Cover Sheet
University Proposal to State

Proposal to:	California Air Resources Board	Due date:	
	1001 I Street, Sacramento, CA 95814	Submitted:	

State agency contact:	Alice Kindarara	Phone #:	
	Branch Chief	Email:	

Project title:	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study				
Funding amount:	$700,000				
Project period:	07/01/2025	to	06/30/2027		
IT Activity/Component?	No	**x**	Yes		*Explain in coversheet addendum*

University PI:	Rebecca J. Schmidt	Phone #:	530-752-3226
	University of California, Davis	Email:	rjschmidt@ucdavis.edu
	Public Health Sciences		
	One Shields Ave, Davis, CA 95616		

	Samuel Boyes, C&G Analyst	Alternate contact:	Tina Palomino
	One Shields Ave, Davis, CA 95616		530-752-0466
	530-752-5458		tlpalomino@ucdavis.edu
	proposals@ucdavis.edu		

I certify that this proposal is compliant with the State & University Proposal and Administration Manual and that Scope of Work and Proposed Budget Estimate are compliant with University Policy.

Rebecca J. Schmidt	
Principal Investigator Signature	Authorized Official Signature
Rebecca J. Schmidt	Samuel Boyes
Date: May 13, 2025	Date: May 13, 2025

EXHIBIT A

SCOPE OF WORK

☒ Contract ☐ Grant

Does this project include Research (as defined in the UTC)? ☒ Yes ☐ No

PI Name: Rebecca J. Schmidt

Project Title: Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study

Project Summary/Abstract

Millions of pregnant people breathe air contaminated with wildfire particulate matter (PM) each year. Smoke from recent California wildfire plumes covered vast areas including urban centers with some of the highest PM ever recorded in California history for weeks at a time. This increasing threat of more intense and frequent wildfires in California is driving a need to understand potential health impacts of wildfire exposures, especially in vulnerable populations like pregnant women and their developing children. Prenatal wildfire exposure is associated with adverse birth outcomes in many studies, but few studies have examined longer-term health outcomes of gestationally-exposed children and their mothers. Studies of prenatal ambient air pollution suggest associations with child neurodevelopmental, behavioral and respiratory outcomes. The altered hormone state of pregnancy can increase susceptibility of pregnant people to respiratory conditions. Wildfire events can also increase mental health conditions, like anxiety and stress.

This project will address research knowledge gaps regarding long-term health outcomes of children exposed prenatally to wildfires, and their mothers. The Contractor, University of California, Davis (UCD) will use existing data and biospecimens collected in the Bio-Specimen Assessment of Fire Effects (B-SAFE) cohort of mothers exposed to Northern California wildfires 2017-2021 while pregnant, and their children.
The Contractor will administer follow-up surveys to collect additional health information on mothers and children four to eight years after the wildfires. Health information collected will include respiratory, cardiometabolic, and mental health outcomes for mothers and children, and neurodevelopmental and behavioral outcomes in children. The Contractor will also measure metals in maternal and child nails collected after the fires. The Contractor will examine newly generated metals and health data in relation to existing modeled wildfire $PM_{2.5}$ concentrations for the prenatal period. The Contractor will also examine differences in exposure concentrations as well as associations with health outcomes across sociodemographic and neighborhood factors. This project will provide better evidence of the long-term health effects of wildfire smoke exposure, enhancing the California Air Resources Board (CARB's) ability to conduct comprehensive health analyses. The project will also improve CARB's capacity to evaluate the effectiveness of programs aimed at reducing wildfire risks. The findings will be shared broadly with affected communities and inform the creation of lay-friendly materials providing guidance on how to reduce health risks associated wildfire exposure in pregnant people and children.

If Third-Party Confidential Information is to be provided by the State:

☐ Performance of the Scope of Work is anticipated to involve use of third-party Confidential Information and is subject to the terms of this Agreement; ***OR***

☐ A separate CNDA between the University and third-party is required by the third-party and is incorporated in this Agreement as Exhibit A7.

Statement of Significance

Communities are experiencing more frequent and intense wildfires. Smoke from recent California wildfire plumes covered vast areas including urban centers with some of the highest PM ever recorded in California history for weeks at a time.[1,2] This increase in wildfire intensity is driving a need to understand potential health impacts of wildfire exposures, especially in vulnerable populations like pregnant women and their developing children. Wildfire PM contains combustion components that activate proinflammatory and oxidative stress pathways.[3] California wildfire smoke and ash contain toxic levels of heavy metals like arsenic, cadmium, and lead.[4,5] Urban wildfire smoke is of greater concern because high temperature combustion of building materials releases toxic volatile organic compounds that show serious health impacts.[6] Further, the PM concentrations people were exposed to during recent wildfires exceeded those previously studied by orders of magnitude.[7] Wildfire smoke can increase respiratory symptoms and infections, exacerbations of asthma, respiratory-related emergency room visits and hospitalizations, and deaths.[8-11] Pregnancy is a period highly vulnerable to environmental exposures like air pollution.[12,13] Studies in macaques, the closest animal model of human development, suggest long-term developmental wildfire impacts on neurobehavior[14,15] and respiratory health.[16] Few human studies have addressed long-term health effects of prenatal exposure in women or children.

Black carbon particles, part of combustion-derived PM, reach the fetal side of human placenta and correlate with maternal exposure.[17] PM can activate proinflammatory pathways[18-22] and placental stress,[23] which can disrupt fetal neurodevelopment (ND).[22,24-27] Prenatal ambient PM is associated with adverse birth,[28,29] respiratory,[30] cardiometabolic,[30] and ND outcomes,[31] including intellectual,[32,33] autism,[21–33] attention[34] and cognitive impairments.[33,35-39] Similarly, prenatal wildfire smoke is linked to adverse birth outcomes,[40-42] and infant respiratory health.[43] In a subset of 105 B-SAFE cohort children whose mothers completed Child Behavior Checklist (CBCL) assessments for their four-year-old children born after gestational exposure to

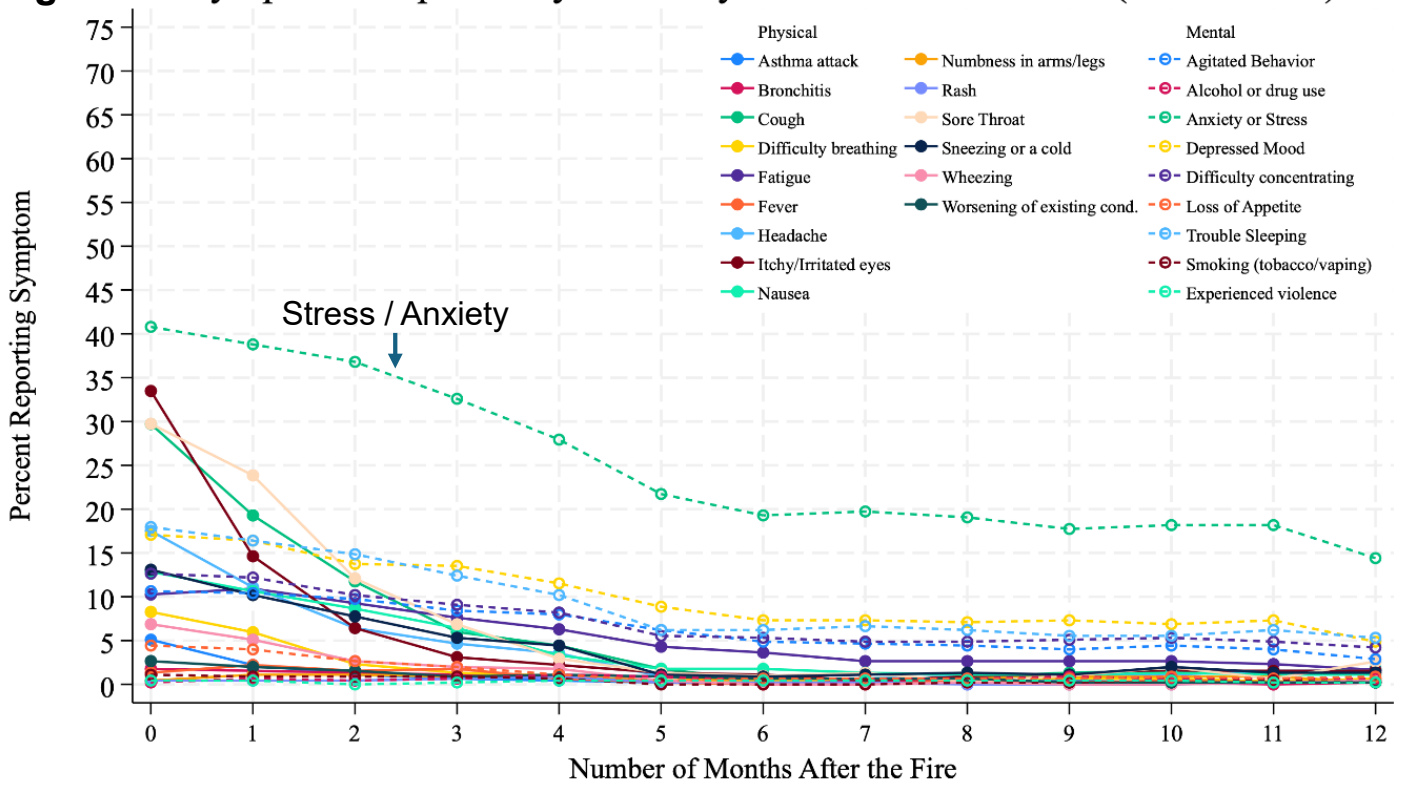
Table 1. Associations of Average Wildfire $PM_{2.5}$ (IQR Change) with Child Behavior Checklist Outcomes

	All (N=105)		Males (N=52)		Females (N=52)	
Child Behavior Checklist Outcome	Beta (95% CI)	*P*	Beta (95% CI)	*P*	Beta (95% CI)	*P*
Total Problems	10.75 (4.52, 16.98)	0.001	14.34 (5.76, 22.91)	0.002	2.00 (-8.04, 12.05)	0.69
Externalizing Problems	9.94 (3.34, 16.54)	0.004	13.80 (5.39, 22.21)	0.002	1.97 (-9.98, 13.92)	0.74
Internalizing Problems	9.20 (3.10, 15.30)	0.003	10.55 (2.03, 19.08)	0.016	4.22 (-5.90, 14.34)	0.41
Stress Problems	5.99 (1.95, 10.04)	0.004	7.89 (1.02, 14.76)	0.025	0.57 (-3.18, 4.32)	0.76
Depressive Problems	3.34 (0.25, 6.43)	0.034	3.27 (-1.75, 8.28)	0.196	2.18 (-1.85, 6.22)	0.28
Anxiety Problems	3.73 (-0.38, 7.84)	0.075	5.48 (-1.20, 12.16)	0.105	1.01 (-3.77, 5.80)	0.67
ASD Problems	8.87 (4.92, 12.82)	0.000	12.15 (6.32, 17.97)	0.000	1.70 (-4.04, 7.43)	0.55
ADHD Problems	3.85 (1.39, 6.32)	0.003	5.60 (1.50, 9.70)	0.008	0.29 (-2.52, 3.11)	0.84
Oppositional Defiant Problems	5.66 (1.95, 9.36)	0.003	7.96 (3.21, 12.71)	0.001	0.24 (-6.47, 6.95)	0.94

2017 and 2018 wildfires in Northern California, the Contractor found novel preliminary evidence that prenatal wildfire $PM_{2.5}$ is linked to child behavioral problems, particularly in males (Table 1). Wildfire-associated $PM_{2.5}$ estimates for California for 2017-2021 were derived using the rapidfire R package.[44] Ground-level 24-hour average $PM_{2.5}$ estimates were linked to geocoded residential and evacuation/relocation addresses for B-SAFE families. Beta coefficients (β) and 95 percent confidence intervals (CIs) for the association between an interquartile range (IQR) change in average $PM_{2.5}$ exposure over the course of the wildfire and child CBCL T-scores were obtained from linear regression models adjusted for maternal education. These findings are among the first evidence suggesting sex-specific long-term neurodevelopmental and behavioral outcomes associated with prenatal wildfire exposure. To the Contractor's knowledge, no others have studied prenatal wildfire exposures with later child cardiovascular (CV), mental, ND, and behavioral health.

Pregnancy-induced immune changes can impact airway responses to environmental triggers.[13] For asthmatic women, pregnancy can worsen asthma symptoms and affect control.[45-48] Higher airway inflammation susceptibility and altered immune responses in pregnancy combined with high wildfire $PM_{2.5}$ exposures could predispose mothers to future respiratory health issues. Acute health effects of wildfires are

Figure 1. Symptoms Reported by Moms by Month After All Fires (2017 - 2021)



well-documented,[8,10,11] but few have studied long-term health impacts as observed for other disasters, such as the World Trade Center collapse and the Dutch Fireworks disaster.[49-56] Short-term wildfire exposure has been shown to be associated with CV events,[57-62] but long-term changes after prenatal exposure have not yet been studied. As disasters, wildfires can also induce emotional and psychological distress.[50,63] The Contractor's preliminary B-SAFE findings suggests long-lasting mental health symptoms in mothers, with stress and anxiety reported up to a year after the fires (Figure 1). Air pollution health effects are more pronounced under psychological stress.[64-68] As urban wildfires are becoming common in California, studying asthma, CV, and mental health changes after such events would be a sentinel contribution, especially in a cohort of women likely to be at higher risk given their age and pregnancy hormone status.

Race is a sociopolitical construct that manifests in systemic and multilevel racism and structural discrimination, as well as downstream structural factors including socioeconomic disadvantage, chronic stress, and disproportionate exposure to environmental hazards such as ambient air pollution.[69,70] While trends in population exposure to $PM_{2.5}$ from wildfire smoke differ from those of other ambient $PM_{2.5}$ sources, emerging research suggests population disparities in the burden of wildfire smoke exposure.[71,72] Racism and structural discrimination may also result in disparities in opportunity for personal protective action during wildfire smoke events that exacerbate exposure and health disparities, driven in part by differential access to information on air quality, housing quality and resulting infiltration of airborne pollutants,[73] and residential mobility[74] during wildfire events.

The Contractor will address the current research gaps on how exposure to wildfire events during the prenatal period might relate to later health outcomes of the mother and the exposed child, four-nine years later. The Contractor will further examine differences in wildfire exposure burdens across participant characteristics and neighborhood factors.

The Contractor has assembled an interdisciplinary and cohesive team within UCD with expertise across several research fields, including environmental epidemiology, neurodevelopment, climate and health, respiratory health, fire emissions and air pollution modeling, and statistical analysis methodology with a history of working productively together. The UCD team will collaborate the Purdue University to generate new metals measures on stored nail samples collected after the fires. The overall objective is to characterize wildfire exposures in the B-SAFE cohort and better understand the potential long-term health outcomes associated with these exposures, and how these may differ by background factors, including social determinants of health. To meet these objectives, the Contractor will conduct a literature review, attain health information from families exposed to wildfire events several years later and assess associations with previous wildfire PM2.5 exposures and related metals measures from previously collected nail samples, and examine these associations by participant characteristics and behaviors.

Research Questions (Q) and Hypotheses (H) that will be addressed by this project:

Q1. Which elemental metal concentrations measured in nails collected from mothers and babies after wildfire events are associated with wildfire $PM_{2.5?}$

H1. The Contractor hypothesizes that nail concentrations of heavy metals like arsenic, cadmium, and lead, previously found in wildfire smoke and ash in California[5] will be higher in those exposed to higher concentrations of wildfire $PM_{2.5}$.

Q2. Which participant characteristics are associated with wildfire smoke mitigation behaviors?

H2. The Contractor expects that individuals with higher education will be more likely to wear masks and those with higher socioeconomic status (SES) will be more likely to evacuate.

Q3. Which maternal and child health outcomes are associated with wildfire $PM_{2.5}$ exposure concentrations in events that occurred several years prior?

H3a. The Contractor hypothesizes that child neurodevelopmental and behavior problems and respiratory issues reported four-nine years after the fires will be higher for children born after higher gestational $PM_{2.5}$ exposure.

H3b. The Contractor hypothesize that maternal respiratory issues reported four-nine years after the fires will be higher for mothers with higher prenatal $PM_{2.5}$ exposure.

Q4. Are wildfire-associated metals exposure concentrations associated with later maternal and child health outcomes?

H4. The Contractor expects that heavy metals that are associated with wildfire $PM_{2.5}$ will also be associated with later child neurodevelopmental outcomes.

Q5. Are there wildfire PM2.5 exposure concentration thresholds that are associated with health outcomes?

H5. The Contractor hypothesizes based on previous work with statewide data that associations with child neurodevelopmental outcomes will be associated with wildfire $PM_{2.5}$ above certain threshold concentrations.

Q6. Do associations between wildfire exposures and health outcomes differ by background factors (race, ethnicity, maternal education, protective behaviors, neighborhood poverty, and background air pollution)?

H6. The Contractor hypothesizes based on previous work with statewide data that wildfire $PM_{2.5}$ concentrations will not differ by race, ethnicity, maternal education, or neighborhood poverty, but associations with health outcomes will differ across these factors as well as background air pollution and use of protective behaviors.

This project will identify, prioritize, and address research knowledge gaps regarding long-term health outcomes of mothers and their children exposed to wildfires during pregnancy, by leveraging extant data and biospecimens collected in the B-SAFE cohort of mothers and children exposed to 2017-2021 wildfires. The Contractor will administer follow-up surveys to collect additional health information on mothers and children four to eight years after the wildfires. Information collected will include respiratory, CV, and mental health for mothers and children, and neurodevelopmental and behavioral outcomes in children. The Contractor will measure metals in maternal and child nails collected after the fires as an exposure of concern to mothers. The Contractor will examine newly generated metals and health data in relation to existing modeled wildfire $PM_{2.5}$ concentrations for the prenatal period. The Contractor will also examine differences in exposure concentrations as well as associations with health outcomes across demographic and neighborhood factors to identify groups at higher risk. The findings will be shared broadly with affected communities and will inform generation of lay-friendly materials providing guidance on how to reduce health risks associated with wildfire exposure in pregnant people and children.

The results of this project will inform CARB's wildfire and climate change programs on which maternal and child health outcomes are associated with wildfire smoke exposures that occurred several years earlier during pregnancy. The results will explore critical exposure windows and threshold exposure doses in relation to long-term health outcomes. The results will characterize wildfire exposures for B-SAFE participants and how they differed across wildfire year, participant and neighborhood factors. The results will also identify mitigation behaviors used by participants across participant characteristics and investigate whether they helped attenuate associations with later health outcomes. This will inform public health messaging during future wildfires, especially for pregnant people and their families. Finally, the results will determine whether metals measured in nails collected postnatally are associated with prenatal wildfire $PM_{2.5}$ exposure, and whether they are associated with later health outcomes.

