MD, Maureen Swanson, MPA, Kristie Ellickson, PhD, Deborah A. Cory-Slechta, PhD, Beate Ritz, MD, PhD, John Balmes, MD, Laura Anderko, RN, PhD, Evelyn O. Talbott, DrPH, Robert Gould, MD, and Irva Hertz-Picciotto, PhD, MPH

Children are exposed prenatally and in early childhood to multiple environmental stressors that can adversely affect their cognitive abilities, academic performance and consequent educational trajectories, adult health, wealth, and social status.[1,2] Project TENDR (Targeting Environmental Neuro-

pollutants—polycyclic aromatic hydrocarbons, nitrogen dioxide, fine particulate matter ($PM_{2.5}$, including ultrafine particulate matter [UFP]; ≤100 nm), and other pollutants for which nitrogen dioxide and $PM_{2.5}$ are markers—as exemplary targets for action. The purpose of this commentary is to present Proj-

neurodevelopmental disorders in children.[8,9] A growing body of human studies associate exposure to combustion-related air pollutants ($PM_{2.5}$, polycyclic aromatic hydrocarbons, nitrogen dioxide, black carbon) with adverse effects on brain development, including deficits in intelligence, memory, and be-

Acknowledgements

This work was supported by **Project TENDR**

Authors:

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TENDR has received grants from John Merck Fund, Ceres Trust Fund, Passport Foundation, Pediatric Epilepsy Research Foundation, and the National Institute of Environmental Health Sciences (R13ES026504). D.Payne-Sturges is supported by the National Institute of Environmental Health Sciences (award K01ES028266).

Objectives

1. Describe key mechanisms of neurological effects of PM air pollution
2. Identify air pollutants that have been associated with neurodevelopmental effects
3. Describe policy options to reduce air pollution exposures

Health Burdens of $PM_{2.5}$ & Ozone in the US

Excess mortalities (adults)[A]	130,000 to 340,000
Percentage of all deaths due to $PM_{2.5}$ and Ozone[B]	6.1%
Impacts among Children	
ER visits for asthma (age <18)	110,000
Acute bronchitis (age 8-12)	200,000
Exacerbation of asthma (age 6-18)	2,500,000

According to a WHO report, air pollution in 2012 caused the deaths of 7 million people worldwide.

Smog settles over downtown Los Angeles. DAVID ILIFF/WIKIMEDIA COMMONS
https://e360.yale.edu/digest/us-air-pollution-deaths-nearly-halved-over-two-decades

Source: Fann, N.; Lamson, A.D.; Anenberg, S.C.; Wesson, K.; Risley, D.; Hubbell, B.J. Estimating the national public health burden associated with exposure to ambient PM2.5 and ozone. Risk Anal 2012, 32, 81-95,

Sources of ambient air pollution

- Burning of fossil fuels
- Factories and industrial activities
- Agricultural activities
- Mining operations
- Wild fires

Air pollution is a complex mixture

Haze over Washington on Feb. 4. 2019 (National Park Service webcam image)

