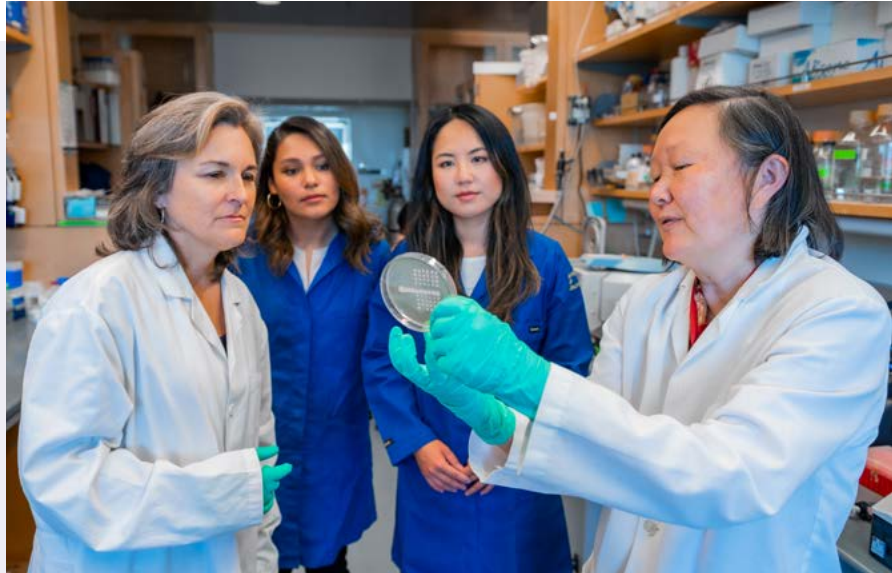


WHAT THE SCIENCE SAYS: PRHE's Research Answers Pressing Questions on Environmental Health

Toxic chemicals are found in our air, food, water, consumer products, and at home and at work. Where do these chemicals come from? How do they get into our bodies? Who is most vulnerable? And **how do they affect our health?**

UCSF's Program on Reproductive Health and the Environment (PRHE) conducts **ground-breaking, multi-disciplinary research** that answers important questions of how chemicals and contaminants in our homes and environment affect fertility, pregnancy, and fetal and child development. PRHE also mentors and trains the next generation of environmental health scientists.

Since PRHE's founding, the team has contributed to more than **160 studies on health and the environment** with 23 studies published in peer-reviewed journals in 2020 alone. The following is a small sample of PRHE's research.



Dr. Tracey J. Woodruff, professor and director of UCSF's Program on Reproductive Health and the Environment, and director of the EaRTH Center looks at a bio specimen with PRHE Clinical Research Coordinators Maribel Juárez and Harim Lee, and Dr. Jennifer Fung, UCSF professor and co-director of the EaRTH Center/UCSF lab.

BORN PRE-POLLUTED

• What's Contaminating Mothers and Children?

PRHE has conducted seminal studies examining how and to what extent pregnant women and children are exposed to toxic chemicals and pollutants. Dr. Woodruff and her team were among the first to identify over 43 chemicals in pregnant women in the U.S. (*Environmental Health Perspectives*, 2011), apply innovative technology to find 109 chemicals in pregnant women and newborns, including evidence of 55 chemicals not previously documented in people (*Environmental Science & Technology*, 2021), and discover toxic chemicals such as BPA (*ES&T*, 2013) and flame retardants (*Scientific Reports*, 2020) in cord blood.

• How Do Chemicals Affect Child Development?

PRHE leads one of the cohorts of the National Institutes of Health Environmental Influences on Child Health Outcomes (ECHO) study, the largest of its kind to examine how the environment affects children's health and development, including the impact of chemicals and pollutants. Studies from this work include identifying a link between PFOS,

stress, poverty, and brain development (*International Journal of Environmental Research and Public Health*, 2021), and how cumulative exposures to chemicals in utero affect children's health and development (*PLOS One*, 2017). Recently, PRHE was the first in the U.S. to demonstrate how pregnant women and fetuses are exposed to fluoride, a chemical of growing concern due to its potential harms on brain development (*Environmental Health*, 2020).

CHEMICALS, POLLUTANTS AND HEALTH

• How Do Chemicals Impact Pregnancy?

PRHE demonstrated the relationship between pollutants in the environment and pregnancy complications (*Reproductive Sciences*, 2008), how endocrine disrupting chemicals disrupt women's reproductive health (*Journal of Midwifery & Women's Health*, 2016), and found a possible association between some PFAS exposure and preterm birth (*EH*, 2020). We led novel studies finding significant associations between exposures to fracking chemicals and adverse birth outcomes (*Environmental Research*, 2019), and placental development (*Toxicological Sciences*, 2021).