Technical Plan

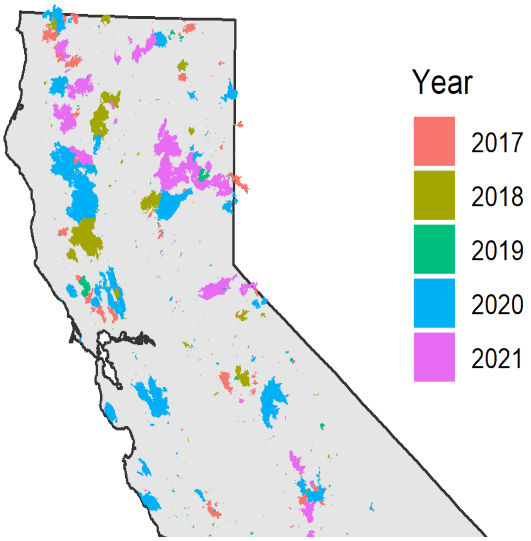
Study Population – B-SAFE Wildfire Pregnancy Cohort

The B-SAFE study was designed to address the growing need to understand internal exposures, mechanistic responses, and the mental, physical and developmental health outcomes associated with wildfires through timely collection of surveys and biological specimens from affected families. B-SAFE enrolled people who were pregnant during wildfires that occurred in Northern California from 2017-2021 (Figure 2) or became pregnant in the three months after the fires, and their children. Eligible women were 18 plus years old, able to speak, read and understand English or Spanish, and resided in Northern California at the start of the wildfires. B-SAFE enrolled 544 mother-child pairs in total: 172 for 2017 Napa/Sonoma fires, 225 for 2018 Camp Fire, 18 for 2019 Kincade Fire, 95 for 2020 Complex Fires, and 34 for 2021 Dixie/Caldor Fires. Most participants were non-Hispanic, white, college educated, married and non-smokers (Table 2).

Participants completed questionnaires on wildfire experiences, including smoke mitigation/avoidance behaviors, damage, loss, exposures, address history, pregnancy and health history, demographic and lifestyle factors, and birth outcomes. Perceived Stress Scales (PSS)[75] were completed by mothers at enrollment and postnatal visits, and again for 2017 and 2018 wildfire families in a 2023 pilot survey study.

Biospecimens collected at pregnancy, delivery, and postnatal visits included: prenatal and postnatal maternal peripheral blood plasma, serum, hair, saliva, urine, toenails, and exposome wristbands; placenta, umbilical cord blood, and meconium at delivery; breastmilk and baby saliva and toenails.

Locations of B-SAFE participant home residences at the wildfire start are shown in Figure 3a and evacuation/relocation addresses (or street intersections) during and after the wildfires (up to a year later) are shown in 3b. Overall, 187 (34 percent) participants evacuated, with wide variation across fire years (from three-68 percent). Most relocations (97 percent) were within Northern California, with some moving up to six times.



Wildfire-associated $PM_{2.5}$ estimates for CA for 2017-2021 were derived in preliminary work using the rapidfire R package (Figure 4).[44] Estimates of ground-level 24-hr average $PM_{2.5}$ were linked to geocoded home/relocation addresses. B-SAFE mothers' median daily $PM_{2.5}$ varied by wildfire year (Figure 5/Table 3).

Table 2. Characteristics of B-SAFE Participants		
Maternal Age	(Years) Mean (SD)	33 (4.5)
Race	White or Caucasian	451 (83)
n (%)	Asian	22 (4)
	Other	16 (3)
	Multiple races	34 (6)
Ethnicity	Hispanic or Latino/a	61 (11)
n (%)	Not Hispanic or Latino/a	460 (85)
Maternal	High School or Less	19 (4)
Education	Some College But No Degree	64 (12)
n (%)	Technical/Associate's Degree	60 (11)
	Bachelor's Degree	204 (38)
	Master's Degree	130 (24)
	Professional/Doctoral Degree	57 (11)
Relationship	In a Relationship	17 (3)
Status	Married or Living as Married	419 (77)
n (%)	Single	45 (8)
Smoker	Yes	17 (3)
n (%)	No	479 (88)
Child Sex	Male	245 (50)
	Female	245 (50)
Prenatal	Pre-Conception	63 (12)
Trimester of	Trimester 1	143 (27)
Wildfire	Trimester 2	169 (32)
Exposure	Trimester 3	152 (28)

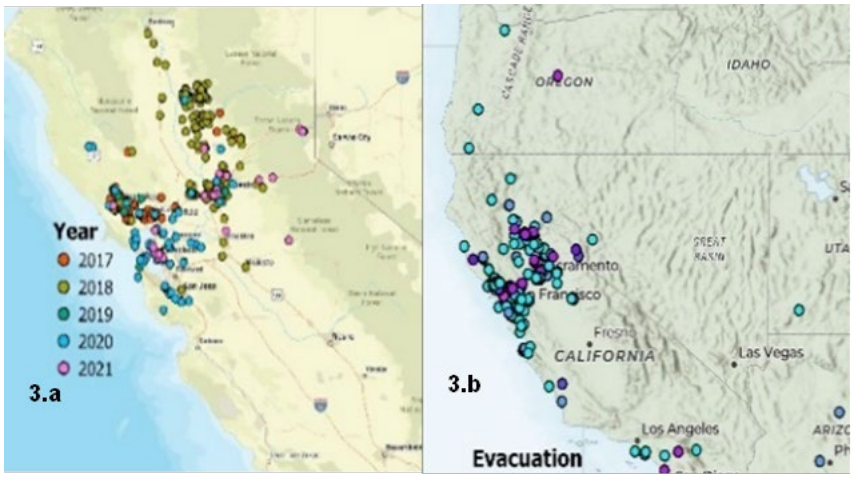


Figure 3.a. Home locations at fire start and **3.b.** Relocation Locations for B-SAFE Families ≤1Yr Post-Wildfire.
Map excludes 6 relocations in TX, LA, IL, ML, Canada

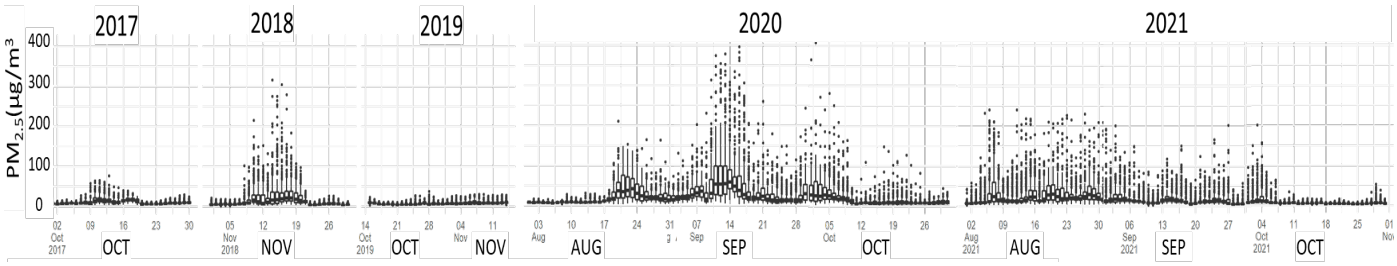


Figure 4. $PM_{2.5}$ in N. CA Wildfire Periods

Figure 5. Median Daily $PM_{2.5}$ for B-SAFE Mothers During CA Wildfire Periods

Table 3. Wildfire PM2.5 Exposure Concentrations for B-SAFE Mothers during Northern California Wildfires

	2017	2018	2019	2020	2021	All Years
Moms (N)	172	225*	18	95	34	544
Moms with PM(N)	170	263	15	93	26	567
Mean (SD)	16.4 (15.8)	57.9 (83.7)	7.4 (3.7)	17.5 (21.9)	12.7 (19.5)	24.8 (47.5)
Mdn (Q1/Q3)	8.2 (6.8/21.1)	12.5 (5.3/83.8)	6.5 (5.0/8.8)	9.2 (6.4/18.2)	7.4 (5.1/12.6)	8.5 (5.9/18.5)
Min/Max	2.2/91.3	0.2/538.0	2.9/68.9	1.9/296.0	1.7/226.7	0.2/538.0
Pctile: 90/95/99	45.2/52.1/60.9	178.0/230.9/376.0	11.2/13.1/21.3	39.4/63.7/113.0	21.4/34.7/107.9	57.6/112.0/249.8

* Includes 44 remote participants

Project Tasks

Task 1: Identify Gaps in Scientific Knowledge on Long-Term Health Effects of Wildfire Smoke Exposure

To assess the current state of knowledge on the long-term health effects of prenatal wildfire smoke exposure, the Contractor will conduct a systematic literature review focusing on published, peer-reviewed, studies evaluating maternal and child health outcomes. Given high wildfire risk in California and Northern America, the Contractor will prioritize studies in those areas, and in vulnerable populations. The literature review will be led by UCD. The Contractor will then obtain feedback on the findings in a meeting open to the public and B-SAFE participants regarding the prioritization of gaps to address generally, in the context of B-SAFE, and in this specific CARB-funded project. The Contractor will prepare a review article on a topic that fills gaps in existing literature and submit it to a peer-reviewed, open-access journal for publication.

Task 1.1. Literature Search and Review of Research on Children.

The Contactor will conduct the literature search in the following databases: Google Scholar, PsycINFO, PubMed, and Web of Science, and follow the Preferred Reporting Items for Systematic Reviews and Meta-analyses [76] reporting guideline. Given associations observed between short- and long-term exposure to wildfire-related smoke and PM and adverse respiratory,[77] CV,[62,78] and cognitive outcomes [79,80] in adults, the Contractor will examine how prenatal exposure to wildfire smoke and related pollutants, including $PM_{2.5}$ and metals, associate with long-term ND, CV, and respiratory health in children. The Contractor will use inclusive search terms to ensure an exhaustive search, e.g., (“pregnancy” OR “prenatal” OR “perinatal”) AND (“forest fire smoke” OR “wildfire smoke” OR “biomass smoke” OR “wildland fire smoke” OR “landscape fire smoke” OR “peat fire smoke” OR “wood smoke” OR “prescribed fire”) AND (“cognit*” OR neuropsych* OR memory OR dementia OR “executive function” OR attention OR brain OR neuropsych* OR autism OR ADHD OR adaptive OR PVT OR psychomotor OR memory OR IQ OR intelligen* OR “problem solv*” OR neurodevelop*).

The Contractor will incorporate information from existing, recent, high-quality reviews, and focus the review on topics not previously reviewed extensively, including constituents of wildfire smoke and biological mechanisms of these constituents. When human studies are limited, the Contractor will broaden the exposure period from prenatal to include early postnatal life for children, and incorporate evidence from non-human primate studies, particularly on mechanisms and long-term outcomes of wildfire exposures. The Contractor will prioritize studies restricting to Wildland-Urban Interface (WUI) or landscape wildfires as opposed to those that include prescribed burns.

Task 1.2. Literature Search and Review of Research on Mothers.

The Contractor will use the same methods outlined in Task 1.1 to examine how exposure to wildfire smoke and related pollutants, including $PM_{2.5}$ and metals, during the prenatal period associate with long-term mental, CV, and respiratory health in mothers.

Task 1.3. Community Input Meeting

After the Task 1 literature review is completed (Task 1.1, 1.2), the Contractor will organize and convene a Community Input Meeting to gather feedback on knowledge gaps related to the long-term maternal and child health effects of prenatal wildfire smoke exposure and the objectives of the current project. The Contractor will advertise the meeting, which will offer remote participation (via Zoom) to capture a broad population of women and families in Northern California, targeting women of childbearing age in wildfire-smoke prone regions, including the participants of the B-SAFE cohort. The Contractor will present the findings of the literature review and then obtain feedback regarding the prioritization of gaps to address generally, and then further discuss what is feasible to address in the context of B-SAFE, and in this specific CARB-funded project.

Task 1 Deliverables:

Provide a literature review on the findings of the systematic literature review on the long-term maternal and child health outcomes associated with prenatal wildfire exposure. This will include a table summarizing major findings, study design/methodological approaches, and potential limitations of previous studies.

Submit a review article manuscript for publication in peer-reviewed open-access journals, potentially focusing on topics not extensively covered in previous reviews.

Convene a Community Input Meeting and provide a summary of the meeting.

Task 2: Characterize Study Participants' Exposure to Wildfire Smoke Pollutants by Social Determinants of Health

The Contractor will characterize prenatal exposure to wildfire-specific PM2.5 concentrations in B-SAFE participants, measure elemental metal concentrations in archived maternal and baby nails of B-SAFE participants (Purdue University), and examine PM2.5 and metals by participant characteristics and neighborhood factors to determine which groups had increased wildfire exposures. The Contractor will also study whether behaviors to minimize exposure, such as use of masks and air purifiers, differed by these participant and neighborhood factors. The results of the exposure assessment will be developed into a manuscript and submitted for publication in a peer-reviewed, open-access journal.

To assign wildfire-associated $PM_{2.5}$ metrics, the project team will: i) determine where and when each individual resided during each day of the exposure period of interest, from three months preconception through the end of pregnancy, including evacuations/relocations; as well as for the period one year prior and one year after the exposure window, relevant for confounding and effect modification ii) estimate daily statewide $PM_{2.5}$ concentrations, including wildfire-specific and urban wildfire-specific $PM_{2.5}$; iii) assign daily $PM_{2.5}$ estimates for each participant based on the location history; and iv) generate relevant exposure metrics for each participant.

Task 2.1. Location History.

A strength of this study over most linkage studies to date is exposure assessment that will account for the participants' location history throughout the child's development and knowledge of the precise timing of the wildfire events participants were exposed to. This allows more detailed exposure operationalization. The B-SAFE study collected detailed pregnancy and postnatal address histories, including initial home address and relocation history and dates for evacuations and each subsequent move. For 2017/2018 families in a 2023 pilot study, the Contractor collected updated residential histories for the child's first four years of life. In this project, the Contractor will collect updated address histories to cover 15 months preconception through current day. All addresses will be geocoded to obtain a longitude and latitude (ArcGIS v10.8; ESRI) using the ArcGIS World Geocoding Service.

Task 2.2. Wildfire Emissions and Air Pollution Modeling.

California state-wide model criteria pollutants, wildfire smoke, and ultrafine particles ($PM_{0.1}$), at four kilometers (km) resolution for 2000-2021 were previously generated in the Contractor's United States Environmental Protection Agency (US EPA)-funded study (EPA STAR 84048401, Principal Investigator [PI] Schmidt, Nuño) in collaboration with Raffuse and Kleeman using chemical transport models (CTMs). Dr. Kleeman's CTM used emissions, meteorology, and chemistry information to predict exposure fields for a wide range of primary and secondary pollutants including oxidation products such as ozone and nitrogen dioxide , phenolic compounds, $PM_{2.5}$ and $PM_{0.1}$, plus components relevant for atmospheric chemistry (e.g., formaldehyde is an intermediate species that

forms from reactions of precursor compounds and then goes on to form other compounds). The CTM uses the Statewide Air Pollution Research Center photochemical mechanism to predict the reaction rate of primary pollutants and the formation of secondary pollutants. Gas-particle partitioning calculations predict formation of secondary organic and inorganic PM species. Tagging methods are used to predict source contributions to $PM_{2.5}$ and $PM_{0.1}$, to differentiate wildfire from background, and for both natural wildfire smoke and wildfire smoke resulting from burning of urban areas, which will include combustion products from plastic, rubber, and other human materials.[81] Dr. Kleeman used the latest wildfire smoke plume rise calculations that are critical to determining concentrations of exposure.[82] The Contractor enhanced accuracy of wildfire emissions by using higher resolution local data sources that are not available globally and thus not used in standard emissions datasets. Wildfire emissions were developed by improving on the methods of the Comprehensive Fire Information Reconciled Emissions modeling.[83] Detailed burned areas were acquired from the California Department of Forestry and Fire Protection's Fire Resource Assessment Program database of historical fire perimeters, and recently compiled emission factors from the Smoke Emissions Repository Application were applied.[84] Emissions modeling were conducted using the BlueSky-Pipeline.[85] Meteorological fields during the study period were simulated using the Weather Research and Forecast model. Predicted exposure fields were merged with wildfire smoke concentrations using a Random Forest Regression machine learning approach that mitigates effects of the uncertainty in emissions estimates and meteorological inputs to the CTM calculations.

Task 2.3. Background Air Pollution and Wildfire Exposure Assignment.

Exposure fields from the CTM model will be linked to geocoded addresses from address histories collected from mothers for the time from before the wildfires (prenatal period) through the last B-SAFE postnatal visit, which include any evacuation/relocation addresses. In previously funded research, B-SAFE conducted one postnatal visit, most often when the child was four months (mean 4.9 months, SD 3.3 months, range zero -14 months) old, to collect biospecimens (including nails) and health data, and the Contractor already has geocoded addresses through this time. With the newly collected address history information from this new CARB project, the Contractor will collect addresses for the child's first years of life as well. The Contractor will only consider background PM exposure through the child's first year of life. Estimates of ground-level 24-hour average $PM_{2.5}$ total mass, and the fraction of the total mass from two combined sources – biomass combustion and WUI – to represent wildfire $PM_{2.5}$, and background $PM_{2.5}$ (i.e., source contributions to $PM_{2.5}$ that are not specific to wildfire and biomass combustion) will be linked to geocoded home/relocation addresses (to the address reported in their address history for that day based on dates given at each address). Contractor has one km results over central regions of Los Angeles, San Francisco, Sacramento, and Fresno for the years 2000-2020. The Contractor is not currently downscaling the four km results using a statistical or machine learning approach. Weekly and period-specific (e.g., trimesters, preconception, etc.) sums and averages of $PM_{2.5}$ and exposures (total mass, wildfire PM, and background PM) will be calculated from the daily values.

Task 2.4. Calculate Wildfire Exposure Metrics.

From the daily air pollution exposures assigned to each mother during this period, the Contractor will quantify several exposure metrics to use in the analyses. The Contractor's primary exposure metric is 1) cumulative wildfire-specific $PM_{2.5}$ exposure, calculated as the sum of all daily exposures to wildfire-generated $PM_{2.5}$ from conception until the child's birth. The Contractor postulate that exposures exceeding health-relevant levels may be more harmful, and thus the Contractor will also 2) calculate cumulative wildfire-specific $PM_{2.5}$ exposure exceeding nine micrograms per cubic meter (µg/m3) (National Ambient Air Quality Standards [NAAQS] annual average standard) and 3) exceeding 35 µg/m3 (NAAQS 24-hour standard).[86] To better understand timing, 4) the Contractor will calculate each of the above cumulative exposure measures for the three-months prior to conception

and each trimester (defined as: weeks one-13, weeks 14- 26, and weeks 27-37 using estimated delivery date to back-calculate date of conception). Preconception exposure is included because it could produce lasting maternal health responses that could influence pregnancy after conception or be correlated with paternal sperm exposure. Because the use of cumulative exposure metrics by trimester will result in a smoothing/reduced exposure characterization for some extremely high, acute exposures, the secondary exposure metric that includes exposure exceeding standard thresholds will capture these peaks. 5) The Contractor will, for pregnancy, pre-conception, and each trimester, calculate the cumulative exposure to $PM_{2.5}$ for wildfires burning natural vegetation and wildfires at the wildfire-urban interface. Depending on findings for the preconception period, 6) the Contractor will consider calculating and analyzing cumulative exposures for the entire period from pre-conception through birth in sensitivity analyses. 7) The Contractor will additionally calculate each of the above cumulative exposure measures for each week of gestation for use in distributed lag models to examine more precisely critical windows of exposure.

Task 2.5. Background Air Pollution.

As some research has indicated effect modification based on background air pollution,[87] the Contractor will estimate mean and maximum background air pollution for the period one year prior to the three months pre-conception. Because associations with health outcomes could be confounded by air pollution in the first two years of life, thus the Contractor will calculate the mean and maximum air pollution for each of the first two years of life.

A potential limitation is that the Contractor will only have air pollution estimated through 2021 during the project period and will not be able to account for two postnatal years for the 2021-wildfire exposed children. The Contractor can use their postnatal exposure as a proxy for later years, as there was not impact by any large wildfire events in northern California after 2021. Further, the Contractor can estimate the residual confounding due to lack of this data by examining the difference in effect estimates for other wildfire years with full estimation of the two postnatal years.

Task 2.6. Modeling Considerations.