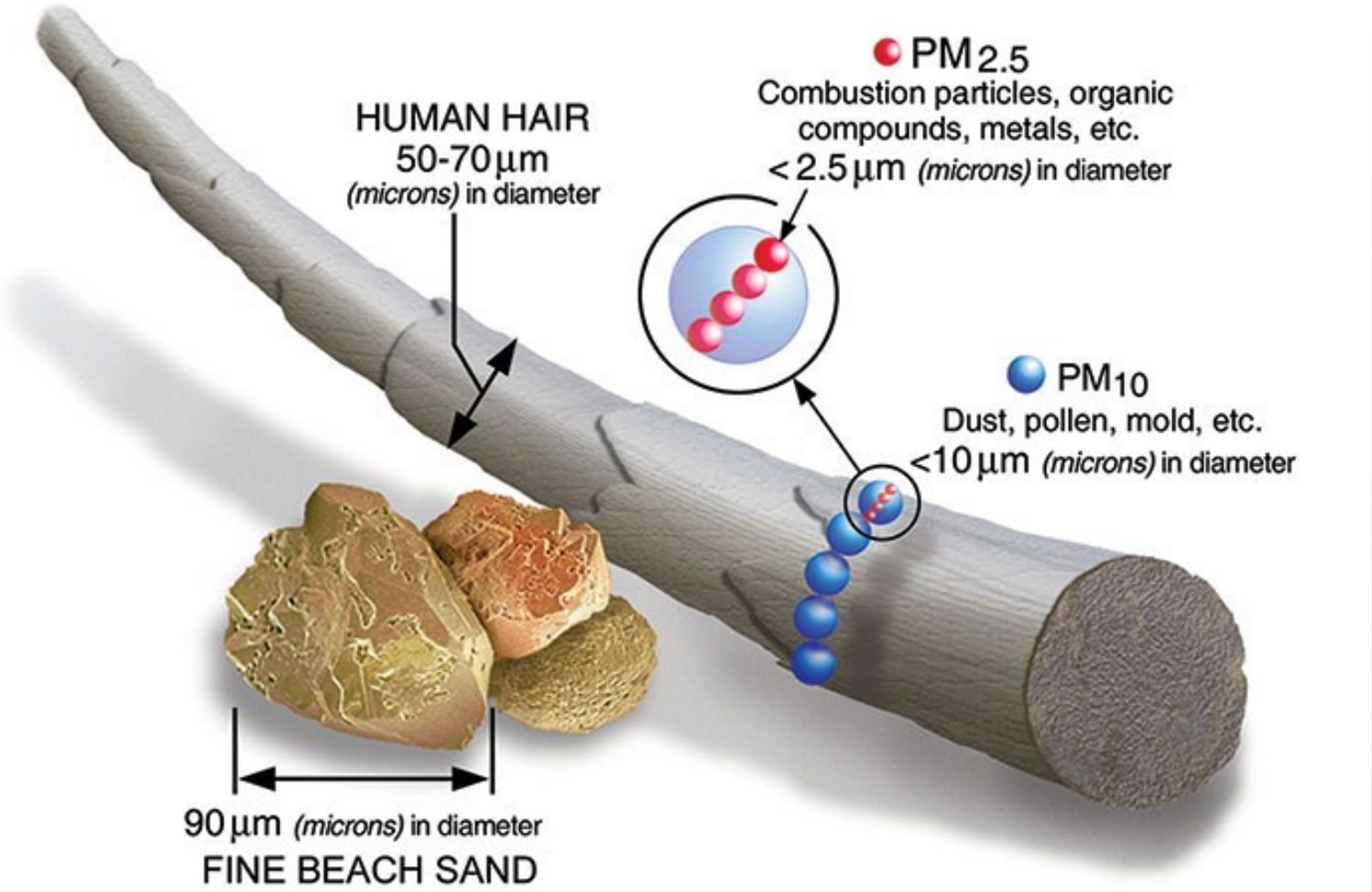
Gases

CO_2, CO, NOx, ozone, SO_2

Particles (PM)