- **How Does Air Pollution Affect Pregnancy and Infant Mortality?**

Dr. Woodruff was among the first to document air pollution's effects on infant mortality (*EHP*, 2008) and led the seminal international study which found air pollution is linked to low birthweight (*EHP*, 2011). More recently, PRHE discovered significant relationships between how air pollution increases preterm birth (*Environmental Epidemiology*, 2019) and how prenatal exposure to air pollution affects adverse children's health and developmental outcomes (*Environmental Research*, 2019).

- **What Are Flame Retardants Doing to Our Health?**

PRHE found PBDE flame retardants lower IQ (*EHP*, 2017), identified PBDEs in maternal and fetal tissue (*Environment International*, 2018), and studied how PBDEs impact thyroid development and function (*ES&T*, 2011). We also found that flame retardant substitutes for PBDEs can be just as harmful as the chemicals they were replacing (*ES&T*, 2019).

- **What Chemicals Are in Our Food?**

PRHE researchers have uncovered phthalates in fast food packaging (*EI*, 2018), how the industrialized food system undermines reproductive health (*Health Affairs*, 2011), and how exposure to organophosphate pesticides (ingested through eating or by living near farms) negatively affect children's health (*ES&T*, 2009).

POLLUTING INDUSTRIES AND MARGINALIZED COMMUNITIES

- **How Does Where We Live Affect Exposures?**

Dr. Woodruff and colleagues were among the first to examine health disparities in pregnancy from air pollution (*EHP*, 2008). PRHE also revealed how race and geographic differences affect people's exposure to PBDE flame retardants, documenting higher exposures among Black and Hispanic pregnant women (*Scientific Reports*, 2020), and contributed to one of the first studies showing asthma hospitalizations were higher in redlined neighborhoods in California (*Lancet Planetary Health*, 2020) and that preterm birth dropped following a steel mill closure in Utah (*Epidemiology*, 2008).

- **How Does Industrial Pollution Impact Fertility and Preterm Birth?**

PRHE has contributed to studies that demonstrate significant reduction in adverse birth outcomes following actions to reduce chemical exposures, including finding fertility improved after nearby coal and oil plants closed (*EH*, 2018),

and that fracking increased problematic birth outcomes in Pennsylvania (*Environmental Research*, 2019).

- **How Are Race and Employment Connected to Chemical Exposures?**

PRHE's research has revealed higher exposures to phthalates among Black women (*ES&T*, 2016), higher exposures to PBDE flame retardants among Black and Hispanic pregnant women (*Scientific Reports*, 2020) and higher phthalate exposures among low-income Vietnamese nail salon workers (*IJERPH*, 2020), documenting racial inequities related to harmful chemicals.

SHAPING SCIENCE AND PUBLIC POLICY

- **How PRHE's Science Informs Decision-Making**

PRHE's research focuses on science that informs systemic policy change including: recommendations to improve the estimation of health benefits of environmental regulations (*Science*, 2017), identifying how vulnerable populations bear the brunt of inadequate Environmental Protection Agency (EPA) policies (*American Journal of Public Health*, 2019), and showing the U.S. could reduce childhood asthma and save \$210 million annually in health costs by limiting formaldehyde (*PLOS One*, 2021). PRHE also identified more deaths from methylene chloride than had been previously reported after EPA failed to ban the chemical from commercial use (*JAMA Internal Medicine*, 2021).

- **Advancing Science and Health Care**

PRHE has been a leader in connecting the environment to women's and prenatal health among healthcare providers, working with major medical organizations to issue guidance on reducing chemical use and preventing harmful exposures (*Obstetrics & Gynecology*, 2013; *International Journal of Gynecology and Obstetrics*, 2015). PRHE has also improved how science is evaluated for evidence-based decision-making, including developing the Navigation Guide systematic review method to better evaluate chemical risks (*EHP*, 2014), recommended by the National Academy of Sciences for EPA use (*NAS*, 2021, 2018, 2017), and uncovered inadequate methods used by EPA in their risk assessments that undermined the Agency's conclusions on health risks under the Toxic Substances Control Act (TSCA) (*Systematic Reviews*, 2020).

PRHE wants to acknowledge the incredible work and dedication of our many scientists, postdocs, clinical research coordinators, data and policy analysts who have contributed to our body of research over the years. We also want to thank our funders who made this work possible.