For modeling purposes, the Contractor will scale pollutants to the IQR of the full sample for a given exposure period and estimate the changes in scores per IQR increase in single- and multi-pollutant models. The Contractor will conduct analyses of associations with wildfire $PM_{2.5}$ adjusting for total $PM_{2.5}$ (from all sources) minus the proportion due to wildfire combustion. The Contractor will also examine whether behaviors to mitigate exposure collected in B-SAFE surveys (use of air cleaners, masks, minimizing time outdoors, etc.) modify the results.

To address the issue of differential gestational age at delivery (varying exposure opportunities) and pregnancy censoring, the Contractor will shorten trimester three and total gestational age for exposure being examined for everyone to 37 weeks to remove variation by the length of gestation past term. The Contractor also considered conducting a sensitivity analysis defining Trimester three as the last four weeks before delivery and not evaluate trimester three for births <31 weeks gestation to avoid differential averaging period by gestational age. The Contractor discussed other approaches to examine critical exposure windows such as Bayesian distributed lag interaction models [88] but these more complicated methods tend to arrive at similar conclusions, and given the relatively small sample size and the high amount of within-dyad correlation among the estimated time-series of exposures, the Contractor cannot anticipate sufficient statistical power to use these models reliably.

Limitations. The Contractor acknowledges that the models of outdoor $PM_{2.5}$ during wildfire events at each residential location will not accurately capture exposure of participants while indoors, where they spend most of their time. The Contractor does not have any information collected from indoor sensors during the wildfire periods for these participants. However, the Contractor could gain access to Purple

Air indoor sensors for Northern California during the wildfire periods and compare them to outdoor sensors in the same regions during the wildfire event to inform the correlation of the outdoor data with indoor data where available (not limited to the participants). Current funding for this project does not allow the Contractor to do this work.

Metals Measurement: Rationale.

California wildfire smoke and ash contain toxic levels of heavy metals like arsenic, cadmium, and lead[4,5] are linked to adverse human health outcomes, including child development.[89,90] The Contractor will add measurement of metals in nail specimens collected after the wildfires in mothers in children. Baby fingernails start developing as early as gestational week seven, with some variability in timing, and most observed by nine-ten weeks.[91] Fetal toenails begin developing about two to four weeks later. Fingernails typically grow around 3.47 millimeter (mm) per month, while toenails grow at approximately 1.62 mm per month.[92] The Contractor will measure metals in both for babies to capture the earlier gestation period in fingernails and the longer period represented by toenails. While in mothers it will be difficult to match the timing of the wildfires to their nail growth and sampling frame, metals exposures can persist across time, and nails can reflect long-term exposure to certain metals like arsenic, mercury, manganese, and selenium.[93]

Task 2.7. Quantify Metals

Metals will be quantified by Purdue University in extant baby fingernail and toenail specimens collected for the 2018, 2020, and 2021 wildfires for about 200 B-SAFE babies and their mothers using benchtop x-ray fluorescence (XRF) in Dr. Specht's lab. XRF non-destructively measures 23 elements (Table 4) in nails as environmental and nutritional exposure biomarkers.[94] Concentrations of lead, copper, iron , and selenium measured using XRF are comparable to standard inductively-coupled plasma mass spectrometry measures.

Table 4. Elements measured in nails using XRF

Na	Sodium	Ti	Titanium	Zn	Zinc
Mg	Magnesium	V	Vanadium	As	Arsenic
Al	Aluminum	Cr	Chromium	Se	Selenium
Si	Silicon	Mn	Manganese	Br	Bromium
P	Phosphorus	Fe	Iron	Hg	Mercury
S	Sulfur	Co	Cobalt	Pb	Lead
Cl	Chlorine	Ni	Nickle	Cd	Cadmium
Ca	Calcium	Cu	Copper		

Task 2.8. Participant and Neighborhood Characteristics

Participant and Neighborhood Characteristics will include B-SAFE participant education, race, and ethnicity. Because neighborhood-level demographic and socioeconomic factors can contribute to disparate air quality-related health risk,[95-97] including birth outcomes, the Contractor will also examine neighborhood factors based on the family's home address before the wildfires, such as Census tract demographic and socioeconomic variables (e.g., neighborhood poverty) and composite indices as surrogate measures of neighborhood-level environmental, social, and structural factors, such as Child Opportunity Index (COI),[98] Area Deprivation Index (ADI),[99,100] and CalEnviroScreen.[101] These are publicly available indexes that will be downloaded and linked to geocoded addresses.

Task 2.9. Descriptive Statistics

Descriptive statistics on distributions of wildfire $PM_{2.5}$ and metal exposures will be examined by participant and neighborhood characteristics. The Contractor will present the results be using clear and informative visualizations, including exposure maps for the study region, as well as heatmaps, comparative histograms and other figures to enhance understanding of pollutant distributions and differences among groups.

Task 2 Deliverable:

Provide CARB with summary tables and plots of the distribution of $PM_{2.5}$ exposure, metals concentrations, and use of exposure mitigating behaviors (mask use, air purifiers, evacuations) across fires, participant characteristics, and neighborhood characteristics. The findings will be included in a manuscript that will be prepared and submitted for publication in peer-reviewed open-access journals.

Task 3: Estimate Health Impact Functions for Long-Term Health Outcomes of Prenatal Wildfire Smoke Pollutants

The Contractor will use existing B-SAFE data as well as collect additional data on long-term health outcomes of B-SAFE mothers and their children, several years after the wildfires.

Task 3.1. Existing Survey Health Data.

The Contractor has already collected survey data on neurodevelopmental and respiratory health of children and maternal perceived stress in a 2023 pilot study for 105 families exposed to the 2017 and 2018 wildfires when their children were about four years old. This data will be extracted from Research Electronic Data Capture (REDCap) and prepared for analyses.

Task 3.2. New Survey Administration to Collect Health Data.

The Contractor will administer surveys to the rest of the B-SAFE families (up to 420) to collect the same information to increase the sample size with long-term outcomes, as well as to all previously enrolled families (540) to collect additional information on child and maternal health (Table 5), four-nine years after the wildfire events. The Contractor expects based on the past efforts that approximately 60-70 percent will be reachable and will respond.

Mental health measures will include a validated depression (Beck Depression Inventory, [BDI])[102] and anxiety (Beck Anxiety Inventory, [BAI])[103] screeners for mothers and the CBCL[104,105] for children, the (PSS)[75] for mothers and the Perceived Stress Scale for Kids (PeSSKi)[106] for children, Patient–Reported Outcome Measurement Information System (PROMIS) General Life Satisfaction – Short Form 5a for mothers and PROMIS Global Health Scales for mothers and children. Respiratory health will be assessed for mothers, fathers, and all children (including the wildfire-exposed child and their siblings).

Questionnaire survey assessing presence and symptoms relating to asthma will be obtained from parents and all children. For children, questionnaire will include standardized questions modified from the International Study of Asthma and Allergies in Childhood[107] used in the European consortium Mechanisms of the Development of ALLergy.[108] For parents, questionnaire will surveyed whether parents develop a new diagnosis of asthma and if current symptoms are controlled during wildfire and at the time of the survey using validated Asthma Control Test and Juniper Asthma Control Questionnaire (ACQ).[109] Covariates including sex, race/ethnicity, family history of asthma and atopic conditions, and secondhand smoking. CV health will be assessed for mothers, fathers and all children (including the wildfire-exposed child and their siblings) by collecting parent-reported height and weight data to calculate body mass index (BMI), asking whether a doctor has told them they have high blood pressure, high cholesterol, high blood glucose, or arrhythmia (abnormal heart beat) and for adults, using the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System [110] survey questions designed to assess the prevalence of cardiovascular disease, including self-reported prevalence of myocardial infarctions, coronary heart disease, and stroke. Neurodevelopmental/Behavioral measures will include parent-reported assessments including the CBCL,[104,105] the short Social Responsiveness Scale (SRS),[111] the Behavior Rating Inventory of Executive Function (BRIEF)[112,113] and the Swanson, Nolan and Pelham Teacher and Parent Rating Scale SNAP-IV Rating Scale,[114] a validated Attention deficit hyperactivity disorder screener.[115] These instruments generate age- and sex-normed T-scores that will be used in analyses. If upon scoring these assessments the participant meets criteria for clinical concerns, the Contractor will inform participants that their assessment results show concerns that should be followed up with a health provider. The Contractor will merge past-collected pilot data with newly collected data and prepare variables for use in analyses.

Potential Limitations. The project timeline is short for reconsenting, enrolling, and collecting surveys for all B-SAFE participants. The Contractor plans to prioritize families with younger children to collect assessments at ages similar to what was collected in the pilot (around age four years). The sample size for health less common health outcomes will likely be too small for certain analyses, so the Contractor will focus on those for which there are enough numbers to provide more reliable results. The Contractor plans to conduct visits with all participants for in-person assessments through other funding over the next five years, so the Contractor will be able to build on this work.

Task 3.3. Modeling Strategy to Assess Associations between Wildfire Exposures and Maternal and Child Health Outcomes.

The Contractor will primarily rely on generalized linear models to assess the associations between long-term maternal and child health outcomes and modeled wildfire $PM_{2.5}$ and measured metals concentrations, while accounting for relevant covariates such as participant and neighborhood factors described in Task 1, as well as background air pollution estimates. Effect size estimates will be tailored to the outcome type. Models will be fit with and without interaction terms to test for effect modification of exposure-outcome associations by hypothesized modifiers, including child sex, race/ethnicity, and exposure mitigation behaviors, as sample size allows. For the analysis of trimester-specific exposures, the Contractor will employ multiple time-point analysis adding each time-specific exposure metric for cumulative wildfire-specific $PM_{2.5}$ for each trimester and the three -months preconception, into one model to concurrently account for distinct sensitive windows.[117,118] The Contractor will calculate Pearson's correlation coefficients for period-specific pollutant metrics to assess appropriateness of co-pollutant adjustment.

Table 5. Wildfire Exposure and Health Outcomes

WF Exposure Measures	Maternal Health Outcomes	Child Health Outcomes	Health Outcome
Maternal Toenail Metals	Depression (BDI)	Depression (CBCL)	Mental
Baby Toenail Metals	Anxiety (BAI)	Anxiety (CBCL)	
Baby Fingernail Metals	Stress (PSS)	Stress (PeSSKi)	
Cumulative WF PM2.5	PROMIS Life Satisfaction		
Weekly WF PM2.5	PROMIS Global Health	PROMIS Global Health	Global Health
WF WUI PM2.5	Asthma/ Allergy Survey (ACQ)	Asthma/ Allergy Survey	Respiratory
WF Biomass PM2.5	BMI (Ht, Wt)	BMI (Ht, Wt)	Cardiovascular
WF PM2.5 Max	Hx of Dr. Dx of HBP, High Chol, Glucose, Arrhythmia	Hx of Dr. Dx of HBP, High Chol, Glucose, Arrhythmia	
WF PM2.5 Mean	CVD, MI, CHD, stroke (BRFSS)		
		Problem Behaviors (CBCL)	Neurodevelopment
		Autism Traits (SRS)	
		Executive Function (BRIEF)	
		ADHD (SNAP-IV)	

Task 3.4. Distributed Lag Models (DLM) to Examine Critical Exposure Timing for Wildfire $PM_{2.5}$

In exploratory analysis, the Contractor will use DLMs to model the association between outcomes and mean/cumulative weekly wildfire $PM_{2.5}$ exposures during gestational weeks one to 40. For simplicity, the Contractor will begin by specifying the time-series of weekly exposures with each exposure assigned a separate regression coefficient (a simple linear specification).

The Contractor will also fit more complex distributed lag (nonlinear) model that are operationalized using “cross-basis” functions, which allows the simultaneous estimation of (nonlinear) exposure-response association and nonlinear effects across lags, the latter termed *lag-response association*.[44] The exposure-response function will be again be assumed to be linear and the lag structure will be modeled using a natural cubic spline with approximately five degrees of freedom (*df*), setting knots at equally spaced values in the original lag scale (one-40 weeks). Model selection (including the placement of knots) will rely on the Akaike information criterion , to balance goodness-of-fit with parsimony.[45]

Task 3.5. Concentration Response Functions

For up to 11 exposure/outcome relationships where modeled exposures account for significant heterogeneity in the outcome, the results of the regression analysis in Task 3.3 will inform the specification of generalized linear (regression) models that will be used to estimate concentration response models. The Contractor will prioritize evaluation of wildfire $PM_{2.5}$ with continuous health outcomes for which will have more statistical power, including maternal depression, anxiety, and PSS, global health scores, and Body Mass Index (BMI);) child CBCL T-scores (total and subscales), PeSSKi, BMI, SRS, BRIEF, and SNAP-IV scores. Additionally, the Contractor will incorporate sensitivity analyses and use cross-validation for model validation (e.g., Goodness-of-Fit) to ensure the robustness of the findings.

When appropriate, outcome and exposure data will be log-transformed to stabilize variance and lessen outlier influence. For element values below the detection limit when non-detection is < 30 percent, the Contractor will impute the estimated conditional expected value given that it is below the detection limit, assuming a log-normal distribution. When detection is more frequent, the Contractor will use multiple imputation, Tobit regression, or other suitable approaches.[119,120]

The Contractor will use linear regression analysis to characterize the adjusted exposure-outcome associations of wildfire $PM_{2.5}$ or nail metal exposures with continuous T-scores for child neurodevelopmental and behavioral (NDB) outcomes, as well as other continuous health measures. Logistic regression will be used for dichotomous health measures.

Wildfire $PM_{2.5}$ will be examined in relation to nail metal concentrations using linear regression models for each element, with consideration of the prenatal timing of wildfire exposure, as well as the baby's age at the time of nail collection. The Contractor will compare concentrations in each baby's fingernails and toenails for those who provided both, and between mothers and their baby using linear regression.

The Contractor will develop a manuscript highlighting key findings with statistically significant results and submit it for publication in a peer-reviewed, open-access journal.

Task 3.6. Additional Modeling Considerations.

Careful attention will be given to specifying the correct functional form for the adjusted exposure-outcome curves by fitting alternative specifications using generalized additive models (e.g. splines and locally weighted scatterplot smoothing) as well as categorical specification (e.g. tertiles) to determine whether the modeling of exposure-outcome relationship should account for possible thresholds, plateaus, or other deviations from a linear specification. To determine which covariates to include, the Contractor will use a directed acyclic graph [116] that includes measured and unmeasured factors to ensure no backdoor path is unblocked, including paths opened by adjustment for a collider. Regression models will include covariates to adjust for confounding (such as: maternal age, education, BMI, parity, gestational diabetes or hypertension, child year of birth, and home ownership, region, and seasonality), precision variables like child age at assessment, and with interaction terms to test for effect modification of exposure-outcome associations by hypothesized modifiers, including background air pollution (non-wildfire $PM_{2.5}$, average in three months prior to wildfire event), participant and neighborhood factors, and child sex.[121-123] The Contractor will employ multiple time-point analysis adding each time-specific exposure metrics for cumulative wildfire-specific $PM_{2.5}$ for each trimester and the three-months preconception, into one model to concurrently account for distinct sensitive windows.[117,118] The Contractor will calculate Pearson's correlation coefficients for period-specific pollutant metrics to assess appropriateness of co-pollutant adjustment. Given this is a first analyses of non-independent exposures, the Contractor will not correct for multiple comparisons using False Discovery Rate, and will instead interpret findings in the context of an exploratory analyses of different exposure operationalizations.

For all regression analyses, the Contractor will conduct sensitivity analyses using extreme but plausible values of bias-correction formulas[124,125] to check robustness of the findings under different scenarios of *selection bias*, such as survival bias,[126] and from non-response (due to loss to follow-up or non-ignorable missingness due to missing covariate data.[127]

Power Considerations: In preliminary data analysis, Contractor determined that PM exposures were able to account for 10.5 percent of the residual variation in CBCL Scores when added to a model that included a robust set of covariates. Contractor specified that it would be important to estimate similar partial correlations with sufficient precision to ensure that the total width of the 95 percent CI was less than the true partial correlation, a key consideration for effect size estimates in concentration-response functions.[128] For a true partial correlation of 33 percent, a sample size of 115 fulfills this requirement and provides 95 percent power under two-sided testing (alpha=five percent) to reject the null hypothesis of no partial correlation. Thus, that will be the minimum sample size for regression analysis. The Contractor anticipates sample sizes will vary from 200 up to 500, a size that ensures a total CI width < half of 33 percent.

Limitations: The Contractor anticipates there will be outcomes that are less common where the numbers will be too small to allow evaluation of associations with exposure, and/or stratification by potential effect modifying variables. As a first study, this project will still inform the proportion with these outcomes after wildfire exposure. The Contractor will focus the public-facing materials on well-powered findings and note the limitations of the study and need to interpret with caution the less-robust results in translation materials.

Task 3 Deliverables*:*

Provide a summary on descriptive statistics for each primary maternal and child health outcome, their associations with wildfire $PM_{2.5}$ and metals, and concentration response functions for statistically significant associations. The summary will include primarily summary tables and figures plotting effect estimates/CI. Key findings that are well-powered will be included in manuscripts drafted and submitted for publication in peer-reviewed open-access journals.

Task 4. Assess Disparities in the Associations of Wildfire Smoke Exposure with Health Impacts

The Contractor will include analyses with consideration of self-reported race and ethnicity, home ownership, and neighborhood factors as proxies for systemic racism and structural discrimination that drive health inequities and social determinants of health, as well as lead to differences in exposures, outcome rates, and opportunities for self-protective action during wildfire smoke events. Robust effect modification findings will be added to manuscripts drafted as part of Task 3.

Task 4.1. Effect Modification.

The Contractor will conduct regression analysis for wildfire $PM_{2.5}$ exposure and maternal and child outcome associations (described in Task 3) while examining effect modification with stratification when power is sufficient (e.g., maternal perceived stress score, child CBCL total score) by factors that could influence vulnerability to the health effects associated with wildfire exposure, including: race, ethnicity, maternal education, home ownership, protective behaviors, neighborhood poverty, background air pollution, and other potentially modifying factors identified in Task 1, where feasible. Effect modification will be investigated by stratifying regression models when sample size allows sufficient cell sizes, and with addition of interaction product terms to the models between wildfire $PM_{2.5}$ and the vulnerability factor. The Contractor will explore similar analyses using the metal exposures when sample size is sufficient. Effect modification results will be interpreted in the context of the literature review findings.

Potential Limitations: The Contractor expect that the sample size and cell sizes when stratifying some categorical outcomes will be too small to produce robust results. The Contractor will focus on associations between wildfire $PM_{2.5}$ exposure and continuous outcomes, where the Contractor has maximal power.

Task 4 Deliverables:

Provide a summary depicting tables and plots of effect estimates (and CI) stratified by race, ethnicity, maternal education, home ownership, protective behaviors, neighborhood poverty, background air pollution, and other potentially modifying factors identified in Task 1, where feasible, as effect modifiers of the associations between wildfire $PM_{2.5}$ (and metals) in relation to maternal and child health outcomes.

Task 5. Develop Accessible Outreach Materials on Key Findings and Recommendations for Vulnerable Populations

Task 5.1. Materials Development

In coordination with CARB, the Contractor will develop materials highlighting key findings from the study and other relevant work on downstream maternal and child health outcomes associated with prenatal wildfire $PM_{2.5}$ exposure and provide recommendations for protecting pregnant people and their children from wildfire-associated adverse health effects. From the Contractor's preliminary data from the B-SAFE pilot and broader literature on developmental impacts of air pollution, the Contractor expects to find associations between prenatal wildfire $PM_{2.5}$ exposure and higher occurrence of other childhood neurodevelopmental and behavioral problems, which will be important to highlight as a reason to reduce prenatal smoke exposure as much as possible. If these and other associations with adverse health outcomes are found, this will inform toxic air contaminant programs. Further, the Contractor's work on identifying time during pregnancy that might be most critical to reduce wildfire exposures, as well as whether there are certain threshold concentrations at which expecting mothers should be most concerned, will inform messaging for when to take additional measures to reduce smoke exposure. Further, the Contractor will gain insight as to whether reducing smoke exposure by use of masks, air purifiers, and other behaviors, can help mitigate these concerns.