volatile organic and inorganic contaminants, including PAHs and metals

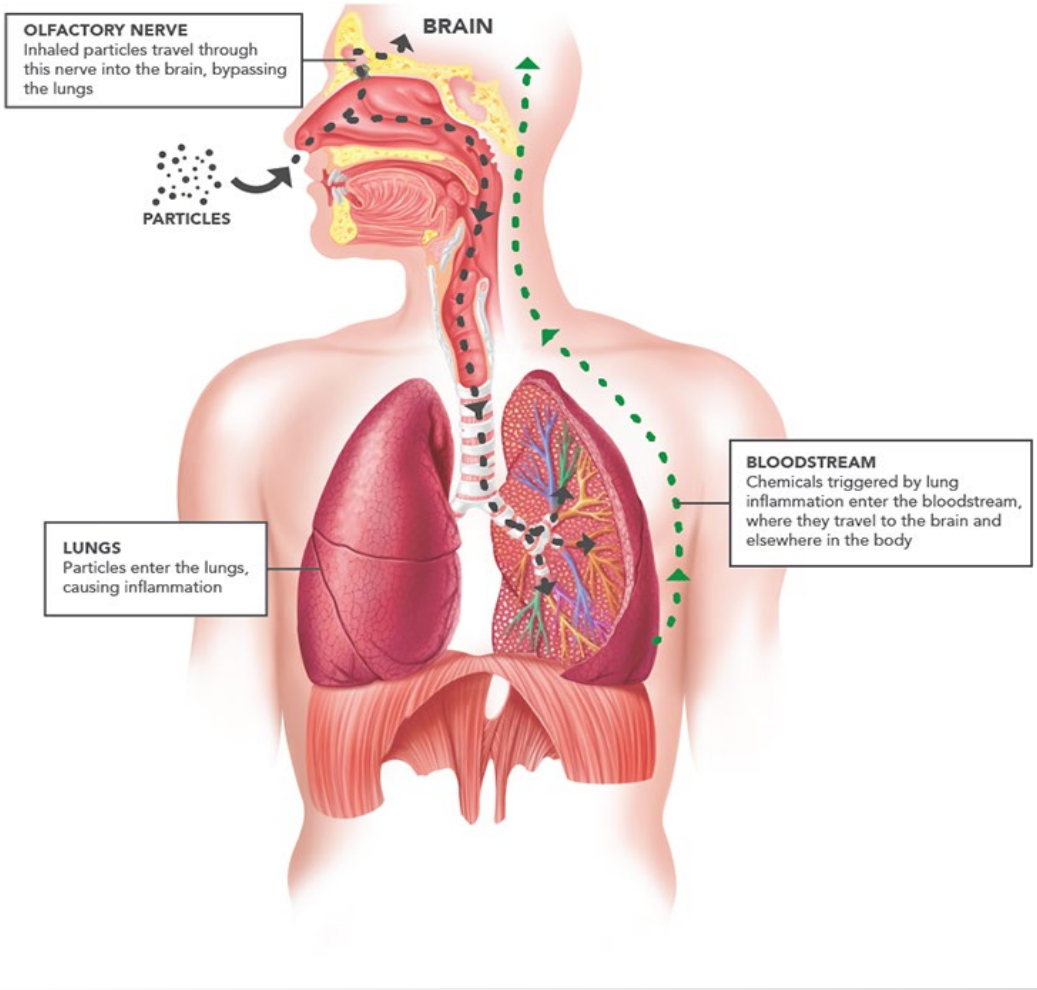
Particle size is the problem



https://www.epa.gov/pm-pollution/particulate-matter-pm-basics

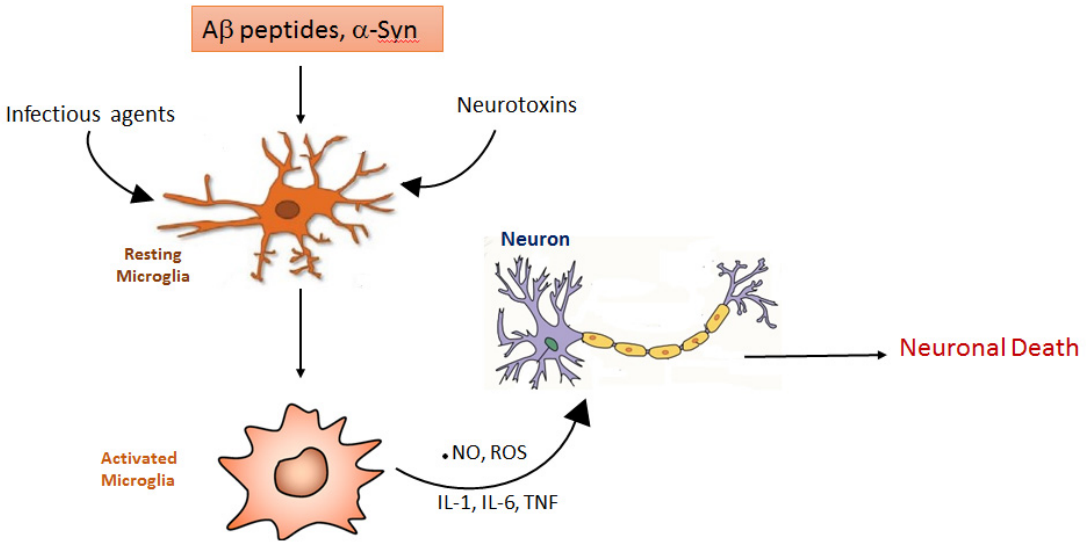
Particulate matter (PM) air pollution and the brain

- Translocate to the central nervous system (CNS) via the olfactory epithelium
- Pass through blood brain barrier
- Trigger brain and systemic inflammation



CARB https://ww2.arb.ca.gov/resources/fact-sheets/air-pollution-and-brain

Potential mechanisms



Neuroinflammation

Oxidative stress

Glial activation

White matter injury

Image from Acute and Chronic Inflammation: Microglia in Neuroprotection and Neurodegeneration By: **Chandra Mohan**, *Ph.D. MilliporeSigma, Temecula, CA*

Prenatal AP exposures

Maternal AP exposures

↓

Pulmonary and systemic inflammation/ oxidative stress

↓

Excess placental oxidative stress and inflammation

+

Altered placental/fetal epigenetic processes

↓

Abnormal placentation
Impaired nutrient/oxygen perfusion
Altered gene expression
Poor growth and development

Free Clip Art

Allen, J.L. et al.. *Curr Environ Health Rep* 2017, *4*, 180-191; Volk, H.E. et al. JAMA Psychiatry 2013, 70, 71-77; Jedrychowski,W et al. Environ Res 2009, 109, 447-456.

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neurodevelopmental disorders in children.[8,9] A growing body of human studies associate exposure to combustion-related air pollutants ($PM_{2.5}$, polycyclic aromatic hydrocarbons, nitrogen dioxide, black carbon) with adverse effects on brain development, including deficits in intelligence, memory, and be-

AP and cognitive development

- Prenatal and postnatal exposures to $PM_{2.5}$, NO_2, black carbon and PAHs associated with lower cognitive development scores, IQ

Study	Sample characteristics	Measurement of air pollution	Outcome
Vishnevetsky et al. (2015) USA	N=276; 7 years	Entire pregnancy/Cord PAH-DNA adducts in high hardship group	Full-scale IQ –β: −5.81 (95% CI: −10.35, −1.26) Verbal comprehension –β: −3.36 (95% CI: −7.61, 0.90) Processing speed –β: −4.17 (95% CI: −9.75, 1.41) Perceptual reasoning –β: −5.44 (95% CI: −10.27, −0.61) Working memory –β: −6.67 (95% CI: −11.38, −1.95)
Harris et al. (2015) USA	N = 1109; mean 8 yrs	Prenatal and childhood PM2.5 estimated at residential addresses from land use regression models.	Per 3.8 μg/m^3 increase in PM2.5 3rd trimester associated with lower Verbal IQ: –0.2 (95% CI: –1.4, 1.1); Nonverbal IQ: –0.2 (95% CI: –1.8, 1.4); Visual motor: 0.9 (95% CI: –0.8, 2.5);
Guxens et al. (2014) Netherlands, Germany, Italy, France, Greece, Spain	N= 9482; 1- 6 years	Entire pregnancy/NO_2 estimated at participants' birth residential address from land-use regression models	Per 5.3 ppb increase in NO_2 associated with reduced Psychomotor Development β = −0.68 (95%CI: −1.25, −0.11);
Suglia et al., 2008 USA	N = 202; age 8-11 yrs	Black carbon estimated by land-use regression model at child's address	Per 0.4 μg/m^3 increase in black carbon predicted decreased in IQ (KBIT): composite score: −3.4 (−6.6 to −0.3); WRAML: visual score: −5.4 (−8.9 to −1.9), general score: −3.9 (−7.5 to 0.3)

