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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
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).

Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing partial funding to ATSDR under Inter-Agency Agreement number DW-75-95877701. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU publications.
Dr. Laura Anderko PhD RN
Region 3 PEHSU: The Mid-Atlantic Center for Children’s Health and the Environment
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
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

NUTRITION

TOXICANTS

GENETICS

SOCIAL ENVIRONMENT

Traits/Abilities

Developmental Syndromes

Learning disability

ADHD

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

http://dx.doi.org/10.1289/EHP1588

Summary: Children in America today are at an unacceptable 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 those 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 priority 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 unacceptable high prevalence of neurodevelopmental disorders in our children, we must eliminate or significantly reduce exposures to chemicals that contribute to those conditions. We must adopt a new framework for assessing chemicals that have the potential to disrupt brain development and prevent the use of these 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; Goo et al. 2015; Langelier 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 (6.9 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 (Chamberlain 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—polyfluorinated diphenyl ether flame retardants (PFDEs) and organophosphate (OP) pesticides—are estimated at 155.44 billion euros ($169.43 billion dollars) annually (Bellinger 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 (Goedl 2009).

Vulnerability of the Developing Brain to Chemicals

Many toxic chemicals can interfere with healthy brain development, and cause 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 (Langeb et al. 2015; Lye et al. 2014; Rice and Baune 2009). 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 (Mutio 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 detect 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 PFDEs, polybrominated aromatic hydrocarbons (PBAs), 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 (ATSOR 2011; Brent et al. 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 (Eiden et al. 2007; Furlong et al. 2014; Furlong et al. 2010; Rauh et al. 2006; Shelton et al. 2014).
- PFDE flame retardants (Chen et al. 2014; Cowell et al. 2015; Eiden et al. 2013; Herbstman et al. 2010).
- Combustion-related air pollutants, which generally include PAHs, nitrogen dioxide and particulate matter, and other air pollution 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
- 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.
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www.pehsu.net/nationalclassroom.html
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
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.

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. Project TENDR (Targeting Environmental Neurodevelopmental Risors in children. A growing body of human studies associate exposure to combustion-related air pollutants (PM$_{2.5}$, 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-
Acknowledgements

This work was supported by Project TENDR

Authors:
Devon Payne-Sturges, DrPH, Melanie A. Marty, Ph.D., Frederica Perera, DrPH, PhD, Mark D. Miller, M.D., 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

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

<table>
<thead>
<tr>
<th>Health Burden</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess mortalities (adults)$^A$</td>
<td>130,000 to 340,000</td>
</tr>
<tr>
<td>Percentage of all deaths due to PM$_{2.5}$ and Ozone$^B$</td>
<td>6.1%</td>
</tr>
</tbody>
</table>

### Impacts among Children

<table>
<thead>
<tr>
<th>Impact</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ER visits for asthma (age &lt;18)</td>
<td>110,000</td>
</tr>
<tr>
<td>Acute bronchitis (age 8-12)</td>
<td>200,000</td>
</tr>
<tr>
<td>Exacerbation of asthma (age 6-18)</td>
<td>2,500,000</td>
</tr>
</tbody>
</table>

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

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

Gases

$\text{CO}_2$, CO, NO$_x$, ozone, SO$_2$

Particles (PM)

volatile organic and inorganic contaminants, including PAHs and metals

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

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.

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. Project TENDR (Targeting Environmental Neurodevelopmental Disorders in Children)8,9 A growing body of human studies associate exposure to combustion-related air pollutants (PM<sub>2.5</sub>, polycyclic aromatic hydrocarbons, nitrogen dioxide, fine particulate matter (PM<sub>2.5</sub>, including ultrafine particulate matter [UFP]; ≤ 100 nm), and other pollutants for which nitrogen dioxide and PM<sub>2.5</sub> are markers—as exemplary targets for action. The purpose of this commentary is to present Proji-
### 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