Materials generated will be culturally and linguistically appropriate, summarized in lay-friendly terms at an accessible reading level, and distributed broadly through multiple channels, including through media (with press-releases), online resources (in partnership with the UCD Environmental Health Sciences Core Center, EHSCC), and local public health and community groups. Contractor will solicit input from community partners of EHSCC and US EPA-funded project (EPA STAR 84048401, MPI: Schmidt, Nuño) in the generation and distribution of outreach materials.

Task 5 Deliverables:

Submit a lay summary and an infographic highlighting findings on long-term maternal and child health outcomes associated with wildfire smoke exposure in pregnancy, and who might be most vulnerable.

Task 6. Meetings, Reports, and Data

At the beginning of the project, the Contractor will hold a kick-off meeting with CARB. The Contractor will meet with CARB staff quarterly and submit quarterly progress reports using the CARB-designated template. Each progress report will accompany an invoice for the same period.

Nine months prior to the end of the study, the Contractor will submit the draft final report (DFR), which will detail the research background, objectives and specific aims, materials and methods, results, discussion, key findings and recommendations from the Community Input Meeting. The DFR shall be copy-edited before being sent to CARB for review and the Principal Investigator shall attest that the Final Report has been reviewed and approved. The DFR will be submitted in accordance with the Final Report format and CARB staff. CARB's comments will be sent to the Contractor and after receiving the reviewer's comments, the Contractor shall modify and resubmit the modified DFR to the CARB Project Manager. The modified DFR will be subject to formal review by the Research Screening Committee (RSC). Once accepted by the RSC, the Contractor will revise the modified DFR addressing the RSC comments and any remaining concerns from CARB staff and will submit the revised final report to CARB. If CARB has additional comments on the report, the Contractor will be notified so appropriate changes can be made; otherwise, CARB will accept the revised final report as the final.

The Contractor will submit the final report in an Americans with Disabilities (ADA) compliant format. A notation in the Final Report task should denote that the University will incorporate a one-page Public Outreach Document into the Final Report, that will be widely used to communicate, in clear and direct terms, the key research findings from the study to the public. The format for the Public Outreach Document is outlined in Exhibit A1, Section 2. CARB's standard for ADA compliance requires that the submitted document adhere to the Web Content Accessibility Guidelines (WCAG) 2.1 AA (https://www.w3.org/TR/WCAG21/) and Federal Section 508 (https://www.section508.gov/).

The Contractor will also include an Equity Implications Section into the Final Report, that will summarize how the research results inform disparate impacts of policies, regulations, or programs on priority communities. The Final Report shall be copy-edited before being sent to CARB for review and the Principal Investigator shall attest that the Final Report has been reviewed and approved.

The Principal Investigator (PI) will present project results at a Technical Seminar in plain language to the CARB staff and the public. The Technical Seminar slides shall be submitted in an ADA compliant format. CARB's standard for ADA compliance requires that the submitted document adhere to WCAG 2.1 AA (https://www.w3.org/TR/WCAG21/) and Federal Section 508 (https://www.section508.gov/).

CARB will publish publicly available detailed project reports outlining the findings, methodologies, and their impacts on racial equity, ensuring accessibility for diverse audiences. In addition, interactive tools, webinars, and presentations can be conducted to share the findings of this project while demonstrating equity-centered metrics and highlighting the outcomes of this research.

Contractor will prepare raw, de-identified data, modeled data, and analysis results (Tables, plots/figures, exposure maps) generated during the project in electronic format.

Task 6 Deliverables:

Deliver a DFR nine months prior to contract expiration and a Final report in the final project month.

Convene a Technical Seminar to present project results.

Submit a de-identified data file and an electronic copy of all data generated by this study.

Summary of Input Datasets and Generated Data Products

	Tasks	Description	Data		Source/Format
			Timeframe	Resolution	
Input	1	Existing Literature on wildfires and health	2000-now	N/A	PubMed/Electronic Databases of Peer-reviewed Literature
	2 - 4	Wildfire PM2.5 across fires in Northern California	2017-2021; Daily	4km (1 km in some areas)	Dr. Kleeman CTM
	2 - 4	Background (non-wildfire) PM2.5 in California	2017-2021; Daily	4km (1 km in some areas)	Dr. Kleeman CTM
	2	Maternal Toenails	Postnatal/WF	Individual mother	B-SAFE Repository
	2	Infant Fingernails	Postnatal/WF	Individual child	B-SAFE Repository
	2	Infant Toenails	Postnatal/WF	Individual child	B-SAFE Repository
	2	B-SAFE Participant Characteristics	Collected Post WF 2018-2022	Individual mother and child	Existing survey data (Qualtrics and REDCap); will be cleaned and merged
	2	B-SAFE Participant Smoke Exposure Mitigating Behaviors	Collected Post WF 2018-2022	Individual mother and household	Existing survey data (Qualtrics and REDCap); will be cleaned and merged
	2	Neighborhood-level characteristics of B-SAFE participant residential locations	At start of wildfires 2017-2021	Household geocoded addresses; Census Tract	Existing neighborhood measures publicly available for download (COI, ADI, CalEnviroScreen, RUCA,

					Census tract demographic & SES)
	3-4	Existing survey data from B-SAFE pilot participants on maternal PSS, and child CBCL, respiratory health	Collected in 2023 for 2017 & 2018 WF-exposed	Individual mother and child	REDCap; will be cleaned and prepared for analyses
Output	1	Literature Review on prenatal wildfires and maternal and child long-term health outcomes	2000-2025	N/A	Review Manuscript drafted and submitted for publication
	2	Weekly, trimester-specific, and pregnancy cumulative wildfire PM2.5 for B-SAFE participants	2017-2021	Sum of Daily Exposures	Summary tables and plots of wildfire PM2.5 across fires, and participant and neighborhood characteristics
	2	Maternal fingernail and infant fingernail and toenail metals	Months after 2018, 2020, and 2021 wildfires	Individual participant	XRF non-destructive measures of 23 elements (Table 4)
	3	Maternal Health Outcomes	4-9 years post wildfire	Individual mother	BDI, BAI, PSS, PROMIS Life Satisfaction & Global Health, ACQ, BMI, Medical History of CV Outcomes (Table 4)
	3	Child Health Outcomes	4-9 years post wildfire	Individual child	CBCL, PeSSKi, PROMIS Global Health, Asthma/Allergy Survey, BMI, Medical History of CV Outcomes, SRS, BRIEF, SNAP-IV
	3	Descriptive findings for each maternal and child health outcome	4-9 years post wildfire	Individual mother and child	Summary of response rate and descriptive statistics tables for each primary health outcome measure
	3	Associations estimated between wildfire PM2.5 and each maternal and child health outcome.	Exposure periods examined: Pregnancy, Trimesters, Weeks	Individual	Summary and drafted manuscript on findings for associations between wildfire PM2.5 and maternal and child health outcomes
	3	Associations estimated between nail metals and each maternal and child health outcome.	Exposure periods examined: Pregnancy, Trimesters, Weeks	Individual	Summary and drafted manuscript on findings for associations between metals and maternal and child health outcomes
	3	Concentration-response functions generated for significant associations	Exposure periods examined: Pregnancy, Trimesters, Weeks	Individual	Summary on findings of concentration-response functions
	4	Examine as effect modifiers of the associations from Task 3: race/ethnicity, maternal education, protective behaviors, neighborhood poverty, and background air pollution	Exposure periods examined: Pregnancy, Trimesters, Weeks	Individual	Summary of associations between wildfire PM2.5 (and metals) and maternal and child health outcomes stratified by effect modifiers
	5	Develop with CARB and share lay-summaries and other materials highlighting key findings from this study	N/A	N/A	Lay summary and infographic highlighting findings from this study on long-term maternal and child health outcomes associated with wildfire smoke

					exposure in pregnancy, and who might be most vulnerable
	6	Share findings to public and B-SAFE Participants	N/A	N/A	Lay-friendly seminar sharing key findings

DATA MANAGEMENT PLAN

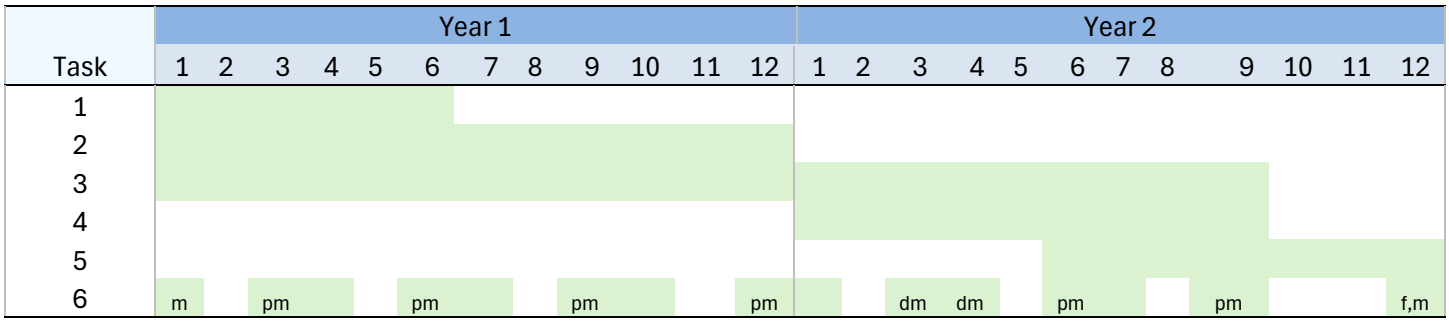
Data will be collected using RedCap forms that will be completed by B-SAFE families. Preferred contact information previously collected will be used to notify the participants of the opportunity to participate in the follow-up study, with a description of the study data to be collected and the purpose of the study. Remote informed consenting will be completed prior to any data surveys being released for completion. Participants will have the option in the consent form to approve or deny sharing of their de-identified data to other entities. Participants will also be informed of the option to withdraw from the study and/or to have their data withdrawn and destroyed at any time.

Data and Safety Monitoring

The risk of a loss of confidentiality is minimized by the training of project staff and the high level of security in the information systems. Deductive disclosure could occur because of the residential information the Contractor will collect and store. Other identifying information, such as name, social security numbers, etc., will not be accessible to anyone outside of the UCD study staff, and only to those study personnel who have a need for such information. Strong firewalls protect all of the servers, and double verification is required to access the data. Files with identifying information will be encrypted with strong encryption, and no analytic databases contain identifying information except in the circumstances when dates and addresses are used for deriving study variables (exposure to air pollution, etc.). Addresses will be converted to spatial coordinates before linkage to exposure files. In those cases, the data manager/programmer analyst will utilize the Personally Identifiable Information (PII) and then deletes those variables from the working file, before merging with the primary analytic files. The databases used for tracking the contacts with subjects will have restricted access. The code linking identification (ID) numbers to other personal identifying information will be kept in a locked file cabinet, and in electronic files that do not contain any other information and do not exist on computers containing any other information about the participants. The same is true for specimens, which will be bar-coded with scrambled study ID numbers. Data collected through RedCap is secure. The Contractor's Information Technology (IT) staff monitor continuously for threats to the security of the research files and hardware used for storage. The IT staff are highly trained in cyber security. All project staff complete Cyber security trainings at least annually.

PROJECT SCHEDULE

Task 1 Identify Gaps in Scientific Knowledge on Long-Term Health Effects of Wildfire Smoke Exposure
Task 2: Characterize Study Participants' Exposure to Wildfire Smoke Pollutants by Social Determinants of Health
Task 3: Estimate Health Impact Functions for Long-Term Health Outcomes of Prenatal Wildfire Smoke Pollutants
Task 4: Assess Disparities in the Associations of Wildfire Smoke Exposure with Health Impacts
Task 5: Develop Accessible Outreach Materials on Key Findings and Recommendations for Vulnerable Populations
Task 6: Meetings, Reports, and Data



p = Quarterly progress report
d = Deliver draft final report (to be submitted nine months prior to contract expiration)
f = Deliver final report
m = Meeting with CARB staff

Meetings

A. Initial meeting. Before work on the contract begins, the Principal Investigator and key personnel will meet with the CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, the project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.

B. Progress review meetings. The Principal Investigator and appropriate members of his or her staff will meet with CARB's Contract Project Manager at quarterly intervals or more often if needed to discuss the progress of the project. This meeting may be conducted by phone.

C. Technical Seminar. The Contractor will present the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento.

CONFIDENTIAL HEALTH DATA AND PERSONAL INFORMATION (For projects with Health Data and/or Personal Information)

CARB will not be provided access to and will not receive any confidential health data or other confidential personal information under this contract. Further, CARB will have no ownership of confidential health data or other confidential personal information used in connection with this contract. The entities conducting the research in this contract will follow all applicable rules and regulations regarding access to and the use of confidential health data and personal information, including the Health Insurance Portability and Accountability Act (HIPAA) and requirements related to the Institutional Review Board (IRB) process. CARB will not be a listed entity with authorized access to confidential information pursuant to the IRB process for this contract.

PROJECT MANAGEMENT PLAN

As the PI for this project, Dr. Rebecca Schmidt will be responsible for the scientific direction and overall conduct of the project. Dr. Schmidt will contribute to all phases of the project but will specifically play the lead on Tasks 2-6 in regard to child neurodevelopmental outcomes. Dr. Schmidt will also supervise study staff and coordinate across all investigators on this project to ensure all deliverables are met on time and will facilitate communications with CARB.

Dr. Anh Nguyen, Co-Investigator will provide her clinical expertise on allergic rhinoconjunctivitis and asthma, and lead the respiratory health outcomes aspects of the study, primarily for Task 3.

Dr. Daniel Tancredi, Co-Investigator, will contribute statistical expertise in overseeing the specification, fitting, validation and interpretation of the regression models and estimation of health impact functions examination of interactions for Tasks 2-4.

Dr. Deborah Bennett, Co-Investigator, will provide environmental exposure assessment expertise on wildfire $PM_{2.5}$ and metals exposure assessment for the project.

Dr. Meghan Miller, Co-Investigator, will oversee the clinical aspects for the project and advise on neurodevelopmental assessments.

Dr. Kathryn Conlon, Co-Investigator, will provide expertise as an environmental and climate epidemiologist and oversee analysis and interpretation of the maternal mental health outcomes as well as CV-related outcomes of mothers and children.

Dr. Michael Kleeman, Co-Investigator, will provide expertise and assist in using the exposure fields for wildfire $PM_{2.5}$ over California that he generated and advise on models for exposure analysis and interpretation.

Mr. Sean Raffuse, Co-Investigator, will provide input on modeled wildfire emissions for the 2017-2021 California wildfires and provide expertise on analysis and interpretation of the $PM_{2.5}$ estimates for the project.

Dr. Amanda Goodrich, Co-Investigator, will lead Task 1 literature review, and work with the study team under the supervision of Drs. Schmidt and Tancredi on statistical analysis for Tasks 2-4 with a focus on wildfire $PM_{2.5}$ exposures, and prepare reports (Task 6).

Dr. Aaron Specht, Co-Investigator, will oversee the measurement of metals in nails for the project Task 2.7 and contribute his expertise to interpretation of findings.

Other Personnel

Ms. McKenzie Oliver, project manager, will be responsible for overseeing participant recruitment and retention, along with data collection activities, communications with the participants, administration of informed consent, subject tracking, Institutional Review Board (IRB) submissions, and adherence to the protocols. Ms. Oliver will train and supervise the Clinic Research Coordinator (CRC) and ensure compliance with the study protocol, Health Insurance Portability and Accountability Act (HIPAA) and IRB requirements.

PostDoctoral Researcher, TBN, will lead statistical analysis and summarize results for metals exposures in Tasks 2-4.

Ms. Elizabeth Angel, Data Manager will be responsible for newly collected data, creating RedCap data entry forms, merging files, cleaning the data through univariate checks of completeness, credibility/plausibility and

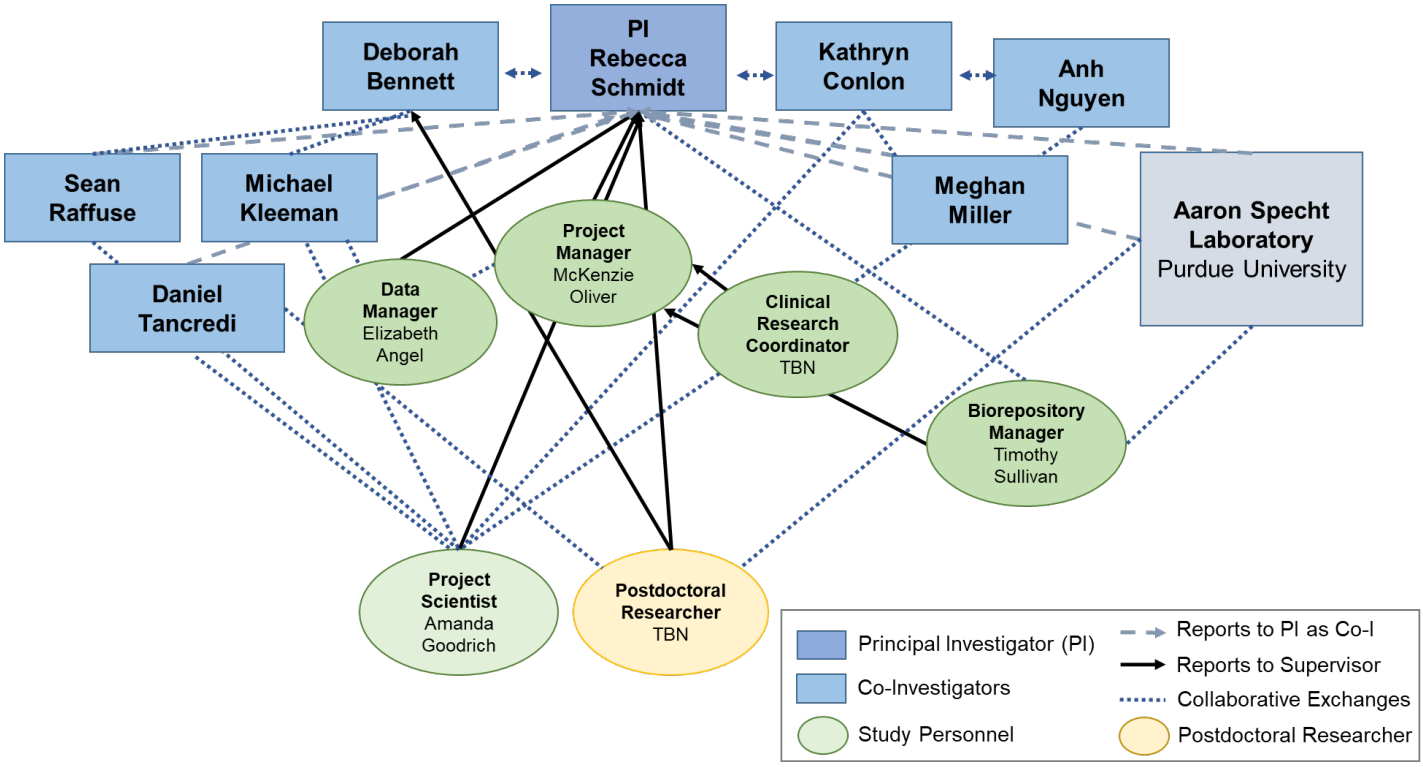
consistency of values, and the construction and updating of variables for the aims to share with investigators. These include the outcomes of the developmental assessments, the results of the laboratory exposure measurements, covariates as potential confounders and meta-data related to the specimens. Ms. Angel will be responsible for managing the tracking system database, uploading data for specimens, and will generate specimen lists for shipments to laboratories.

