What We Know About Toxic Chemicals And Children's Mental Health

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Affiliation and Disclaimers

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State of Children's Mental Health

Mental Health is an important factor in children's overall well-being. Children's Mental Health has increasingly declined over the past 2 decades to a point of crisis[1].

Based on 2016-2019 surveillance data for children ages 3-17 years living in the United States[2]

8.9%

Received behavior problems diagnosis

4.4%

Received depression diagnosis

9.4%

Received Anxiety Diagnosis

Between 2011 and 2021

The percentage of high school students who reported seriously considering suicide rose from 16% to 22%[3]

Between 2011 and 2020

2x

Youth mental health emergency visits nearly doubled[4]

Children's Vulnerability to Chemical Exposures

In utero and throughout childhood, children can be exposed to hundreds of chemicals, such as BPAs, lead, and PFAS.

- These chemicals can disrupt important processes in brain development, including processes related to mood and emotion regulation.
- The brain is developing from embryogenesis up until at least age 21 and thus children are particularly vulnerable to environmental exposures and any disturbance to normal neurodevelopment can have life long consequences.

The Intersection of Environment and Mental Health

- Mental Health disorders are complex and there are several factors that can lead to adverse mental health outcomes including genetic, social, and environmental factors.
- In recent years, scientists across multiple disciplines including toxicology, epidemiology, psychology, and psychiatry have increasingly recognized the environmental determinants of mental health outcomes.
- E.g., there is a growing body of research that shows childhood exposure to air pollution can worsen mental health. More data on climate change and youth mental health including the emotional toll environmental destruction and climate change takes on youth, referred to as eco or climate anxiety.

Methodology

Aim

Assess the landscape of recent literature on prenatal and/or childhood environmental exposures and consequent symptoms related to mood, anxiety, and behavior disorders such as depression, generalized anxiety disorder, and conduct disorder, respectively.

Inclusion

Exposures from conception until age 21 years in accordance with the U.S. Environmental Protection Agency's Policy on Children's Health[5]

Dates from January 2017 to December 2022

Exclusion

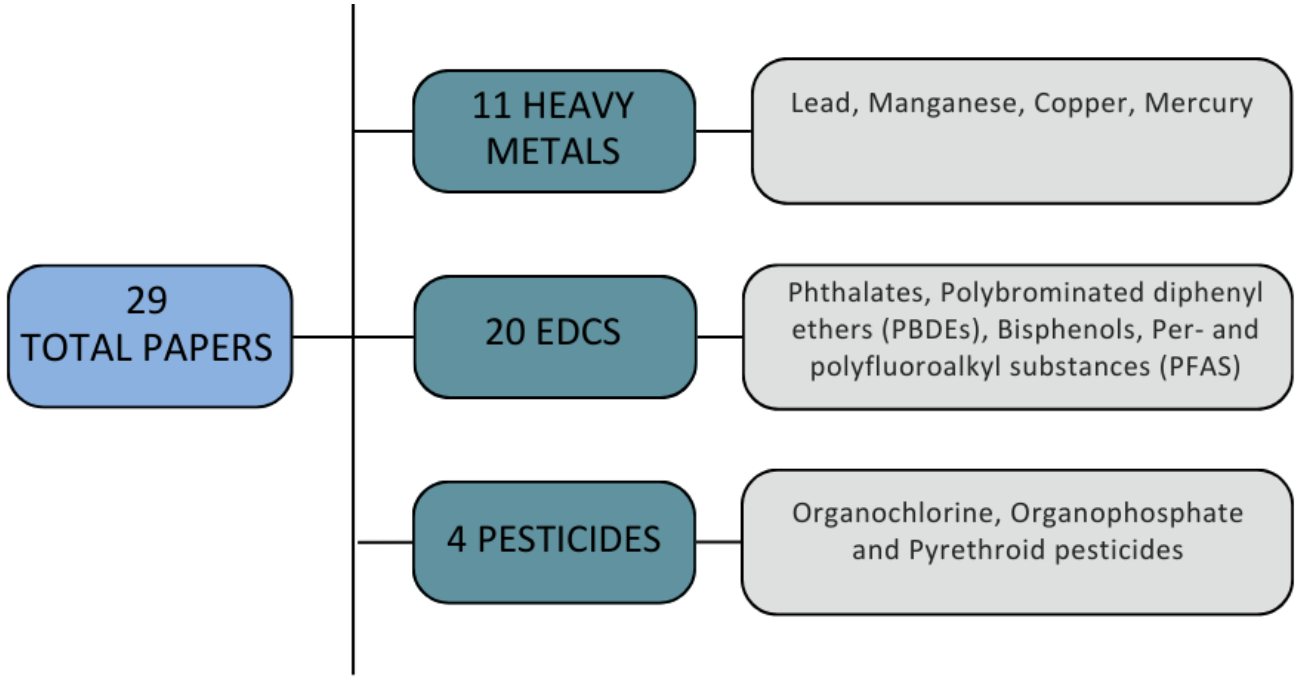
Studies that exclusively focused on neurodevelopmental disorders, cognition, intelligence quotient, and/or learning disorders