AP and Autism Spectrum Disorder

- Increasing evidence links prenatal exposure to traffic-related air pollutants and PM2.5 to autism spectrum disorder.
- As well, some studies find associations between early postnatal exposure to PM2.5 and development of autism spectrum disorder or Aspergers.

Becerra TA, et al. Environ Health Perspect. 2013;121(3):380–386.
Raz R, et al. Environ Health Perspect. 2015;123(3):264–270.
Ritz B et al. Environ Epidemiol. 2018 Dec; 2(4): e028
Costa et al. Curr Environ Health Rep. 2017 June ; 4(2): 156–165. (good review)

PM2.5 and Autism Spectrum Disorder

Raz et al., 2015

Quartile of PM2.5 ($\mu g/m^3$)	OR[a] (95% CI) for ASD
Second (12.4–14.5)	1.65 (0.98-2.8)
Third (14.6–16.7)	1.84 (1.07-3.17)
Fourth (16.7–30.8)	2.06 (1.17-3.63)
Per Interquartile range (4.40)	1.63 (1.08-2.47)

Cases = 160; matched controls = 968 (nested case-control, Nurses' Health Study II cohort)

a. adjusted for child sex, year of birth, month of birth, maternal and paternal age at birth, census income

AP and Autism Spectrum Disorder
Ritz et al., 2018

- Danish nationwide case-control study of 15,387 children with ASD born 1989–2013 and 68,139 population controls matched by birth year and sex identified from the birth registry.
- Estimated PM (2.5 and 10), NO_2 and SO_2 at residence

Adjusted ORs for ASD per interquartile range (IQR) increase for 9 month after pregnancy:

Pollutant	Odd Ratio
NO_2	1.08 (95% CI: 1.01, 1.15)
PM2.5	1.06 (95% CI: 1.01, 1.11)
PM10	1.04 (95% CI: 1.00, 1.09)
SO_2	1.21 (95% CI: 1.13, 1.29)

AP and ADHD and other behaviors (anxiety and inattention)

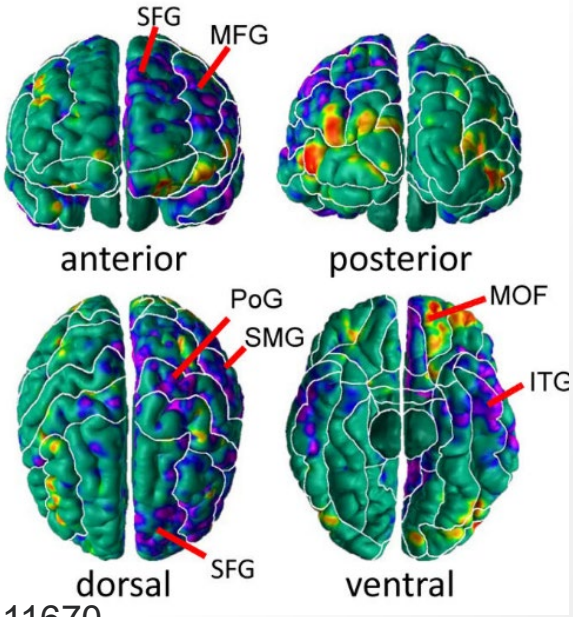
- Prenatal exposures to PAHs, a component of PM2.5, have been associated with
  - symptoms of anxiety, depression, and inattention
  - ADHD
    - High maternal PAH-adducts associated with Conner's Parent Rating Scale-Revised DSM-IV Inattentive

      (OR = 5.06, 95% CI [1.43, 17.93])

Margolis, A.E. et al., *J Child Psychol Psychiatry* **2016**, *57*, 851-860
Perera et al PLoSOne. 2014;9(11):e111670.
Peterson BS, et al. JAMA Psychiatry. 2015;72(6):531–540.

AP and changes in brain morphology

- PAHs, a component of PM2.5, have been associated with
  - reduced size of brain regions important for processing information and impulse control.



Perera et al PLoSOne. 2014;9(11):e111670.
Peterson BS, et al. JAMA Psychiatry. 2015;72(6):531–540.