Ms. Angel will provide data completeness reports and sociodemographic summaries to the research team at regular meetings. Ms. Angel will also create scoring algorithms for neurodevelopmental assessments. Ms. Angel will prepare files for sharing both internally and externally, and associated documentation, and will take primary responsibility in submitting de-identified data to CARB.

Mr. Timothy Sullivan, Biorepository Manager, will be responsible for pulling and shipping nail samples collected for the B-SAFE study to the collaborating laboratory of Dr. Aaron Specht at Purdue University for receiving the nail samples when returned after non-destructive analysis, and for maintaining the Freezerworks tracking database.

Under the supervision of the Project Manager, the Clinical Research Coordinator will assist with participant recruitment and retention, administer informed consent, set up study records, assist the study manager with regulatory compliance, including abidance to HIPAA, and she will also assist in ensuring incentives are delivered.

Organizational Chart



DESCRIPTION OF EXISTING FACILITIES

The UCD provides an exceptionally rich environment for multidisciplinary investigations. UCD is geographically the largest of the ten campuses of the UC system (approximately 5,300 acres), second largest in overall budget, and third largest in student enrollment. UCD is one of only 63 universities admitted to the prestigious Association of American Universities.

UCD is a dynamically growing major research institution. With $846.7 million in extramural research awards in fiscal year 2017-18, UCD is one of the nation's leading research universities. UCD offers 99 undergraduate majors and 90 graduate programs. Current student enrollment is approximately 35,000, of which more than 5,000 are graduate students and 3,000 are students in one of the professional schools (including Medicine, Nursing, and Veterinary Medicine).

UCD is recognized for its leadership in the biological sciences. In the past several years, UCD has established important curricula and infrastructure relevant to interdisciplinary translational research. This includes a National Institutes of Health -funded Clinical and Translational Science Center (CTSC), its three associated training programs, and numerous other training programs that serve researchers from the pre-doctoral through the junior faculty level.

The University of California system has been designated by the Internal Revenue Service as a 501©(3) non-profit organization.

Computer Facilities

The Division of Information and Educational Technology (IET) provides computing, communications and media resources and services in support of research and instruction. IET supports 120,000 computing accounts, 3,600 wireless access points on a secure and encrypted wireless network that covers most major campus areas, and the UCD Data Center. All UCD faculty have access to the campus high-speed data network, which includes a dedicated research network supporting ten gigabits per seconds (gbps)

connections to research systems on campus and directly attached to the campus border allowing the transfer of large data sets to regional, national and international partners; two border routers supporting multiple 10Gbps links to internal and external networks – one on the Davis campus and one at the UCD Medical Center – that provide high-speed connections to Corporation for Education Network Initiatives in California (CENIC), Internet2, the National Lambda Rail, ESNet and other regional and national research networks; high-speed optical network that provides multiple ten gbps links between the main Davis campus and the UCD Medical Center in Sacramento; four, ten gbps connections to CENIC; and extension of the campus fiber optic backbone into research spaces allowing ten gbps connections to the campus research and production network. Campus network security services include virtual private network, firewall and host level security management services, and intrusion detection, prevention and security alert services. In addition, authentication passphrases meet National Institute of Standards and Technology (NIST) 800-63-1 specifications and allow access to information resources held by federal government agencies and other academic institutions.

Library

The General Library at UCD is one of the premier research libraries in North America. In addition to Peter J. Shields Library, there are four other General Library Facilities: the Physical Sciences Library, the Loren D. Carlson Health Sciences Library, the Agricultural and Resource Economics Library, and the Medical Center Library in Sacramento. The combined collects of the various General Library facilities total more than 2.6 million volumes, and more than 41,000 periodical and journal titles are received annually. The MELVYL @ System, an online catalog of books and journals, can be used to access the collections of UCD and the other eight UC campuses. The libraries also offer access to databases and numerous other electronic resources, both on-site and via the UCD Network.

Intellectual Resources

The environment for the study at UCD has multiple unique aspects that will contribute to the successful completion of the project. The overall atmosphere at UCD promotes collaboration across diverse disciplines as evidenced by the number of funded joint program projects.

The UCD MIND Institute (Medical Investigation of Neurodevelopmental Disorders) is located at the UCD Medical Center, Sacramento campus and was opened in 2003. The facility houses clinics, academic offices, laboratories, and an auditorium and serves as the focal point for collaborative and translational research in ASD. Drs. Schmidt, Miller, and Hertz-Picciotto are active members of the UCD MIND Institute and attend seminars and discussions relevant to neurodevelopmental disorders on a regular basis. The doctors are also members of the MIND Institute's Intellectual and Developmental Disabilities Research Center (IDDRC).

The UCD EHSC Center is a National Institute of Environmental Health Sciences (NIEHS)-funded program project headed by epidemiologist Dr. Irva Hertz Picciotto that is focused providing core support to environmental health researchers at UCD. Drs. Schmidt, Conlon, and Bennett are active members of the EHSC Center.

The infrastructure at UCD is also well suited to support the successful conduct of the research in terms of university core facilities and administrative support available to Dr. Schmidt's and Chambers' laboratories.

UCD has access to shared departmental core facilities and equipment as well as the Analytical Cores associated with the MIND Institute IDDRC and the EHSC Center. These cores offer use of biostatisticians and additional equipment. Other research at UCD that enriches the environment of the study includes nearby investigators focused on nutrition, neuroscience, genes mediating brain development, and neurodevelopmental disorders including autism, and a strong diversity, equity, and inclusion program.

UCD School of Medicine and UCD Medical Center

The UCD Health System, comprised of the UCD School of Medicine and UCD Medical Center, is nationally recognized and excels at translating scientific discoveries and new technologies into improved patient care and community-wide health. Faculty in the School of Medicine specialize in a wide range of basic and applied research including those related to cancer biology, vascular biology, genetic diseases and functional genomics, health services, infectious diseases, neuroscience, nutrition, telemedicine, and vision science. More than 500 research studies are currently under way in the School of Medicine facilities in Davis and at the Medical Center in Sacramento, funded by federal, state, foundation, and pharmaceutical/ biotechnology sources. In addition, School of Medicine faculty are engaged in innovative collaborations within the UCD community — with the California Regional Primate Research Center, School of Veterinary Medicine, Division of Biological Sciences, College of Agriculture and Environmental Sciences, and the College of Engineering.

A number of major research programs at UCD involve collaborating scientists from multiple parts of the campus. These include the Cancer Center, the Center for Neuroscience, the MIND Institute, the Center for Comparative Medicine, the Center for Tissue Regeneration and Repair, the Center for Health Services Research in Primary Care, the Telehealth Center, and the California Regional Primate Center. Other major programs exist in human genetics, genomics, pharmacogenomics and membrane biology.
The UCD School of Medicine also collaborates with several affiliated research institutions, such as Shriners Hospital for Children, Veterans Affairs Northern California Health Care System, United States Department of Agriculture's Western Human Nutrition Research Center, and Lawrence Livermore National Laboratory. In addition, School of Medicine faculty are engaged in innovative collaborations with the California Regional Primate Research Center, School of Veterinary Medicine, Division of Biological Sciences, College of Agricultural and Environmental Sciences, and College of Engineering.

Department of Public Health Sciences

The Department of Public Health Sciences (PHS) is a clinical and basic research department in the UCD School of Medicine. The PHS mission is to improve the health of people through population-based approaches by carrying out educational programs, research, public service and policy development. The effort focuses on health promotion and disease prevention, occupational and environmental health, health care delivery, gerontology, ethical issues, reproductive, rural, minority and international health.

PHS has approximately 8,000 square feet of office space on the UCD campus, an additional 6,400 square feet off campus in South Davis, and a 1,000 square foot office suite at the UCD Medical Center in Sacramento. In addition, faculty and research staff members have designated space at the UCD MIND Institute and (CTSC in Sacramento, and the Center for Health and the Environment in South Davis. Drs. Schmidt, Conlon and Hertz-Picciotto are in both the Division of Epidemiology and the Division of Environmental and Occupational Health. Dr. Nuno is housed in the Division of Biostatistics and Dr. Bennett is in the Division of Environmental and Occupational Health. All have office space, IT and administrative support in the department's main campus offices.

Division of Epidemiology

The Division of Epidemiology conducts research in areas ranging from age-related diseases, women's health, cancer, children's health and development, and occupational health risks, to behavioral sciences and economic impact of occupational illness and injury. The Division develops and uses research methods to understand patterns and etiology of disease, developmental disorders, and injury and disability in populations. The Division currently has research projects assessing vascular contributions to dementia risk, epidemiology of age-related dementia, health disparities in dementia, lifestyle and environmental factors related to endocrine changes and symptoms of menopause in a multi-ethnic cohort, environmental exposures affecting childhood neurodevelopment, and traumatic injuries incurred during military service, among many others.

Division of Biostatistics

The Division of Biostatistics in the Department of Public Health Sciences supports basic and clinical research in the School of Medicine and conducts research on biostatistical methodology. The division occupies 2,500 square feet on the Davis campus, adjacent to the Genome Center and other basic science buildings, and includes space for faculty, staff, graduate students, and servers. Biostatistics also has 220 square feet of office space and a shared meeting room in the Clinical and Translational Science Center facility at the UC Davis Medical Center campus in Sacramento, facilitating collaboration with researchers there. Major equipment for the Division includes: 1) Silicon Mechanics HPC: 4 node computing cluster, with 96GB of memory for each node. The computing cluster connects to a 12 terabyte (TB) disk array. An 8 TB disk array provides data protection. 2) Sun Microsystems T5400 Enterprise, 4 x Sun Scalable Processor Architecture 16 core processors, 3) Silicon Mechanics Rackform R422: 4 x Intel Xeon E7-4830v3 central processing units, 2.10 gigahertz, 22 nanometer (nm), 1 TB random-access memory (RAM); Storform D55J.v3 with 24 x Seagate 8 TB Enterprise Capacity 3.5 hard disk drives V.5 drive set. In addition, the Division of Biostatistics supports NQuery and Epi-stat software for sample size and power calculations.

Division of Environmental and Occupational Health

The Division's unique strengths lie in environmental and occupational health research including exposure assessment, environmental and occupational epidemiology, and translational efforts. Research addresses a wide range of disease and disabilities, including respiratory, neurologic, reproductive, and developmental outcomes, as well as cancer and CV health. The Division's proximity to the San Joaquin Valley provides us opportunities to work with agricultural communities, both occupational and community exposures and risks. The Division has a close relationship with the MIND institute and a strong program on environmental contributions to autism. There are several Centers associated with the Division, specifically the Environmental Health Sciences Center, the Center for Children's Environmental Health, the Center for Occupational and Environmental Health, the TENDR Program, the Western Center for Agricultural Health and Safety, and the Medical Surveillance Program. Research addresses environmental exposure to indoor air quality, air pollution, pesticides, heat exposure, environmental tobacco smoke, endocrine disruptors, heavy metals and other toxicants in the environment and workplace. The Division works closely with the numerous strong toxicology programs, a strength of UCD. Additional focuses include community engagement, health disparities, environmental justice, health effects of environmental disasters, and impacts of climate change.

Division of Health Informatics

The Division of Health Informatics provides consultation and conducts research in clinical informatics data sharing, computable phenotyping, knowledge management and terminology standardization, participant-centric data policy and bioethics. Current research projects include the development of mobile platforms for health informatics.

Division of Health Policy and Management

The Division of Health Policy and Management conducts research and teaching in health policy and management, and health economics. Current projects and collaborations include a program to measure cardiovascular disease (CVD) in California and to provide training to State managers and staff on health economics related to CVD, quality of end-of-life care, and quality and outcomes of care in mental health services.

PHS Computing Infrastructure, Data Management and Security

Computing Infrastructure

The Department of PHS, in the School of Medicine, manages a unique computing infrastructure, providing robust and secure services for research, administrative, and teaching purposes.

The department supports several physical locations, all interconnected via high-speed networking connections, and all protected by a perimeter security firewall and intrusion detection and prevention system. The computing data facility, located at the UC Davis Data Center, houses 50 plus PHS managed server hosts in a mixed Windows Server, FreeBSD, Solaris, and Linux environments, specializing in HIPAA compliant systems, cluster systems for data analysis, virtualization services, and infrastructure services such as file serving, remote access, print serving, and research collaboration services. All server systems are connected via 1,000 megabytes (Mb).

Client desktop systems are situated in the several physical locations, scattered across UCD Campus and in Sacramento, all interconnected using Microsoft Active Directory technologies. All desktop systems are connected via 100 Mb or 1,000 Mb connections. As of 2017, there are approximately 250 desktop systems connected to the PHS network. All desktop systems comply with secure computing policies, requiring users to have least privilege, proper protection from viruses, spyware/malware, and local software firewall technologies. The PHS network currently supports approximately 20 network printers. Mobile computing and secure remote access are also supported, also secure iPhone mobile computing and secure Android and Windows Mobile computing is supported.

All computing data stored on file servers, computational hosts, and infrastructure devices is protected and backed up regularly to the external computing facility located at Center for Health and the Environment, part of the UCD Campus. The external computing facility also can perform as a backup computing infrastructure site in case of a failure at our main computing site at the Campus Data Center.

Data Management and Security

The UCD Department of PHS offers a vast array of sophisticated data management services. The PHS Systems Development Team works closely with investigators, gathering requirements and providing customized systems and solutions that best fit the protocol and needs of studies. All management solutions are built on existing, stable and secure systems architecture, permeating a common, easily maintainable, extremely extensible and highly secure quality throughout all services offered. The team has created research study subject tracking systems with extensive query capabilities, developed computer-assisted surveys both for interviewer administered and self-administered forms, and facilitated adaptation of the Freezerworks application to the biorepository inventory. All data systems developed in house are based on Open Standards.

Security and Backups

Security at all levels is taken very seriously. Application servers, which house and run the main systems reside on a secure network, protected by network intrusion systems, multiple firewalls, and access logging and auditing. Servers are scanned daily to reveal potential configuration issues. All updates to servers, their daily scans, Internet traffic to and from are all logged and examined by IT staff. Potential intrusions are placed in a blacklist.

Backups occur daily, differential backups occur during the week and full backups happen once a week. Backups are stored on a secure medium and transferred off-site to a secondary secure location. Power backup and redundancy help ensure maximum uptimes for all systems. Data redundancy using state of the art hard drive and Redundant Array of Independent Disks technologies allow for maximum uptime of data access, and easy repair by administrators in the event of a disk failure. A disaster recovery plan is in place, which is reviewed and updated every six months.

All access to the main My Structured Query Language data repositories is limited to only a validated Web service or local system. All communication with the data repositories are logged and audited.

PHS Biorepository

The Department of PHS maintains an extensive repository of over 53,000 biological samples from the CHARGE, MARBLES, B-SAFE, and other studies, including urine, plasma, whole blood, placental tissue, cord blood, newborn blood spots, saliva, deciduous teeth, and hair. The biorepository consists of 34 freezers, including twenty-two -80 freezers, twelve -20 freezers, a centrifuge and biological safety cabinet for sample processing. Several locked cabinets are used to hair samples, teeth and other stable biospecimen or environmental samples. The repository is staffed by one full time equivalent (FTE) biorepository manager, and two FTE lab assistants. Freezerworks software is used for specimen tracking and management. Dr. Schmidt oversees this biorepository.

Scmidt Laboratory

Dr. Schmidt's office is based in the Department of PHS UCD. The Department of PHS has approximately 4,000 square feet of office space on the UCD campus and an additional 4,000 square feet off campus.

The Department's Research Administration Unit supports all research projects managed in the Department, including proposal preparation, purchasing, financial management, and research compliance. The Department of PHS also manages a unique computing infrastructure, providing robust and secure services for research, administrative, and teaching purposes. The computing data facility, located at the Center for Health and the Environment, is managed by the PHS IT Unit, and houses 45 servers in a mixed Windows Server, FreeBSD, Solaris, and Linux environment, specializing in HIPAA and Federal Information Security Management Act (FISMA) compliant systems, cluster systems for data analysis, infrastructure services, such as file serving, remote access, print serving and research collaboration services, and Microsoft Exchange email services. Approximately 150 desktop systems and 20 network printers are connected to the PHS network. Dr. Schmidt has access to space for students and Post-Docs as needed. Dr. Schmidt's Davis campus office is in close proximity to the PHS Biorepository and staff that she oversees, as well as the offices/laboratories of other team investigators. Dr. Schmidt also has space for her staff and research studies at the UCD MIND Institute on the Medical Campus in Sacramento.

UCD MIND Institute

The study will utilize some of the resources of the MIND Institute on the UCD Medical Center campus in Sacramento, California. In particular, the MIND Institute offers resources for assessment and all other aspects of research in autism and other neurodevelopmental outcomes. The MIND Institute is a collaborative,

interdisciplinary biomedical research and clinical services center founded at UC Davis in 1998 by parents of individuals with ASD. The MIND Institute is dedicated to understanding the causes and consequences of neurodevelopmental disorders, and to the development of prevention and intervention programs for these conditions. The MIND Institute has over 200 on-site professionals and staff who are primarily engaged in clinical and basic science research and education, and has a dedicated facility that consists of both research and outpatient clinic space for children and young adults with neurodevelopmental disorders. The Institute also includes a highly skilled and dedicated infrastructure of personnel who provide research, clinical, and administrative support.

The MIND Institute is housed in a two-building complex (110,000 square feet on 11 acres) on the UCD Medical Center Campus in Sacramento, CA. The facility includes research laboratories for human neuroscience and basic science studies, pediatric clinics, academic offices, a public resource center, various meeting rooms, and an auditorium. The MIND Institute was designed to incorporate two primary concepts that were advocated for by families of children with neurodevelopmental disorders. First, the MIND Institute is designed to serve as a haven for families of children with neurodevelopmental disorders, with an internal arrangement and décor that is welcoming, comfortable, and calming for families and children. Second, the complex was designed to foster collaboration among clinicians and scientists, intentionally disregarding the standard departmental divisions, and, instead, intermingling the offices of faculty and staff from different disciplines.

The main building (70,000 square feet) houses both the Massie Family Diagnostic Clinic and the Research Clinic, as well as academic offices. Each clinic has eight specially-designed exam rooms, six of which are equipped with one-way observation windows and state-of-the-art video imaging systems to record patient and research participant assessments for research and/or clinical purposes. The waiting areas have televisions, play equipment, and aquariums to keep children relaxed and occupied. A secure outdoor playground is also available for play and for observation.

It is important to point out that the MIND Institute has established a number of Core Resources that facilitate clinical research. These include a centralized Subject Recruitment and Assessment Core, software for subject tracking and data storage, an Audiovisual Core with a full-time video and graphics consultant, a Statistical Core with a 60 percent time consulting faculty member from the Division of Biostatistics and a Core Phlebotomy Laboratory with two full time phlebotomists. The Institute maintains a subject database that includes demographic and subject information on several thousand potential research subjects. The MIND Institute also offers training programs for international autism researchers that will be utilized in this project.

MIND INSTITUTE WET LABORATORY- A Research Laboratory building is linked to this Clinic/Academic building by a covered walkway. This two-story, 27,000 square foot building contains bench laboratories and core facility rooms; offices for research faculty and students; and meeting and break rooms. This building also contains a fully equipped facility for gene expression microarray analyses and a neuropathology laboratory, which includes a brain and tissue repository. Dr. Schmidt has space in the Research Laboratory at the MIND that will be used to process biospecimens prior to transfer for long-term storage in the PHS Biorepository.