Experimental animal and adult population studies, unless related to a childhood exposure.

Search Engines

Google Scholar and PubMed using terms related to children, mental health, and environmental chemical exposure. References were also screened for additional papers.

Results



The majority of studies (n = 20) assessed prenatal exposure and measured outcomes during early childhood, from 0 to 5 years (n = 13), and mid childhood, from 6 to 10 years (n = 14).

Internalizing behaviors (i.e., anxiety, depression, withdrawal) and **externalizing behaviors** (i.e., aggression, impulsivity, conduct disorder) were the most frequently assessed endpoints.

Every study reported at least one statistically significant association between increased exposure to an environmental chemical and increased mental health symptoms and thus our review indicates that there is a growing body of evidence connecting increased exposure to chemicals in the environment, such as lead and PFAS , to increased child mental health symptoms like anxiety and depression.

Image source: INLeadFree

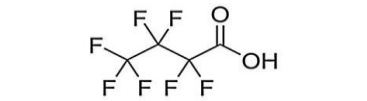
Example: Lead (PB)

- **Lead (Pb)** is one of the most well-established neurodevelopmental toxicants with no known safe level of exposure
- **Sources of exposure include** toys, dust, residential lead paint, drinking water and soil. During pregnancy, Pb harbored in bone can be released into the bloodstream due to normal maternal bone remodeling, which results in elevated maternal Pb concentrations and increased fetal exposure
- **Hypothesized mechanisms of neurotoxicity include:** oxidative stress and neuronal cell death

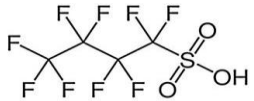
Citation	Assessment Tool	Results
Zeng et al. (2021)	The Strengths and Difficulties Questionnaire (SDQ)	Preschool blood Pb level was negatively correlated with serum Neuropeptide Y (NPY), but positively correlated with behavioral symptom scores; while serum NPY levels were negatively associated with behavioral symptom scores
Joo et al. (2018)	Child Behavior Checklist (CBCL)	Prenatal blood Pb associated with increased total behavior scores in preschool males. Early childhood blood Pb associated with increased total behavior scores in preschool females.
Horton et al (2018)	The Behavior Assessment System for Children 2nd Edition (BASC-2)	Infant Pb exposure (measured in deciduous teeth) associated with increased anxiety symptoms in mid childhood.
Rokoff et al (2022)	The Behavior Assessment System for Children 2nd Edition (BASC-2)	Prenatal Pb associated with increased anxiety symptoms and psychosomatic symptoms in 1- year old-males.
Reuben et al (2019)	Big Five Personality Inventory	Mid childhood blood Pb levels associated with increased internalizing symptoms and general psychopathology in adults.

Lead (PB) Cont.

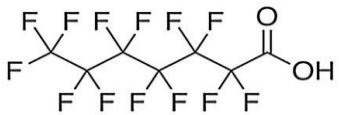
Summary: Pb is a recognized neurotoxicant. In addition to established effects (e.g., reduced intelligent quotient scores), these recent epidemiological studies suggest that increased Pb exposure is also correlated to negative mental health consequences in children.