Social conditions make AP exposures worse

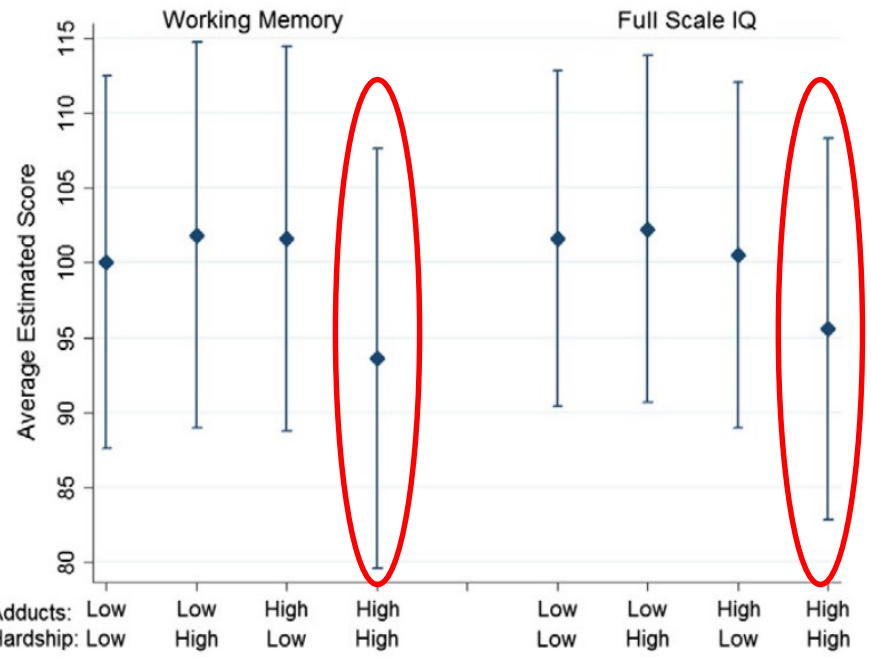
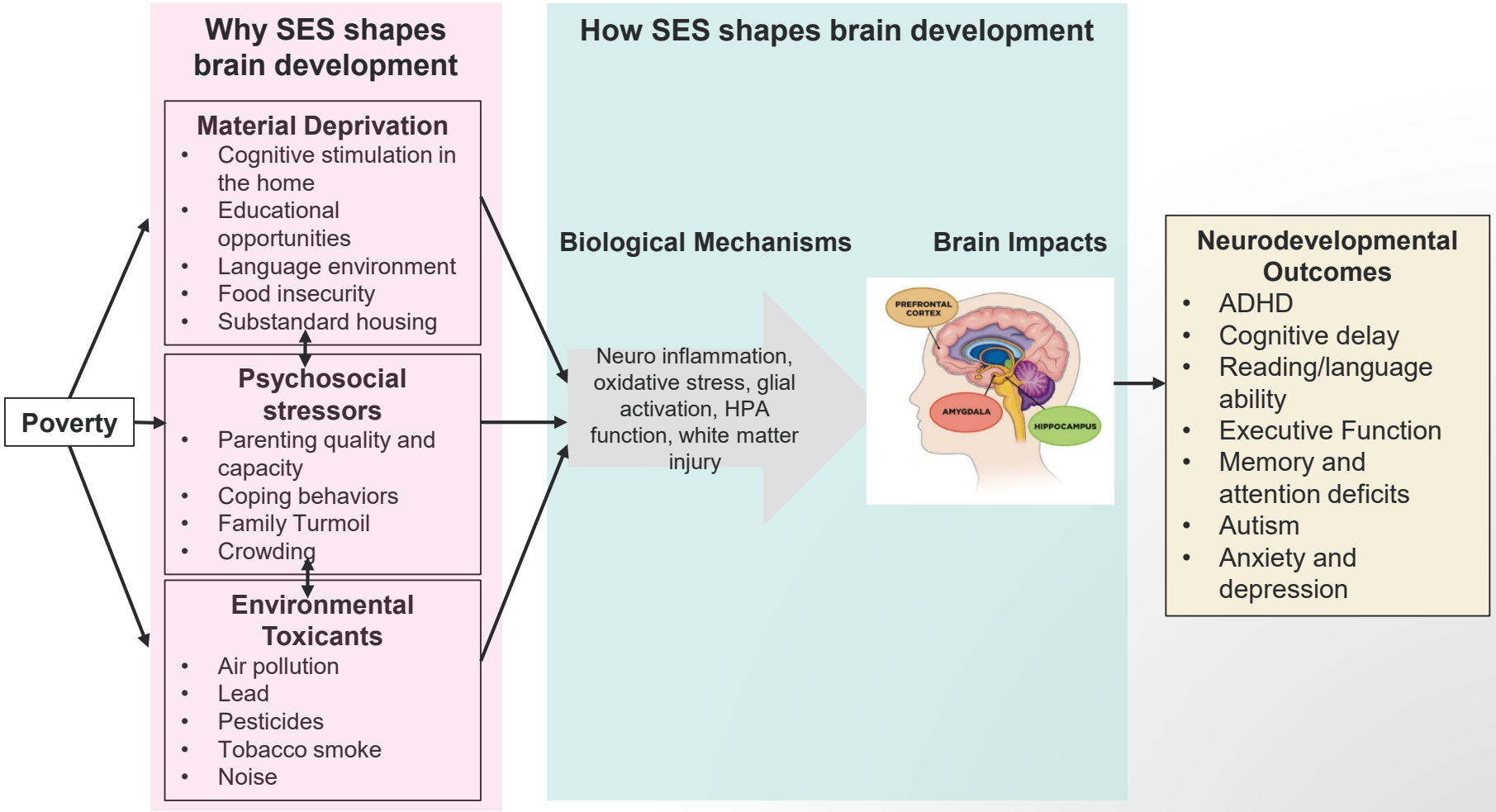


Fig. 2. Full Scale IQ and Working Memory Scores in the low and high cord PAH–DNA adduct groups stratified by recurrent hardship ($n = 276$).