Biorepository

The repository of biological samples consists of three -80 degree Celsius (C) freezers, five -20 degree C freezers, two 4 degree C and two liquid nitrogen tanks. Three centrifuges and biological safety cabinet for sample processing. The repository is staffed by one FTE biorepository manager and by staff research associated. Freezerworks software is used for specimen tracking and management. This biorepository offers freezers that will serve as back-ups if needed.

Data Management

The MIND offers a vast array of sophisticated data management services. The MIND Systems Development Team works closely with investigators, gathering requirements and providing customized systems and solutions that best fit the protocol and needs of studies. All management solutions are built on existing, stable and secure systems architecture, permeating a common, easily maintainable, extremely extensible and highly secure quality throughout all services offered. All data systems developed in house are based on Open Standards.

Security and Backups

Security at all levels is taken very seriously. Application servers, which house and run the main systems reside on a secure network, protected by network intrusion systems, multiple firewalls, and access logging and auditing. Servers are scanned daily to reveal potential configuration issues. All updates to servers, their daily scans, Internet traffic to and from are all logged and examined by IT staff. Potential intrusions are placed in a blacklist. Backups occur daily, differential backups occur during the week and full backups happen once a week. Backups are stored on a secure medium and transferred off-site to a secondary secure location.

International Training Program in Neurodevelopmental Disabilities (ITPND)

The ITPND educates health-care professionals from around the world in the treatment and management of individuals with neurodevelopmental conditions such as autism, fragile X syndrome and related conditions, 22q11.2 deletion syndrome, Down syndrome and the RASopathies.

https://health.ucdavis.edu/mindinstitute/education/itpnd/index.html

Leadership Education in Neurodevelopmental and Related Disabilities (LEND)

The LEND program is a graduate and post-graduate level, interdisciplinary leadership and service training program federally funded through Health Resources and Services Administration's Maternal Child Health Bureau. The purpose of the LEND program is to provide interdisciplinary and leadership training to clinicians, families, self-advocates, and community leaders involved with developmental disabilities. By training future visionary leaders, the LEND will improve the health, developmental, and behavioral outcomes of infants, children, and youth with ASD or other developmental disorders (/DD) and assist their families within highly diverse and dispersed, low income and low resource regions of northern California.

The LEND will develop visionary leaders in communities who are: experts in their disciplines and in interdisciplinary knowledge of ASD/DD; designers of new models of care provision; committed to high quality, evidence-based services; communicate well with families and providers from a wide range of cultural and

economic backgrounds; committed to advocacy and leadership in their communities; providers of culturally competent, family-centered care. The LEND program provides trainees with multiple learning experiences, including empirically supported clinical care and leadership within communities to adopt evidence-based practices for improving services. Dr. Miller is part of the LEND team at the MIND Institute.

https://health.ucdavis.edu/mindinstitute/education/lend/lend-index.html

Intellectual and Developmental Disabilities Research Center (IDDRC)

The MIND IDDRC provides resources to its member scientists that are designed to encourage and accelerate the pace of research that moves the field closer to treatments, strategies for prevention, and eventual cures. The MIND Institute IDDRC is funded by the National Institute of Child Health and Human Development, a component of the National Institutes of Health (grant number: 1 U54 HD079125, PI: Abbeduto). The MIND Institute IDDRC is one of 15 such centers in the United States. Established in 1963 by Congress as "centers of excellence" for research in intellectual and DD, the Eunice Kennedy Shriver Intellectual and Developmental Disabilities Research Centers represent the nation's first and foremost sustained effort to prevent and treat disabilities through biomedical and behavioral research. The MIND Institute IDDRC is the newest member of this prestigious network, having earned the distinction in 2013.

The MIND Institute IDDRC focuses its scientific efforts on three themes: Biobehavioral Characterization of Intellectual and Developmental Disabilities, Environmental Contributions to Intellectual and Developmental Disabilities, and Treatments for Intellectual and Developmental Disabilities. The MIND Institute IDDRC also provides support for those studies through six cores: Administrative Core, Clinical Translational Core, Biological Analysis Core, Neurobehavioral Analysis Core, Rodent Behavior Core, and Biostatistics, Bioinformatics, and Research Design Core.

The IDDRC is a center within the UCD MIND Institute. The IDDRC is fully integrated into and benefits from the outstanding faculty, staff, trainees, and resources of the MIND Institute and its internationally recognized research, clinical, and educational programs. The MIND Institute IDDRC also draws on and contributes to the resources and expertise of other centers and units at UCD, including the Clinical and Translational Science Center, the Center for Mind and Brain, the Institute for Regenerative Cures, and the Center for Neuroscience.

The Institute has a diverse set of on-going, educational programs, including an National Institutes for Health-sponsored, PostDoctoral training program - Interdisciplinary Training for Autism Researchers; a weekly seminar series for presentation and discussion of research issues and findings; and a monthly Distinguished Lecturer Series. The PostDoctoral training program is designed to prepare Ph.D. and M.D. fellows for careers in autism research as truly interdisciplinary autism research scientists. This two-year training program merges the behavioral and biological sciences in the context of an interdisciplinary, autism-focused research program, involves thirty faculty members from diverse fields of study, and is organized around a set of core competencies that addresses multiple areas of autism-related knowledge ranging from human genetics, to neuroanatomy, to clinical diagnosis. The MIND Institute's Weekly Research Series provides a forum for the presentation and discussion of research issues and findings by Institute faculty, PostDoctoral Fellows and Graduate Students, as well as visiting scientists, across a similar range of disciplines. Each academic year since 2003, the MIND Institute has also sponsored monthly presentations and extended visits by highly respected scientists from around the world through its Distinguished Lecturer Series. In addition to meeting with faculty colleagues and student trainees, participants in this series offer two, free public lectures – a more technical presentation and a community-oriented presentation especially designed for the general public.

Research Clinic

Support for research studies conducted at the MIND Institute is provided through several mechanisms, including access to clinic space for subject visits and staff assistance in the areas of recruitment, scheduling, and behavioral and medical assessment. These components of the Research Clinic foster the goals of the MIND Institute: to balance an enjoyable research experience for the families participating in studies, with the collection of quality data for the research teams. The MIND Institute Research Clinic encompasses 13,249 square feet and contains examination and assessment rooms, a phlebotomy laboratory for the collection and processing of human specimens, conveniently located office space for research personnel, and a central reception and patient waiting area, where research subjects are registered and met by study personnel. The waiting area provides semi-private areas for families, as well as many developmentally appropriate toys and other activities for the younger subject populations. Family rooms are offered as an alternative for families that have longer visits as part of their research protocols or require more privacy as part of their diagnosis. The capacity of the Research Clinic allows the scheduling of up to100 one-hour visits per week.

The phlebotomy and specimen processing area of the Research Clinic includes a child-friendly waiting room adjoining the phlebotomy room where family members can comfortably wait during the phlebotomy procedures. The phlebotomy room is furnished with a medical examination table for younger patients, an upright phlebotomy chair for older family members and a TV/VCR for distraction purposes during the procedures. The laboratory contains equipment for “on the spot” processing of samples; alternatively, samples may be taken directly to the adjoining MIND Institute Biological Research Laboratory Building as appropriate.

The MIND Institute IDDRC includes an administrative core and five scientific cores that provide technical expertise, resources, and support services that can be accessed by more than 70 funded projects. Depending on the service used and the intensity of need, IDDRC projects receive the service for free or at a greatly reduced rate. Projects are reviewed for relevance to the mission of the IDDRC with final approval for core access granted by the Intellectual and Developmental Disabilities (IDD) Branch of the National Institute of Child Health and Development (NICHD). For this project, three of the five cores are potential resources. http://www.ucdmc.ucdavis.edu/mindinstitute/centers/iddrc/cores.html

The Clinical Translational Core (CTC) facilitates recruitment of human participants into IDDRC projects through searchable electronic contact registries and targeted community outreach activities, offers specialized clinical assessment expertise to confirm participant diagnoses, and ensures that IDDRC projects include diverse samples. The CTC is directed by Sally Ozonoff, PhD, with Robin Hansen, MD, and Julie Schweitzer, PhD, serving as Co-Directors. This core will be available to facilitate recruitment if there are recruitment challenges.

http://www.ucdmc.ucdavis.edu/mindinstitute/centers/iddrc/cores/clinical_translation.html

Neurobehavioral Analysis Core (NBAC)

The NBAC provides expertise, technology, and resources to support the design and implementation of measures of complex human behavior, allowing IDDRC investigators to enhance their endophenotypic characterizations of individuals with IDD. Endophenotypic characterization requires quantitative assays of functioning at multiple levels of the nervous system and their cognitive and behavioral endpoints. Moreover, these measures must be appropriate for representative samples of individuals with IDD and are designed, executed, and analyzed with the most precision and fidelity possible. Measures must also be suitable for measuring intraindividual change as the result of treatment. The NBAC achieves these goals by making techniques and assays developed or refined in the labs of individual IDDRC investigators more widely available to the IDDRC community, adapting and extending them as required. The NBAC is directed by Tony J. Simon, PhD, with Steven Luck, PhD, and David Hessl, PhD, serving as Co-Directors.

http://www.ucdmc.ucdavis.edu/mindinstitute/centers/iddrc/cores/neurobehavioral_analysis.html

Biostatistics, Bioinformatics, and Research Design Core (BBRDC)

The BBRDC addresses the breadth and depth of IDDRC projects, which collectively require specialized state-of-the-art analytic approaches to longitudinal and high-dimensional data, and the integrative treatment of data derived from both phenotype and genotype.

The BBRDC provides comprehensive statistical support to assist the IDDRC investigators and their projects at all stages of the research process. BBRDC faculty and staff have extensive experience on a broad range of IDD-related clinical and laboratory studies, assisting with study design, protocol and proposal development, data analysis, and publication of results. The BBRDC also assists with the planning and development of research-related data management systems. The BBRDC is directed by Irva Hertz-Picciotto, PhD, MPH, and co-directed by Kyoungmi Kim, PhD.

http://www.ucdmc.ucdavis.edu/mindinstitute/centers/iddrc/cores/bbrd.html

BBRDC services are matched to the special needs of each of the IDDRC clinical, laboratory and population-based studies and cover a full range of services from routine analysis support to innovative methods developed specifically to enhance the research efforts of the IDDRC interdisciplinary team. The core also collaborates with other IDDRC cores, notably on informatics infrastructure and database development.

BBRDC services fall into the following area: (1) study design (providing advice on all aspects of statistical design and analysis planning, supporting protocol development and grant applications with design recommendations and power/sample size calculations); (2) data collection and data management (assisting in the design of the data abstraction, including identifying variables to collect and defining variable fields, advising on database structure and data safety monitoring, monitoring clinical trials for adverse events and data quality); (3) data analysis and reporting (evaluating and conducting statistical analysis for clinical and laboratory studies, interpreting results of statistical analyses in relation to the research objective or hypothesis, collaborating on abstract and manuscript preparation); (4) development of new or adaptation and refinement of statistical methods and software to meet the idiosyncratic needs of IDDRC projects; and (5) education and training, especially of IDDRC trainees at all levels through IDDRC-wide workshops.

REFERENCES

1. Liu JC, Mickley LJ, Sulprizio MP, et al. Particulate Air Pollution from Wildfires in the Western US under Climate Change. *Clim Change.* 2016;138(3):655-666.
2. Wegesser TC, Pinkerton KE, Last JA. California wildfires of 2008: coarse and fine particulate matter toxicity. *Environ Health Perspect.* 2009;117(6):893-897.
3. Basilio E, Chen R, Fernandez AC, Padula AM, Robinson JF, Gaw SL. Wildfire Smoke Exposure during Pregnancy: A Review of Potential Mechanisms of Placental Toxicity, Impact on Obstetric Outcomes, and Strategies to Reduce Exposure. *Int J Environ Res Public Health.* 2022;19(21).
4. California Air Resources Board. New Analysis Shows Spikes of Metal Contaminants, Including Lead, in 2018 Camp Fire Wildfire Smoke|California Air Resources Board. 2022.
5. Wittig V, Williams SM, Duteaux SB. Public health impacts of residential wildfires: Analysis of ash and Debris from the 2007 Southern California Fires. *Epidemiology.* 2008;19(6):S207.
6. Dickinson GN, Miller DD, Bajracharya A, et al. Health Risk Implications of Volatile Organic Compounds in Wildfire Smoke During the 2019 FIREX-AQ Campaign and Beyond. *Geohealth.* 2022;6(8):e2021GH000546.
7. Carreras-Sospedra M, Zhu S, MacKinnon M, et al. Air quality and health impacts of the 2020 wildfires in California. *Fire Ecology.* 2024;20(1):6.
8. Black C, Tesfaigzi Y, Bassein JA, Miller LA. Wildfire smoke exposure and human health: Significant gaps in research for a growing public health issue. *Environ Toxicol Pharmacol.* 2017;55:186-195.
9. Xing YF, Xu YH, Shi MH, Lian YX. The impact of PM2.5 on the human respiratory system. *J Thorac Dis.* 2016;8(1):E69-74.
10. Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliott CT. Critical Review of Health Impacts of Wildfire Smoke Exposure. *Environ Health Perspect.* 2016;124(9):1334-1343.
11. Delfino RJ, Brummel S, Wu J, et al. The relationship of respiratory and cardiovascular hospital admissions to the southern California wildfires of 2003. *Occup Environ Med.* 2009;66(3):189-197.
12. Hertz-Picciotto I, Dostal M, Dejmek J, et al. Air pollution and distributions of lymphocyte immunophenotypes in cord and maternal blood at delivery. *Epidemiology.* 2002;13(2):172-183.
13. Mor G, Cardenas I, Abrahams V, Guller S. Inflammation and pregnancy: the role of the immune system at the implantation site. *Ann N Y Acad Sci.* 2011;1221:80-87.
14. Capitanio JP, Del Rosso LA, Gee N, Lasley BL. Adverse biobehavioral effects in infants resulting from pregnant rhesus macaques' exposure to wildfire smoke. *Nat Commun.* 2022;13(1):1774.
15. Brown AP, Cai L, Laufer BI, Miller LA, LaSalle JM, Ji H. Long-term effects of wildfire smoke exposure during early life on the nasal epigenome in rhesus macaques. *Environ Int.* 2022;158:106993.
16. Black C, Gerriets JE, Fontaine JH, et al. Early Life Wildfire Smoke Exposure Is Associated with Immune Dysregulation and Lung Function Decrements in Adolescence. *Am J Respir Cell Mol Biol.* 2017;56(5):657-666.
17. Bove H, Bongaerts E, Slenders E, et al. Ambient black carbon particles reach the fetal side of human placenta. *Nat Commun.* 2019;10(1):3866.
18. Schraufnagel DE. The health effects of ultrafine particles. *Exp Mol Med.* 2020;52(3):311-317.
19. Hantrakool S, Kumfu S, Chattipakorn SC, Chattipakorn N. Effects of Particulate Matter on Inflammation and Thrombosis: Past Evidence for Future Prevention. *Int J Environ Res Public Health.* 2022;19(14).
20. Dagher Z, Garcon G, Billet S, et al. Role of nuclear factor-kappa B activation in the adverse effects induced by air pollution particulate matter (PM2.5) in human epithelial lung cells (L132) in culture. *J Appl Toxicol.* 2007;27(3):284-290.
21. Han B, Xu J, Zhang Y, et al. Associations of Exposure to Fine Particulate Matter Mass and Constituents with Systemic Inflammation: A Cross-Sectional Study of Urban Older Adults in China. *Environ Sci Technol.* 2022;56(11):7244-7255.
22. Han B, Li X, Ai RS, et al. Atmospheric particulate matter aggravates cns demyelination through involvement of TLR-4/NF-kB signaling and microglial activation. *Elife.* 2022;11.
23. Morales-Rubio RA, Alvarado-Cruz I, Manzano-Leon N, et al. In utero exposure to ultrafine particles promotes placental stress-induced programming of renin-angiotensin system-related elements in the offspring results in altered blood pressure in adult mice. *Part Fibre Toxicol.* 2019;16(1):7.

24. Tsukada T, Shimada H, Sakata-Haga H, Iizuka H, Hatta T. Molecular mechanisms underlying the models of neurodevelopmental disorders in maternal immune activation relevant to the placenta. *Congenit Anom (Kyoto).* 2019;59(3):81-87.
25. Siwetz M, Blaschitz A, El-Heliebi A, et al. TNF-alpha alters the inflammatory secretion profile of human first trimester placenta. *Lab Invest.* 2016;96(4):428-438.
26. Hauguel-de Mouzon S, Guerre-Millo M. The placenta cytokine network and inflammatory signals. *Placenta.* 2006;27(8):794-798.
27. Dammann O, Leviton A. Maternal intrauterine infection, cytokines, and brain damage in the preterm newborn. *Pediatr Res.* 1997;42(1):1-8.
28. Wilhelm M, Ritz B. Local variations in CO and particulate air pollution and adverse birth outcomes in Los Angeles County, California, USA. *Environ Health Perspect.* 2005;113(9):1212-1221.
29. Parker JD, Woodruff TJ, Basu R, Schoendorf KC. Air pollution and birth weight among term infants in California. *Pediatrics.* 2005;115(1):121-128.
30. Johnson NM, Hoffmann AR, Behlen JC, et al. Air pollution and children's health-a review of adverse effects associated with prenatal exposure from fine to ultrafine particulate matter. *Environ Health Prev Med.* 2021;26(1):72.
31. Kalkbrenner AE, Schmidt RJ, Penlesky AC. Environmental chemical exposures and autism spectrum disorders: a review of the epidemiological evidence. *Curr Probl Pediatr Adolesc Health Care.* 2014;44(10):277-318.
32. Costa LG, Cole TB, Dao K, Chang YC, Garrick JM. Developmental impact of air pollution on brain function. *Neurochem Int.* 2019;131:104580.
33. Ha S. Air pollution and neurological development in children. *Dev Med Child Neurol.* 2021;63(4):374-381.
34. Thygesen M, Holst GJ, Hansen B, et al. Exposure to air pollution in early childhood and the association with Attention-Deficit Hyperactivity Disorder. *Environ Res.* 2020;183:108930.
35. Volk HE, Perera F, Braun JM, et al. Prenatal air pollution exposure and neurodevelopment: A review and blueprint for a harmonized approach within ECHO. *Environ Res.* 2020:110320.
36. Loftus CT, Ni Y, Szpiro AA, et al. Exposure to ambient air pollution and early childhood behavior: A longitudinal cohort study. *Environ Res.* 2020;183:109075.
37. Clifford A, Lang L, Chen R, Anstey KJ, Seaton A. Exposure to air pollution and cognitive functioning across the life course--A systematic literature review. *Environ Res.* 2016;147:383-398.
38. Loftus CT, Hazlehurst MF, Szpiro AA, et al. Prenatal air pollution and childhood IQ: Preliminary evidence of effect modification by folate. *Environ Res.* 2019;176:108505.
39. Chiu YH, Hsu HH, Coull BA, et al. Prenatal particulate air pollution and neurodevelopment in urban children: Examining sensitive windows and sex-specific associations. *Environ Int.* 2016;87:56-65.
40. Zhang Y, Ye T, Yu P, et al. Preterm birth and term low birth weight associated with wildfire-specific PM(2.5): A cohort study in New South Wales, Australia during 2016-2019. *Environ Int.* 2023;174:107879.
41. Foo D, Stewart R, Heo S, et al. Wildfire smoke exposure during pregnancy and perinatal, obstetric, and early childhood health outcomes: A systematic review and meta-analysis. *Environ Res.* 2024;241:117527.
42. Park BY, Boles I, Monavvari S, et al. The association between wildfire exposure in pregnancy and foetal gastroschisis: A population-based cohort study. *Paediatr Perinat Epidemiol.* 2022;36(1):45-53.
43. Lan Q, Weinberger K, Luke S, Lavigne E, Weichenthal S, Henderson SB. Wildfire Seasons, Prenatal PM(2.5) Exposure, and Respiratory Infections by Age 1 Year: A Population-Based Case-Control Analysis of Critical Developmental Windows. *ACS EST Air.* 2024;1(11):1483-1494.
44. Raffuse S, O'Neill S, Schmidt R. A model for rapid wildfire smoke exposure estimates using routinely-available data - rapidfire v0.1.3. *EGUsphere.* 2023:1031.
45. Schatz M, Harden K, Forsythe A, et al. The course of asthma during pregnancy, post partum, and with successive pregnancies: a prospective analysis. *J Allergy Clin Immunol.* 1988;81(3):509-517.
46. Stenius-Aarniala B, Piirila P, Teramo K. Asthma and pregnancy: a prospective study of 198 pregnancies. *Thorax.* 1988;43(1):12-18.
47. Fuseini H, Newcomb DC. Mechanisms Driving Gender Differences in Asthma. *Curr Allergy Asthma Rep.* 2017;17(3):19.
48. Schatz M. Interrelationships between asthma and pregnancy: a literature review. *J Allergy Clin Immunol.* 1999;103(2 Pt 2):S330-336.