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample characteristics</th>
<th>Measurement of air pollution</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vishnevetsky et al. (2015)</td>
<td>N=276; 7 years</td>
<td>Entire pregnancy/Cord PAH-DNA adducts in high hardship group</td>
<td>Full-scale IQ $\beta$: $-5.81$ (95% CI: $-10.35$, $-1.26$) &lt;br&gt; Verbal comprehension $\beta$: $-3.36$ (95% CI: $-7.61$, 0.90) &lt;br&gt; Processing speed $\beta$: $-4.17$ (95% CI: $-9.75$, 1.41) &lt;br&gt; Perceptual reasoning $\beta$: $-5.44$ (95% CI: $-10.27$, $-0.61$) Working memory $\beta$: $-6.67$ (95% CI: $-11.38$, $-1.95$)</td>
</tr>
<tr>
<td>Harris et al. (2015)</td>
<td>N = 1109; mean 8 yrs</td>
<td>Prenatal and childhood PM2.5 estimated at residential addresses from land use regression models</td>
<td>Per 3.8 µg/m$^3$ increase in PM2.5 3$^{rd}$ 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);</td>
</tr>
<tr>
<td>Guxens et al. (2014)</td>
<td>N= 9482; 1- 6 years</td>
<td>Entire pregnancy/NO$_2$ estimated at participants' birth residential address from land-use regression models</td>
<td>Per 5.3 ppb increase in NO$_2$ associated with reduced Psychomotor Development $\beta = -0.68$ (95%CI: $-1.25$, $-0.11$);</td>
</tr>
<tr>
<td>Suglia et al., 2008</td>
<td>N = 202; age 8-11 yrs</td>
<td>Black carbon estimated by land-use regression model at child’s address</td>
<td>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 $0.3$)</td>
</tr>
</tbody>
</table>
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.

### PM2.5 and Autism Spectrum Disorder
Raz et al., 2015

<table>
<thead>
<tr>
<th>Quartile of PM2.5 (µg/m³)</th>
<th>OR(^a) (95% CI) for ASD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second (12.4–14.5)</td>
<td>1.65 (0.98-2.8)</td>
</tr>
<tr>
<td>Third (14.6–16.7)</td>
<td>1.84 (1.07-3.17)</td>
</tr>
<tr>
<td>Fourth (16.7–30.8)</td>
<td>2.06 (1.17-3.63)</td>
</tr>
<tr>
<td>Per Interquartile range (4.40)</td>
<td>1.63 (1.08-2.47)</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Odd Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO$_2$</td>
<td>1.08 (95% CI: 1.01, 1.15)</td>
</tr>
<tr>
<td>PM2.5</td>
<td>1.06 (95% CI: 1.01, 1.11)</td>
</tr>
<tr>
<td>PM10</td>
<td>1.04 (95% CI: 1.00, 1.09)</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>1.21 (95% CI: 1.13, 1.29)</td>
</tr>
</tbody>
</table>
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
PAHs, a component of PM2.5, have been associated with
- reduced size of brain regions important for processing information and impulse control.

Social conditions make AP exposures worse

- 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

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, J. et al. Neurotoxicol Teratol 2015, 49, 74-80,
Environments of poverty and combined effects

Why SES shapes brain development

Material Deprivation
- Cognitive stimulation in the home
- Educational opportunities
- Language environment
- Food insecurity
- Substandard housing

Psychosocial stressors
- Parenting quality and capacity
- Coping behaviors
- Family Turmoil
- Crowding

Environmental Toxicants
- Air pollution
- Lead
- Pesticides
- Tobacco smoke
- Noise

How SES shapes brain development

Biological Mechanisms
- Neuro inflammation, oxidative stress, glial activation, HPA function, white matter injury

Brain Impacts

Neurodevelopmental Outcomes
- ADHD
- Cognitive delay
- Reading/language ability
- Executive Function
- Memory and attention deficits
- Autism
- Anxiety and depression

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

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

TENDR AP recommendations

- Maintain and Strengthen Health Protections
- Advance State and Local Actions
- Expand Research to Inform Policies
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.
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 μg/m³

Current PM2.5 NAAQS = 12 μg/m³
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.
Strengthen and enforce federal fuel efficiency 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/
Target existing large sources of combustion-related air pollutants for emissions reductions, dramatically reducing exposures in neighboring communities.
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.
TENDR recommendation 6

- Expand air monitoring near locations where children spend time
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](https://www.epa.gov/innovation/building-capacity-measure-air-pollution-mitigation-strategies-schools)
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
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