- Vishnevetsky et al. 2015 - Prenatal PAH exposures combined with poverty lowers IQ in kids
- Rauh et al. 2004 - combined ETS and material hardship (e.g poverty) resulted in lower cognitive functioning in kids
- Chari et al. 2012 – lead and SES, Lead NAAQS standard is under protective for low income kids

Vishnevetsky, J. et al. *Neurotoxicol Teratol* **2015**, *49*, 74-80,

Environments of poverty and combined effects



Adapted by DC Payne-Sturges from Johnson, S.B.; Riis, J.L.; Noble, K.G. State of the Art Review: Poverty and the Developing Brain. *Pediatrics* **2016**, *137*, doi:10.1542/peds.2015-3075.

Animal Toxicology Studies Demonstrate Neurodevelopmental Toxicity of Air Pollution

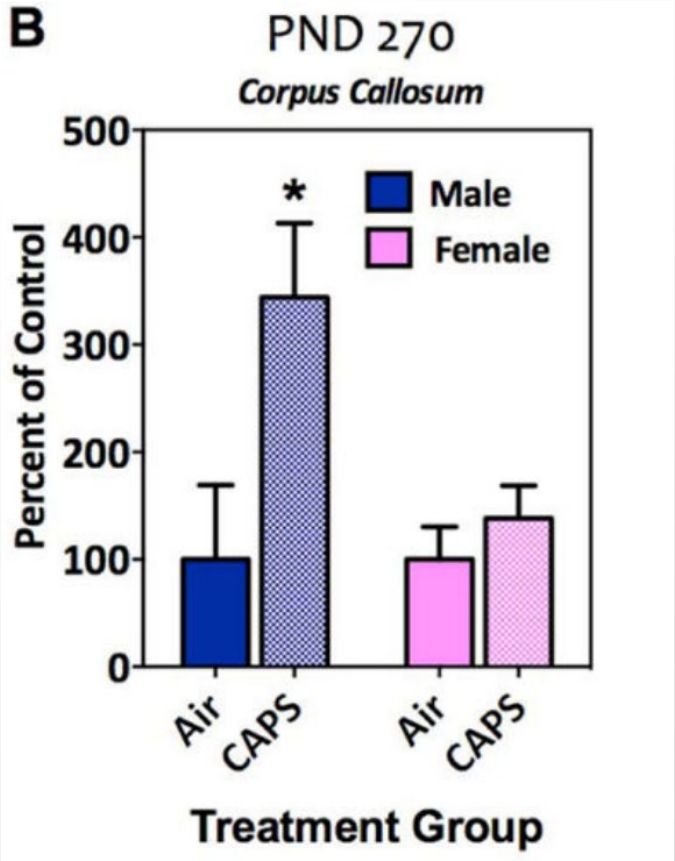
- Prenatal exposures to fine and ultrafine combustion particles in rodent models produced:
  - Structural alterations
  - Hypermyelination
  - Inflammation in fetal brain
  - Altered region-specific neurotransmitter content (dopamine and norepinephrine)
  - In males as adults, increased anxiety, decreased activity and brain microglial activation

Klocke C. et al Toxicol Sci. 2017;156:492–508
Bolton JL et al. FASEB J. 2012;26(11):4743–4754.
Suzuki T,et al. Part Fibre Toxicol. 2010;7(1):7.

Animal toxicology studies

- Postnatal exposures of mice to concentrated urban ultrafine particles (similar to exposures in high traffic areas of major cities)

  demonstrated:
  - Disrupted development of the corpus callosum
  - Elevated brain glutamate levels (an excitatory neurotransmitter) that persist into adulthood
  - Impaired learning and short-term memory
  - Increased impulsivity
  - Effects mainly observed in males



Allen JL, et al. Neurotoxicology. 2017;59:140–154.
Allen JL et al. Environ Health Perspect. 2014;122(9):939–945

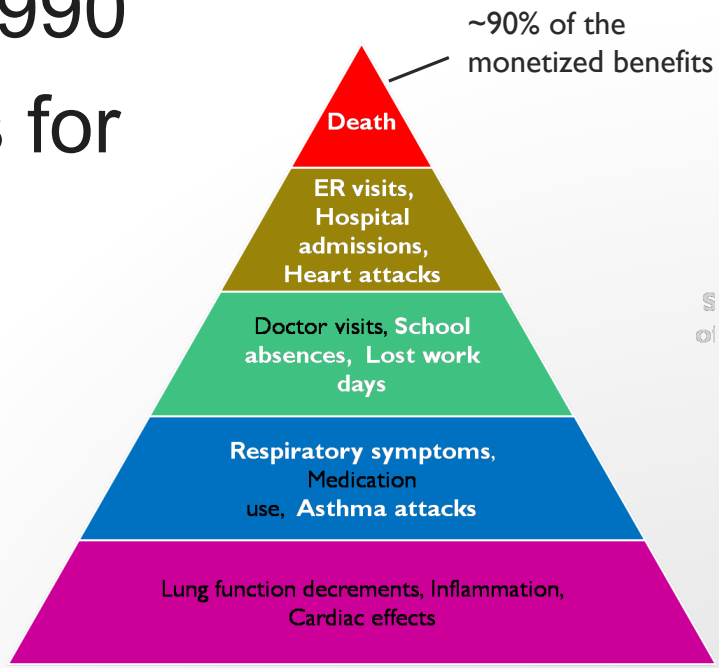
TENDR AP recommendations

- Maintain and Strengthen Health Protections
- Advance State and Local Actions
- Expand Research to Inform Policies