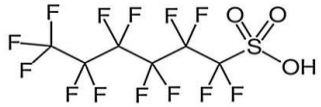
Perfluorobutanoic acid (PFBA)



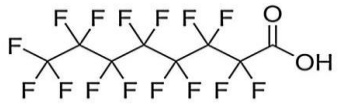
Perfluorobutane sulfonic acid (PFBS)



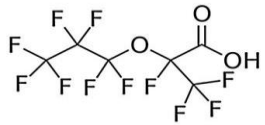
Perfluoroheptanoic acid (PFHpA)



Perfluorohexane sulfonic acid (PFHxS)



Perfluorooctanoic acid (PFOA)



Hexafluoropropylene oxide dimer acid (HFPO-DA or GenX)

Image source: Bevin Blake and Suzanne Fenton, 2020/*Toxicology*

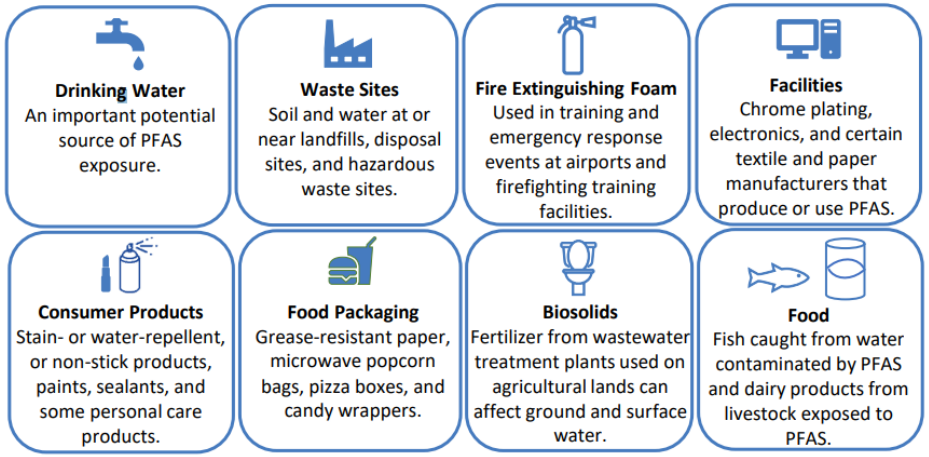


Image source: EPA PFAS Explained

Example: PFAS

- **Per- and polyfluoroalkyl substances (PFAS)** are a chemical class with several thousand different chemical variations. Many PFAS are persistent in humans and the environment.
- **Sources:** PFAS are widely used in almost every industry and in a myriad of consumer products (e.g., food packaging, clothing, cookware, dental floss, cleaning products). PFAS can be detected in the placenta, amniotic fluid, maternal and neonatal blood, and breastmilk. PFAS can contaminate air, drinking water, food, soil, and more.
- **Hypothesized mechanisms of neurotoxicity include:** disruption of the thyroid system, oxidative stress, and dopaminergic signaling pathways alteration

Citation	Assessment Tool	Results
Vuong et al (2021)	The Behavior Assessment System for Children 2nd Edition (BASC-2)	Prenatal serum PFOS, PFHxS, and PFNA associated with worse externalizing behavior, and PFHxS was associated with worse internalizing behavior at ages 5 and 7 years.
Ghassabian et al (2018)	The Strengths and Difficulties Questionnaire (SDQ)	New born PFOS exposure (from dried blood spots) associated with increased conduct and emotional problems at age 7.
Luo et al (2020)	The Strengths and Difficulties Questionnaire (SDQ)	Prenatal plasma PFNA associated with increased externalizing behaviors at ages 7 and 11 years.

PFAS: Cont

Summary: The epidemiological studies reviewed suggest that developmental PFAS exposure may correlate to later abnormalities in both internalizing and externalizing behaviors. However, there are relatively few studies that examine the mental health consequences of PFAS exposure in children and adolescents. Given that ubiquity of PFAS exposure and their biological persistence, this relationship should be explored in future studies.