49. Kim H, Baron S, Baidwan NK, Schwartz A, Moline J, Camacho-Rivera M. New onset of asthma and job status change among world trade center responders and workers. *Am J Ind Med.* 2017;60(12):1039-1048.
50. van der Velden PG, Wong A, Boshuizen HC, Grievink L. Persistent mental health disturbances during the 10 years after a disaster: four-wave longitudinal comparative study. *Psychiatry Clin Neurosci.* 2013;67(2):110-118.
51. Cleven KL, Webber MP, Zeig-Owens R, Hena KM, Prezant DJ. Airway Disease in Rescue/Recovery Workers: Recent Findings from the World Trade Center Collapse. *Curr Allergy Asthma Rep.* 2017;17(1):5.
52. Gargano LM, Thomas PA, Stellman SD. Asthma control in adolescents 10 to 11 y after exposure to the World Trade Center disaster. *Pediatr Res.* 2017;81(1-1):43-50.
53. Wheeler S, Rosenstock L, Barnhart S. A case series of 71 patients referred to a hospital-based occupational and environmental medicine clinic for occupational asthma. *West J Med.* 1998;168(2):98-104.
54. Tarlo SM. Irritant-induced asthma in the workplace. *Curr Allergy Asthma Rep.* 2014;14(1):406.
55. Kim JA, Yoon SY, Cho SY, et al. Acute health effects of accidental chlorine gas exposure. *Ann Occup Environ Med.* 2014;26:29.
56. Kenyon NJ, Morrissey BM, Schivo M, Albertson TE. Occupational asthma. *Clin Rev Allergy Immunol.* 2012;43(1-2):3-13.
57. Alexeeff SE, Van Den Eeden SK, Deosaransingh K, Sidney S, Liao NS, Rana JS. Wildfire air pollution and rates of cardiovascular events and mortality in Northern California in 2018. *Journal of the American Heart Association.* 2025;14(4):e036264.
58. Dennekamp M, Straney LD, Erbas B, et al. Forest Fire Smoke Exposures and Out-of-Hospital Cardiac Arrests in Melbourne, Australia: A Case-Crossover Study. *Environ Health Perspect.* 2015;123(10):959-964.
59. Fu P, Mago V. The association between fire smoke exposure and emergency department (ED) visits and hospital admissions (HA): A systematic review and meta-analysis. *Heliyon.* 2024.
60. Haikerwal A, Akram M, Del Monaco A, et al. Impact of Fine Particulate Matter (PM2.5) Exposure During Wildfires on Cardiovascular Health Outcomes. *J Am Heart Assoc.* 2015;4(7).
61. Rappold AG, Stone SL, Cascio WE, et al. Peat bog wildfire smoke exposure in rural North Carolina is associated with cardiopulmonary emergency department visits assessed through syndromic surveillance. *Environ Health Perspect.* 2011;119(10):1415-1420.
62. Alexeeff SE, Van Den Eeden SK, Deosaransingh K, Sidney S, Liao NS, Rana JS. Wildfire Air Pollution and Rates of Cardiovascular Events and Mortality in Northern California in 2018. *J Am Heart Assoc.* 2025:e036264.
63. Kumagai Y, Carroll M, Cohn P. Coping with interface wild¬fire as a human event: lessons from the disaster/hazards literature. *J Forestry.* 2004;102(6):28-32.
64. Burra TA, Moineddin R, Agha MM, Glazier RH. Social disadvantage, air pollution, and asthma physician visits in Toronto, Canada. *Environ Res.* 2009;109(5):567-574.
65. Wheeler BW, Ben-Shlomo Y. Environmental equity, air quality, socioeconomic status, and respiratory health: a linkage analysis of routine data from the Health Survey for England. *J Epidemiol Community Health.* 2005;59(11):948-954.
66. Chen E, Hanson MD, Paterson LQ, Griffin MJ, Walker HA, Miller GE. Socioeconomic status and inflammatory processes in childhood asthma: the role of psychological stress. *J Allergy Clin Immunol.* 2006;117(5):1014-1020.
67. Gold DR, Wright R. Population disparities in asthma. *Annu Rev Public Health.* 2005;26:89-113.
68. Padula AM, Rivera-Nunez Z, Barrett ES. Combined Impacts of Prenatal Environmental Exposures and Psychosocial Stress on Offspring Health: Air Pollution and Metals. *Curr Environ Health Rep.* 2020;7(2):89-100.
69. Liu J, Clark LP, Bechle MJ, et al. Disparities in Air Pollution Exposure in the United States by Race/Ethnicity and Income, 1990-2010. *Environ Health Perspect.* 2021;129(12):127005.

70. Jbaily A, Zhou X, Liu J, et al. Air pollution exposure disparities across US population and income groups. *Nature.* 2022;601(7892):228-233.
71. Casey JA, Kioumourtzoglou MA, Padula A, et al. Measuring long-term exposure to wildfire PM(2.5) in California: Time-varying inequities in environmental burden. *Proc Natl Acad Sci U S A.* 2024;121(8):e2306729121.
72. Masri S, Scaduto E, Jin Y, Wu J. Disproportionate Impacts of Wildfires among Elderly and Low-Income Communities in California from 2000-2020. *Int J Environ Res Public Health.* 2021;18(8).
73. Krebs B, Neidell M. Wildfires exacerbate inequalities in indoor pollution exposure. *Environ Res Lett.* 2024;19:024043.
74. Shen X, Zhang H, Wang Y, Wang QR. Unveiling the Dynamics of Human Mobility in Response to Wildfire-Induced Air Quality Degradation: An Examination of the 2019 Kincade Fire. *Journal of Management in Engineering.* 2025;41(3).
75. Cohen S, Kamarck T, Mermelstein R. A Global Measure of Perceived Stress. *Journal of Health and Social Behavior.* 1983;24(4):385.
76. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ.* 2021;372:n71.
77. Jiao A, Headon K, Han T, Umer W, Wu J. Associations between short-term exposure to wildfire particulate matter and respiratory outcomes: A systematic review. *Sci Total Environ.* 2023:168134.
78. Chen H, Samet JM, Bromberg PA, Tong H. Cardiovascular health impacts of wildfire smoke exposure. *Part Fibre Toxicol.* 2021;18(1):2.
79. Grennan GK, Withers MC, Ramanathan DS, Mishra J. Differences in interference processing and frontal brain function with climate trauma from California's deadliest wildfire. *PLOS Clim* 2023;2(1):e0000125.
80. Du R, Liu K, Zhao D, Fang Q. Climate Disaster and Cognitive Ability: Evidence From Wildfire. *Int J Public Health.* 2024;69:1607128.
81. Wu J, Laurent O, Li L, Hu J, Kleeman M. Adverse Reproductive Health Outcomes and Exposure to Gaseous and Particulate-Matter Air Pollution in Pregnant Women. *Res Rep Health Eff Inst.* 2016;2016(188):1-58.
82. Paugam R, Wooster M, Freitas S, Val Martin M. A review of approaches to estimate wildfire plume injection height within large-scale atmospheric chemical transport models. *Atmos Chem Phys.* 2016;16:907-925.
83. Larkin NK, Raffuse S, Huang S, Pavlovic N, Lahm P, Rao V. The Comprehensive Fire Information Reconciled Emissions (CFIRE) inventory: Wildland fire emissions developed for the 2011 and 2014 U.S. National Emissions Inventory. *Journal of the Air & Waste Management Association.* 2020;70(11):1165-1185.
84. Prichard SJ, O'Neill SM, Eagle P, et al. Wildland fire emission factors in North America: synthesis of existing data, measurement needs and management applications. *International Journal of Wildland Fire.* 2020;29(2):132-147.
85. Larkin NK, O'Neill SM, Solomon R, et al. The BlueSky smoke modeling framework. *International Journal of Wildland Fire.* 2009;18(8):906-920.
86. National Ambient Air Quality Standards. 2024. https://www.epa.gov/criteria-air-pollutants/naaqs-table.
87. Heft-Neal S, Driscoll A, Yang W, Shaw G, Burke M. Associations between wildfire smoke exposure during pregnancy and risk of preterm birth in California. *Environ Res.* 2022;203:111872.
88. Wilson A, Chiu Y-HM, Hsu H-HL, Wright RO, Wright RJ, Coull BA. Bayesian distributed lag interaction models to identify perinatal windows of vulnerability in children's health. *Biostatistics.* 2017;18(3):537-552.
89. Liu C, Huang L, Huang S, et al. Association of both prenatal and early childhood multiple metals exposure with neurodevelopment in infant: A prospective cohort study. *Environ Res.* 2022;205:112450.
90. Hsueh YM, Lee CY, Chien SN, et al. Association of blood heavy metals with developmental delays and health status in children. *Sci Rep.* 2017;7:43608.
91. Munteanu O, Filipoiu FM, Cirstoiu MM, Baloiu AI, Petrescu IA, Bohiltea RE. A Comprehensive Study Regarding the Intrauterine Development of Nails. *Organogenesis.* 2021;17(1-2):14-19.
92. Yaemsiri S, Hou N, Slining MM, He K. Growth rate of human fingernails and toenails in healthy American young adults. *J Eur Acad Dermatol Venereol.* 2010;24(4):420-423.

93. Martinez-Morata I, Sobel M, Tellez-Plaza M, Navas-Acien A, Howe CG, Sanchez TR. A State-of-the-Science Review on Metal Biomarkers. *Curr Environ Health Rep.* 2023;10(3):215-249.
94. Specht AJ, Adesina KE, Read DE, Weisskopf MG. Benchtop x-ray fluorescence to quantify elemental content in nails non-destructively. *Sci Total Environ.* 2024;918:170601.
95. Bravo MA, Anthopolos R, Bell ML, Miranda ML. Racial isolation and exposure to airborne particulate matter and ozone in understudied US populations: Environmental justice applications of downscaled numerical model output. *Environ Int.* 2016;92-93:247-255.
96. Miranda ML, Edwards SE, Keating MH, Paul CJ. Making the environmental justice grade: the relative burden of air pollution exposure in the United States. *Int J Environ Res Public Health.* 2011;8(6):1755-1771.
97. Bell ML, Ebisu K. Environmental inequality in exposures to airborne particulate matter components in the United States. *Environ Health Perspect.* 2012;120(12):1699-1704.
98. Acevedo-Garcia D, McArdle N, Hardy EF, et al. The child opportunity index: improving collaboration between community development and public health. *Health Aff (Millwood).* 2014;33(11):1948-1957.
99. Kind AJH, Buckingham WR. Making Neighborhood-Disadvantage Metrics Accessible - The Neighborhood Atlas. *N Engl J Med.* 2018;378(26):2456-2458.
100. Area Deprivation Index. 2020.
101. CalEnviroScreen 4.0. CA.gov; 2021.
102. Beck AT, Steer RA, Brown GK. Beck Depression Inventory BDI–2. Pearson Education, Inc.; 1996.
103. Beck AT. Beck Anxiety Inventory (BAI). Pearson Education, Inc.; 1993.
104. Achenbach TMR, L.A. *Manual for the ASEBA Preschool Forms & Profiles. .* Burlington, VT: University of Vermont, Research Center for Children, Youth, & Families; 2000.
105. Costello EJ, Benjamin R. Epidemiology and child diagnosis. In: Last CG, Hersen M, eds. *Handbook of child psychiatric diagnosis Wiley series on personality processes*. Oxford,England: John Wiley & Sons; 1989.
106. Davis C, Turner-Cobb JM. The Perceived Stress Scale for Kids (PeSSKi): Initial development of a brief measure for children aged 7-11 years. *Stress Health.* 2023;39(1):125-136.
107. Asher MI, Keil U, Anderson HR, et al. International Study of Asthma and Allergies in Childhood (ISAAC): rationale and methods. *Eur Respir J.* 1995;8(3):483-491.
108. Pinart M, Benet M, Annesi-Maesano I, et al. Comorbidity of eczema, rhinitis, and asthma in IgE-sensitised and non-IgE-sensitised children in MeDALL: a population-based cohort study. *Lancet Respir Med.* 2014;2(2):131-140.
109. Juniper EF, Gruffydd-Jones K, Ward S, Svensson K. Asthma Control Questionnaire in children: validation, measurement properties, interpretation. *Eur Respir J.* 2010;36(6):1410-1416.
110. Behavioral Risk Factor Surveillance System Survey Questionnaire. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2023. https://www.cdc.gov/brfss.
111. Constantino JN, Davis SA, Todd RD, et al. Validation of a brief quantitative measure of autistic traits: comparison of the social responsiveness scale with the autism diagnostic interview-revised. *J Autism Dev Disord.* 2003;33(4):427-433.
112. Baron IS. Behavior rating inventory of executive function. *Child Neuropsychol.* 2000;6(3):235-238.
113. Gioia GA, Isquith PK, Guy SC, Kenworthy L. TEST REVIEW Behavior rating inventory of executive function. *Child Neuropsychol.* 2000;6(3):235-238.
114. Swanson JM, Schuck S, Porter MM, et al. Categorical and Dimensional Definitions and Evaluations of Symptoms of ADHD: History of the SNAP and the SWAN Rating Scales. *Int J Educ Psychol Assess.* 2012;10(1):51-70.
115. Hall CL, Guo B, Valentine AZ, et al. The Validity of the SNAP-IV in Children Displaying ADHD Symptoms. *Assessment.* 2020;27(6):1258-1271.
116. Hernan MA, Hernandez-Diaz S, Werler MM, Mitchell AA. Causal knowledge as a prerequisite for confounding evaluation: an application to birth defects epidemiology. *Am J Epidemiol.* 2002;155(2):176-184.
117. Raz R, Levine H, Pinto O, Broday DM, Yuval, Weisskopf MG. Traffic-Related Air Pollution and Autism Spectrum Disorder: A Population-Based Nested Case-Control Study in Israel. *Am J Epidemiol.* 2018;187(4):717-725.
118. Ritz B, Liew Z, Yan Q, et al. Air pollution and Autism in Denmark. *Environ Epidemiol.* 2018;2(4):e028.

119. Lotspeich SC, Grosser KF, Garcia TP. Correcting conditional mean imputation for censored covariates and improving usability. *Biom J.* 2022;64(5):858-862.
120. Lubin JH, Colt JS, Camann D, et al. Epidemiologic evaluation of measurement data in the presence of detection limits. *Environ Health Perspect.* 2004;112(17):1691-1696.
121. Fitzmaurice GM, Laird NM, Ware JH. *Applied Longitudinal Analysis.* New York, NY: Wiley; 2011.
122. Verbeke G, Molenberghs G. *Linear Mixed Models for Longitudinal Data.* New York, NY: Springer; 2000.
123. Skrondal A, Rabe-Hesketh S. *Generalized latent variable modeling: Multilevel, longitudinal, and structural equation models.* Boca Raton, FL: Chapman & Hall/CRC Press; 2004.
124. VanderWeele TJ. Bias formulas for sensitivity analysis for direct and indirect effects. *Epidemiology.* 2010;21(4):540-551.
125. Schnitzer ME, Blais L. Methods for the assessment of selection bias in drug safety during pregnancy studies using electronic medical data. *Pharmacol Res Perspect.* 2018;6(5):e00426.
126. Raz R, Kioumourtzoglou MA, Weisskopf MG. Live-Birth Bias and Observed Associations Between Air Pollution and Autism. *Am J Epidemiol.* 2018;187(11):2292-2296.
127. West BT, McCabe SE. Alternative Approaches to Assessing Nonresponse Bias in Longitudinal Survey Estimates: An Application to Substance-Use Outcomes Among Young Adults in the United States. *Am J Epidemiol.* 2017;185(7):591-600.
128. Forastiere F, Spadaro JV, Ancona C, et al. Choices of morbidity outcomes and concentration-response functions for health risk assessment of long-term exposure to air pollution. *Environ Epidemiol.* 2024;8(4):e314.

EXHIBIT A1

DELIVERABLES

If use of any Deliverable is restricted or is anticipated to contain preexisting Intellectual Property with any restricted use, it will be clearly identified in Exhibit A4, Use of Preexisting Intellectual Property & Data.

Unless otherwise directed by the State, the University Principal Investigator shall submit all deliverables to State Contract Project Manager, identified in Exhibit A3, Authorized Representatives.

Deliverable	Description	Due Date
Racial equity/implicit bias training	The Principal Investigator and key personnel must demonstrate that they have taken, or will take, cultural competency training, implicit bias training, or racial equity training, whichever is administered at their institution. Training certificates or certificates of completion completed within one (1) year prior to the agreement start date will be accepted. If the training has not been completed within one (1) year prior to the agreement start date, then the Principal Investigator and key personnel must demonstrate that they have scheduled the training within 30 days of the agreement start date and shall complete the training within 90 days of the agreement start date.	Within 90 days of the agreement start date.
Initial Meeting	Principal Investigator and key personnel will meet with CARB Contract Project Manager and other staff to discuss the overall plan, details of performing the tasks, project schedule, items related to personnel or changes in personnel, and any issues that may need to be resolved before work can begin.	Month One (1)
Progress Reports & Meetings	The Contractor will submit quarterly progress reports and conduct meetings throughout the agreement term, to coincide with work completed in quarterly invoices.	Quarterly
Task 1 Deliverables	Provide a literature review on the findings of the systematic literature review on the long-term maternal and child health outcomes associated with prenatal wildfire exposure. This will include a table summarizing major findings, study design/methodological approaches, and potential limitations of previous studies. Submit a review article manuscript for publication in peer-reviewed open-access journals, potentially focusing on topics not extensively covered in previous reviews. Convene a Community Input Meeting and provide a summary of the Community Input meeting.	Month Six (6) Month Six Month Six
Task 2 Deliverable	Provide CARB with summary tables and plots of the distribution of PM2.5 exposure, metals concentrations, and use of exposure mitigating behaviors (mask use, air purifiers,	Month 12

	evacuations) across fires, participant characteristics, and neighborhood characteristics. The findings will be included in a manuscript that will be prepared and submitted for publication in peer-reviewed open-access journals.	
Task 3 Deliverable	Provide a summary on descriptive statistics for each primary maternal and child health outcome, their associations with wildfire PM2.5 and metals, and concentration response functions for statistically significant associations. The summary will include primarily summary tables and figures plotting effect estimates/CI. Key findings that are well-powered will be included in manuscripts drafted and submitted for publication in peer-reviewed open-access journals.	Month 21
Task 4 Deliverable	Provide a summary depicting tables and plots of effect estimates (and CI) stratified by race, ethnicity, maternal education, home ownership, protective behaviors, neighborhood poverty, background air pollution, and other potentially modifying factors identified in Task 1, where feasible, as effect modifiers of the associations between wildfire PM2.5 (and metals) in relation to maternal and child health outcomes.	Month ~~24~~ 21
Task 5 Deliverable	Submit a lay summary and an infographic highlighting findings on long-term maternal and child health outcomes associated with wildfire smoke exposure in pregnancy, and who might be most vulnerable.	Month 24
Draft Final Report	Draft version of the Final Report detailing the purpose and scope of the work undertaken, the work performed, the results obtained and conclusions, and a Public Outreach Document and an Equity Implications Section. The Draft Final Report shall be copy-edited before being sent to CARB for review and the Principal Investigator shall attest that the Final Report has been reviewed and approved. The Draft Final Report must be submitted in accordance with the requirements outlined in Exhibit A1, Section 2 – Research Final Report Format.	Nine (9) months prior to the agreement end date
Data	Data compilations first produced in the performance of this Agreement by the Principal investigator or the University's project personnel.	Two (2) weeks prior to agreement end date.
Technical Seminar	Presentation of the results of the project to CARB staff and a possible webcast at a seminar at CARB facilities in Sacramento or El Monte. The Technical Seminar slides shall be submitted in an ADA compliant format. CARB's standard for ADA compliance requires that the submitted document adhere to WCAG 2.1 AA (https://www.w3.org/TR/WCAG21/) and Federal Section 508 (https://www.section508.gov/).	On or before agreement end date.
The following Deliverables are subject to paragraph 19. Copyrights, paragraph B of Exhibit C		
Final Report	Written record of the project and its results. The Final Report must be submitted in accordance with the requirements outlined in Exhibit A1, Section 2 – Research Final Report Format.	Two (2) weeks prior to agreement end date.