Regulation of air Pollution in the US

Clean Air Act as amended in 1990

- Federal EPA sets standards for criteria air pollutants
- PM, NO2 and ozone reductions are driven by associations with mortality primarily in the elderly
- To date have not considered benefits to or costs of neurodevelopmental deficits.



A "Pyramid of Effects" from Air Pollution

Latest US EPA PM2.5 Assessment

- **Determines that there is "likely to be a causal relationship" between long term exposure to PM2.5 and nervous system effects**.
- Considers that evidence for neurodevelopmental effects was more limited (than CV).
- Consideration of co-pollutant confounding was generally lacking in the epidemiologic studies but the uncertainty in the interpretation of study findings was addressed, in part, by the direct evidence of effects provided by experimental animal studies
- Range of 5 year average PM2.5 in epi studies on cognition ranged from 8.5 to 14.9 $\mu g/m^3$

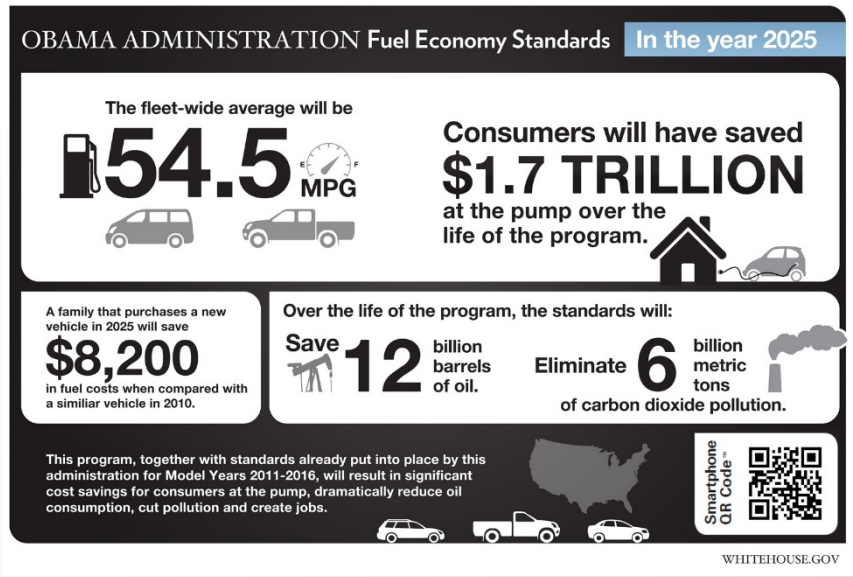
Current PM2.5 NAAQS = 12 $\mu g/m^3$

TENDR recommendation 1

- The US Environmental Protection Agency (EPA) should give greater consideration to the evidence on the effects of air pollutants on neurodevelopment when setting standards for combustion-related air pollutants and when assessing the full cost of the health effects of air pollution.

TENDR recommendation 2

- Strengthen and enforce federal fuel efficiency standards.
- Light-Duty Vehicle Greenhouse Gas Emission Standards and CAFE (fuel economy) Standards issued by the EPA and the National Highway Traffic Safety Administration



President Obama Announces New Fuel Economy Standards
https://obamawhitehouse.archives.gov/blog/2011/07/29/president-obama-announces-new-fuel-economy-standards

TENDR recommendation 3

- Promote and advance clean energy policies that reduce reliance on fossil fuels, including coal, combusted for energy generation and transportation.

Photographer: Stefan Wermuth/Bloomberg
https://www.bloomberg.com/opinion/articles/2018-08-31/electric-vehicles-in-california-their-day-will-come-suddenly

https://news.stanford.edu/2015/06/08/50states-renewable-energy-060815/

TENDR recommendation 4

- Target existing large sources of combustion-related air pollutants for emissions reductions, dramatically reducing exposures in neighboring communities.