Environmental Justice

None of the studies in this review assessed the potential impact of environmental injustice. Children in EJ communities may have increased vulnerability to the impact of chemical exposures on mental health outcomes due to:

Disproportionate exposure/overburdened with pollution

Additional psychological and physical stressors (e.g., traumatic experiences)

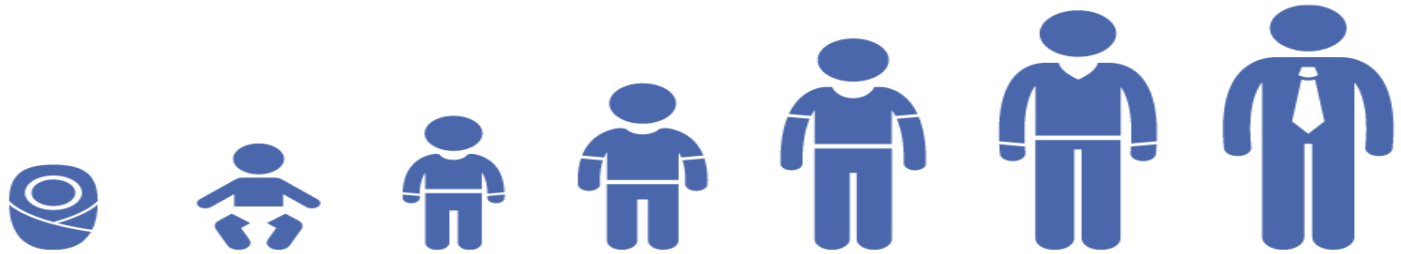
Less access to protective factors (e.g., greenspaces, healthy foods, quality healthcare)

Opportunities to Address EJ in Future Research

- Conducting community based participatory research (CBPR) studies in communities where children and pregnant people have disproportionate exposure to chemically polluted sites (i.e., waste and wastewater facilities, industrial farming, oil and gas refineries, etc.), and/or exposure from sources like contaminated seafood, lead paint, unsafe water, and certain personal care products.
- Cumulative impact of prenatal and childhood exposure to chemical and non-chemical stressors (i.e., psychosocial stress) on mental health outcomes, as well as the potential impact of protective factors

Other opportunities for future research

- Additional longitudinal birth cohort studies with multiple exposure assessments during pregnancy, infancy, and childhood to explore windows of vulnerability to chemical exposures
- Assess chemical mixtures
- Mechanistic studies (e.g., fMRI and MRI studies, hypothesis-driven animal studies)
- Studies to better understand sex-specific outcomes
- Explore potential interactions between risk factors and chemical exposures of interest
- Expand existing national surveys to help fill data gaps for both mental health outcomes and environmental exposures



Conclusion

There’s a growing body of evidence to support a link between prenatal and childhood exposure to certain chemicals and adverse mental health outcomes. However, the data is still limited. We need more research to build a strong body of evidence to inform policies, regulations and healthcare practices.

The mental health of children and teens in the U.S. is in a crisis that not only impacts their health, well-being, and overall life trajectory, but also has a ripple effect into healthcare, education, the economy and society at large. Thus, it is essential to identify and take action to address the environmental risks that may increase the development of these disorders.

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My Publications

- Environmental chemical exposures and mental health outcomes in children: a narrative review of recent literature
- Op-ed: What we know about toxic chemicals and children's mental health

References

1. AAP-AACAP-CHA Declaration of a National Emergency in Child and Adolescent Mental Health
2. Mental Health Surveillance Among Children — United States, 2013–2019
3. The Youth Risk Behavior Survey Data Summary & Trends Report: 2011–2021
4. National Trends in Mental Health–Related Emergency Department Visits Among Youth, 2011-2020
5. *2021 Policy on Children's Health*. Washington, DC, United States Office of the Administrator. U.S. Environmental Protection Agency

Thanks!

DO YOU HAVE ANY QUESTIONS?

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