Darft Ports Primer for Communities
https://www.epa.gov/community-port-collaboration-and-capacity-building/draft-ports-primer-communities

TENDR recommendation 5

- Regional air pollution control agencies across the United States should restrict permitting new sources of combustion-related air pollutants in close proximity to residential areas and other sensitive receptors.

https://www.arb.ca.gov/ch/handbook.pdf

TENDR recommendation 6

- Expand air monitoring near locations where children spend time

CARB Partners with Imperial Valley Group to Monitor Air Quality and Reduce Health Risks. Feb 2018. http://beyondbordersnews.com/2018/02/11/carb-partners-with-imperial-valley-group-to-monitor-air-quality-and-reduce-health-risks/

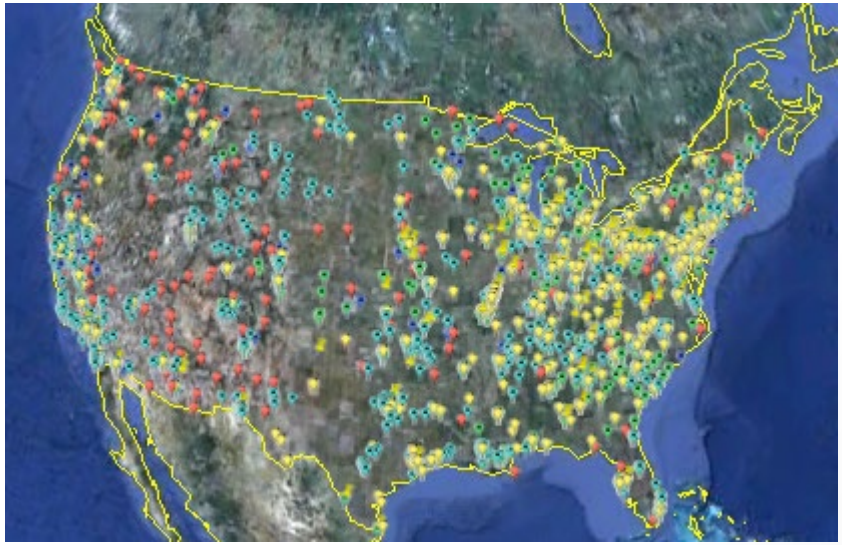
TENDR recommendation 7

The EPA and local partners will expand efforts to evaluate the effectiveness of vegetation and noise barriers near Brookfield Elementary School in Oakland, California. https://www.epa.gov/innovation/building-capacity-measure-air-pollution-mitigation-strategies-schools

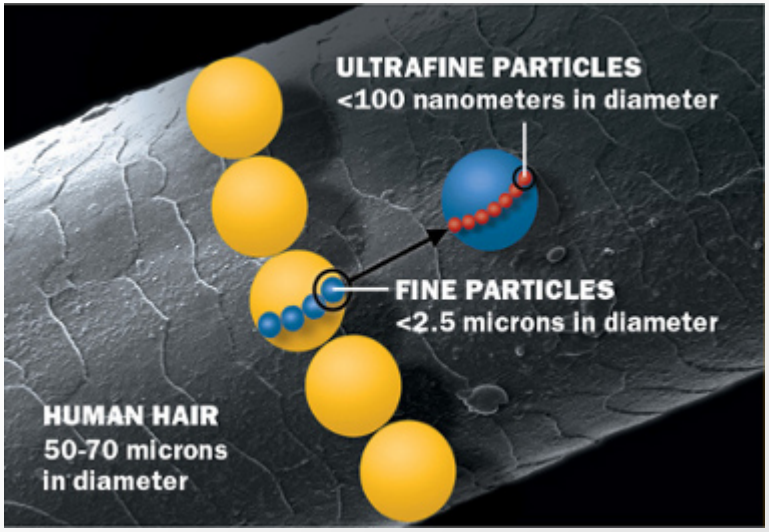
- Expand research on effectiveness of strategies to mitigate exposures near large sources of combustion-related air pollution that could guide implementation in neighborhoods close to such sources.

TENDR recommendation 8

- Increase research on the human health effects of ultrafine particles.



Displays air quality monitor locations.
for all criteria pollutants (CO, Pb, NO2, Ozone, PM10, PM2.5, and SO2)
PM2.5 Chemical Speciation Network monitors
IMPROVE (Interagency Monitoring of PROtected Visual Environments) monitors
NATTS (National Air Toxics Trends Stations)
NCORE (Multipollutant Monitoring Network)
https://www.epa.gov/outdoor-air-quality-data



https://now.tufts.edu/articles/big-road-blues-pollution-highways

Key takeaways

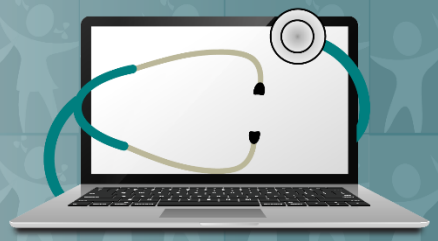
- Brain is a target for air pollution
- We need stricter policies for cleaner air to reduce the negative impacts on neurodevelopment
- Opportunities for Federal and State solutions

Photo: Matthias Ahlke. MünsterscheZeitung. 3/15/19

Thank you!

PEHSU NATIONAL CLASSROOM

Pediatric Environmental Health Specialty Units



www.pehsu.net/nationalclassroom.html

Webinars

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- Case Conferences
  Journal Clubs
  Grand Rounds
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Online Courses

- Evidence-based online courses on a variety of children's environmental health topics.
- Interactive and Self-Paced
- CE Available

Resource Catalog

- Fact sheets, journal publications, reports, and other resources for parents, community members, patients and healthcare professionals
- Topics included:
  Air Quality, Pesticides, Natural Disasters, BPA, Mold, Lead, Mercury