1. Reports and Data Compilations

A. With respect to each invoice period University shall submit, to the CARB Contract Project Manager, one (1) electronic copy of the progress report. When emailing the progress report, the "subject line" should state the contract number and the billing period. Each progress report must accompany a related invoice covering the same billing period. Each progress report will begin with the following disclaimer:

> *The statements and conclusions in this report are those of the University and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products*.

B. Each progress report will also include:

1. A brief summary of the status of the project, including whether the project is on schedule. If the project is behind schedule, the progress report must contain an explanation of reasons and how the University plans to resume the schedule.

2. A brief narrative account of project tasks completed or partially completed since the last progress report.

3. A brief discussion of problems encountered during the reporting period and how they were or are proposed to be resolved.

4. A brief discussion of work planned, by project task, before the next progress report. and

5. A graph or table showing percent of work completion for each task.

C. Nine (9) months prior to Agreement expiration date, University will deliver to CARB an electronic copy of the draft final report in both PDF and Microsoft Word formats. The draft final report will conform to Exhibit A1, Section 2 – Research Final Report Format.

D. Within forty-five (45) days of receipt of CARB's comments, University will deliver to CARB's Contract Project Manager an electronic copy of the final report incorporating all reasonable alterations and additions. Within two (2) weeks of receipt of the revised report, CARB will verify that all CARB comments have been addressed. Upon acceptance of the amended final report approved by CARB in accordance to Exhibit A1, Section 2 – Research Final Report Format, University will within two (2) weeks, deliver to CARB an electronic copy of the final report in both PDF and Microsoft Word formats.

E. As specified in Exhibit A1, Section 2, Final Report will be submitted in an Americans with Disabilities Act compliant Format.

F. Together with the final report, University will deliver a set of all data compilations as specified in Exhibit A1 – Schedule of Deliverables.

G. University's obligation under this Agreement shall be deemed discharged only upon submittal to CARB of an acceptable final report in accordance to Exhibit A1, Section 2 – Research Final Report Format, all required data compilations, and any other project deliverables.

2. Research Final Report Format

The research contract Final Report (Report) is as important to the contract as the research itself. The Report is a record of the project and its results and is used in several ways. Therefore, the Report must be well organized and contain certain specific information. The CARB's Research Screening Committee (RSC) reviews all draft final reports, paying special attention to the Abstract and Executive Summary. If the RSC finds that the Report does not fulfill the requirements stated in this Exhibit, the RSC may not recommend release, and final payment for the work completed may be withheld. This Exhibit outlines the requirements that must be met when producing the Report.

Note: In partial fulfillment of the Final Report requirements, the Contractor shall submit a copy of the Report in PDF format and in a word-processing format, preferably in Word – Version 6.0 or later. The electronic copy file name shall contain the CARB contract number, the words "Final Report", and the date the report was submitted.

Accessibility. Contractor must ensure that the Final Report complies with Web Content Accessibility Guidelines 2.0, levels A and AA, and otherwise meets the accessibility requirements set forth in California Government Code Sections 7405 and 11135, Section 202 of the federal Americans with Disabilities Act (42 U.S.C. § 12132), and Section 508 of the federal Rehabilitation Act (29 U.S.C. § 794d) and the regulations promulgated thereunder (36 C.F.R. Parts 1193 and 1194) (collectively, the "Accessibility Requirements"). For any report provided in PDF format, Contractor shall also provide an electronic version in the original electronic format (for example, Microsoft Word or Adobe InDesign). CARB may request documentation from the Contractor of compliance with the Accessibility Requirements and may perform testing to verify compliance. Contractor must bring into compliance, at no cost to CARB, any report by Contractor or its subcontractors not meeting the Accessibility Requirements. If Contractor fails to bring its or its subcontractors' report into compliance with the Accessibility Requirements within five (5) business days of written notice from CARB, or within the time frame specified by CARB in its notice, Contractor will be responsible for all costs incurred by CARB in bringing Contractor's or its subcontractors' report into compliance with the Accessibility Requirements. Contractor agrees to respond to and resolve any complaint brought to its attention regarding accessibility of deliverables provided under this Contract for a period of one year following delivery of the final deliverable under this Contract.

Deviations from the Accessibility Requirements are permitted only by written consent by CARB.

Watermark. Each page of the draft Report must include a watermark stating "DRAFT." The revised report should not include any watermarks.

Title. The title of the Report should exactly duplicate the title of the contract. However, minor changes to the title may be approved provided the new title does not deviate from the old title. These minor changes must be approved in writing by the contract manager. Significant changes to the title would require a formal amendment.

Page size. All pages should be of standard size (8 ½" x 11") to allow for photo-reproduction.

Corporate identification. Do not include corporate identification on any page of the Final Report, except the title page.

Unit notation. Measurements in the Reports should be expressed in metric units. However, for the convenience of engineers and other scientists accustomed to using the British system, values may be given in British units as well in parentheses after the value in metric units. The expression of measurements in both systems is especially encouraged for engineering reports.

Section order. The Report should contain the following sections, in the order listed below:

Title page
Disclaimer
Acknowledgment (1)
Acknowledgment (2)
Table of Contents
List of Figures
List of Tables
Abstract
Public Outreach Document
Executive Summary
Equity Implications Section
Body of Report
References
List of inventions reported and copyrighted materials produced
Glossary of Terms, Abbreviations, and Symbols
Appendices

Page numbering. Beginning with the body of the Report, pages shall be numbered consecutively beginning with “1”, including all appendices and attachments. Pages preceding the body of the Report shall be numbered consecutively, in ascending order, with small Roman numerals.

Title page. The title page should include, at a minimum, the contract number, contract title, name of the principal investigator, contractor organization, date, and this statement:
"Prepared for the California Air Resources Board and the California Environmental Protection Agency"

Disclaimer. A page dedicated to this statement must follow the Title Page:

> The statements and conclusions in this Report are those of the contractor and not necessarily those of the California Air Resources Board. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products.

Acknowledgment (1). Only this section should contain acknowledgments of key personnel and organizations who were associated with the project. The last paragraph of the acknowledgments must read as follows:

> This Report was submitted in fulfillment of [CARB contract number and project title] by [contractor organization] under the [partial] sponsorship of the California Air Resources Board. Work was completed as of [date].

Acknowledgment (2). Health reports should include an acknowledgment to the late Dr. Friedman. Reports should include the following paragraph:

> This project is funded under the CARB’s Dr. William F. Friedman Health Research Program. During Dr. Friedman’s tenure on the Board, he played a major role in guiding CARB’s health research program. His commitment to the citizens of California was evident through his personal and professional interest in the Board’s health research, especially in studies related to children’s health. The Board is sincerely grateful for all of Dr. Friedman’s personal and professional contributions to the State of California.

Attestation. A page dedicated to this attestation statement must follow the Acknowledgement(s). The Principal Investigator (PI) must digitally sign below the following statement:

> The Final Report for CARB Agreement No. [contract number] titled "[Enter project title]" has been copy-edited for grammar, style, and format and is reviewed and approved by the Principal Investigator (PI), [title and name of PI] of [Contractor Name]. The signature below attests that the PI has completed a thorough review of this Final Report and approves it for submission to the California Air Resources Board.
>
> PI Signature
> Date

Table of Contents. This should list all the sections, chapters, and appendices, together with their page numbers. Check for completeness and correct reference to pages in the Report.

List of Figures. This list is optional if there are fewer than five illustrations.

List of Tables. This list is optional if there are fewer than five tables.

Abstract. The abstract should tell the reader, in nontechnical terms, the purpose and scope of the work undertaken, describe the work performed, and present the results obtained and conclusions. The purpose of the abstract is to provide the reader with useful information and a means of determining whether the complete document should be obtained for study. The length of the abstract should be no more than about 200 words. Only those concepts that are addressed in the executive summary should be included in the abstract.

Example of an abstract:

A recently developed ground-based instrument, employing light detecting and ranging (lidar) technology, was evaluated, and found to accurately measure ozone concentrations at altitudes of up to 3,000 meters. The novel approach used in this study provides true vertical distributions of ozone concentrations aloft and better temporal coverage of these distributions than other, more common methods, such as those using aircraft and ozonesonde (balloon) techniques. The ozone and aerosol measurements from this study, in conjunction with temperature and wind measurements, will provide a better characterization of atmospheric conditions aloft and the processes involved in the formation of unhealthful ozone concentrations than can be achieved with traditional ground-based monitors.

Public Outreach Document. The public outreach document is a one-page document that will be widely used to communicate, in clear and direct terms, the key research findings from the study to the public. CARB will be translating the document into other languages. This document must adhere to the following guidelines:

- Single space, limited to one-page or about 500 words.
- Use narrative form and active voice.
- Incorporate a graphic that it is easy to interpret and captures the results' central message.
- Avoid jargon and technical terms. Use a style and vocabulary level comparable to that of sixth grade reading level.
- The document should contain a title and the following five sections: Issue/s, Main Question, Key Research Findings, Conclusion/s, and More Information. Guidance on how to write these sections is described below.

TITLE: Adopt a short, non-technical title to make the topic clear and concise. The title will likely differ from the original title of the contract.

ISSUE/S: In one to two paragraphs, describe why the project was needed. In this section, identify the problem leading to this study and what the study was set to accomplish to help address the problem. Reference any history that is relevant such as a regulation, legislation, program, law, or other. Without going into detail and disclosing the research findings, mention the methods used in the study and how it informed the results.

MAIN QUESTION: Present a concise central research question driving this project.

KEY RESEARCH FINDING/S: This section covers the key research findings. List key points and or findings.

CONCLUSION/S: In one to two paragraphs, discuss how the results could be used. Mention its relevance to policies, rules, regulations, legislations, or CARB programs. Include suggestions for next steps, additional research, or other actions.

MORE INFORMATION: In two to three short sentences provide specifics about the study. This section should include the full title of the study, sponsor, authors, and where the full report can be found (the final report will be posted on the CARB website). In addition to a direct contact to gain more information (author and CARB contract manager).

Executive Summary. The function of the executive summary is to inform the reader about the important aspects of the work that was done, permitting the reader to understand the research without reading the entire Report. It should state the objectives of the research and briefly describe the experimental methodology[ies] used, results, conclusions, and recommendations for further study. All of the concepts brought out in the abstract should be expanded upon in the Executive Summary. Conversely, the Executive Summary should not contain concepts that are not expanded upon in the body of the Report.

The Executive Summary will be used in several applications as written; therefore, please observe the style considerations discussed below.

Limit the Executive Summary to two pages, single spaced.

Use narrative form. Use a style and vocabulary level accessible to the general audience. Assume the audience is being exposed the subject for the first time.

Do not list contract tasks in lieu of discussing the methodology. Discuss the results rather than listing them.

Avoid jargon.

Define technical terms.

Use passive voice if active voice is awkward.

Avoid the temptation to lump separate topics together in one sentence to cut down on length.

The Executive Summary should contain four sections: Background, Objectives and Methods, Results, and Conclusions, described below.

THE BACKGROUND SECTION. For the Background, provide a one-paragraph discussion of the reasons the research was needed. Relate the research to the Board's regulatory functions, such as establishing ambient air quality standards for the protection of human health, crops, and ecosystems; the improvement and updating of emissions inventories; and the development of air pollution control strategies.

THE OBJECTIVES AND METHODS SECTION. At the beginning of the Objectives and Methods section, state the research objectives as described in the contract. Include a short, one or two sentences, overview of what was done in general for this research.

The methodology should be described in general, nontechnical terms, unless the purpose of the research was to develop a new methodology or demonstrate a new apparatus or technique. Even in those cases, technical aspects of the methodology should be kept to the minimum necessary for understanding the project. Use terminology with which the reader is likely to be familiar. If it is necessary to use technical terms, define them. Details, such as names of manufacturers and statistical analysis techniques, should be omitted.

Specify when and where the study was performed if it is important in interpreting the results. The findings should not be mentioned in the Objectives and Methods section.

THE RESULTS SECTION. The Results section should be a single paragraph in which the main findings are cited, and their significance briefly discussed. The results should be presented as a narrative, not a list. This section must include a discussion of the implications of the work for the Board's relevant regulatory programs.

THE CONCLUSIONS SECTION. The Conclusions section should be a single short paragraph in which the results are related to the background, objectives, and methods. Again, this should be presented as a narrative rather than a list. Include a short discussion of recommendations for further study, adhering to the guidelines for the Recommendations section in the body of the Report.

Equity Implication Section. The equity implications section should summarize how the research results inform disparate impacts of policies, regulations, or programs on priority communities.[1] This section should summarize how sociodemographic factors were examined in this research. Given the data used or collected, which populations are excluded or overrepresented? How were relevant communities engaged in the research effort and/or how were existing data gaps identified and ground-truthed during the research project? If ground-truthed data were found to not accurately reflect the lived experiences of community members, what future research projects could address this disconnect. The research results should inform existing or future CARB programs and the equity implications section should discuss how the research results may inform programs to close disparities in health outcomes, pollutant exposure or climate adaptation, etc., for priority communities. This section should be limited to a maximum of two (2) pages, single spaced and shall include the following sections.

---

[1] Priority communities here encompasses various terms CARB uses such as priority populations[2], communities of concern[3], protected classes[4], or disadvantaged communities[5].
[2] Priority Populations — California Climate Investments
[3] Referenced from the California Public Utilities Commission Environmental and Social Justice Plan an effort resulting from California's Capitol Collaborative on Race & Equity.
[4] Protected Classes | California State Senate
[5] SB 535 Disadvantaged Communities ; California Climate Investments to Benefit Disadvantaged Communities | CalEPA; CalEnviroScreen 4.0 | OEHHA

HISTORICAL ANALYSIS. Provide an overview of the inequities and disparities observed in the existing data or data gathered during the research and how it ties to historic policies. For example, what is the root-cause of the disparity being experienced by the community or population central to this research?

MATERIALS AND METHODS. Describe how this research project examines racial equity. Some methods can include but are not limited to: examining the potential for existing data to address racial inequalities, ground-truthing existing data, engaging priority communities, assessments for racial and ethnic subgroups in the development of data and approaches, identifying data gaps and filling those gaps.

RESULTS AND DISCUSSION. Describe how the results improve our understanding of the equity issues identified or interventions to address those inequalities.

Body of Report. The body of the Report should contain the details of the research, divided into the following sections:[2]

INTRODUCTION. Clearly identify the scope and purpose of the project. Provide a general background of the project. Explicitly state the assumptions of the study.

Clearly describe the hypothesis or problem the research was designed to address. Discuss previous related work and provide a brief review of the relevant literature on the topic.

MATERIALS AND METHODS. Describe the various phases of the project, the theoretical approach to the solution of the problem being addressed, and limitations to the work. Describe the design and construction phases of the project, materials, equipment, instrumentation, and methodology.

Describe quality assurance and quality control procedures used. Describe the experimental or evaluation phase of the project.

RESULTS. Present the results in an orderly and coherent sequence. Describe statistical procedures used and their assumptions. Discuss information presented in tables, figures, and graphs. The titles and heading of tables, graphs, and figures, should be understandable without reference to the text. Include all necessary explanatory footnotes. Clearly indicate the measurement units used.

DISCUSSION. Interpret the data in the context of the original hypothesis or problem. Does the data support the hypothesis or provide solutions to the research problem? If appropriate, discuss how the results compare to data from similar or related studies. What are the implications of the findings?

Identify innovations or development of new techniques or processes. If appropriate, discuss cost projections and economic analyses.

SUMMARY AND CONCLUSIONS. This is the most important part of the Report because it is the section that will probably be read most frequently. This section should begin with a clear, concise statement of what, why, and how the project was done. Major results and conclusions of the study should then be presented, using clear, concise statements. Make sure the conclusions reached are fully supported by the results of the study. Do not overstate or overinterpret the results. It may be useful to itemize primary results and conclusions. A simple table or graph may be used to illustrate.

[2] Note that if the research employs multiple distinct methods, analyses, etc., the final report can include separate materials/methods, results, and discussion sections to allow for coherent discussion of each set of analyses and findings. However, the executive summary and conclusions sections should synthesize the collective findings of the entire study.

RECOMMENDATIONS. Use clear, concise statements to recommend (if appropriate) future research that is a reasonable progression of the study and can be supported by the results and discussion.

References. Use a consistent style to fully cite work referenced throughout the Report and references to closely related work, background material, and publications that offer additional information on aspects of the work. Please list these together in a separate section, following the body of the Report. If the Report is lengthy, you may list the references at the end of each chapter.

List of inventions reported and publications produced. If any inventions have been reported, or publications or pending publications have been produced as a result of the project, the titles, authors, journals or magazines, and identifying numbers that will assist in locating such information should be included in this section.

Glossary of terms, abbreviations, and symbols. When more than five of these items are used in the text of the Report, prepare a complete listing with explanations and definitions. It is expected that every abbreviation and symbol will be written out at its first appearance in the Report, with the abbreviation or symbol following in parentheses [i.e., carbon dioxide (CO_2)]. Symbols listed in table and figure legends need not be listed in the Glossary.

Appendices. Related or additional material that is too bulky or detailed to include within the discussion portion of the Report shall be placed in appendices. If a Report has only one appendix, it should be entitled "APPENDIX". If a Report has more than one appendix, each should be designated with a capital letter (APPENDIX A, APPENDIX B). If the appendices are too large for inclusion in the Report, they should be collated, following the binding requirements for the Report, as a separate document.

The contract manager will determine whether appendices are to be included in the Report or treated separately. Page numbers of appendices included in the Report should continue the page numbering of the Report body. Pages of separated appendices should be numbered consecutively, beginning at “1”.

3. Other Deliverables

A. Contractor must ensure that all products and services submitted, uploaded, or otherwise provided by the Contractor and/or its subcontractors under this Agreement, including but not limited to data, software, plans, drawings, specifications, reports, operating manuals, notes, and other written or graphic work prepared in the course of performance of this Contract (collectively, the “Work”), comply with Web Content Accessibility Guidelines 2.0, levels A and AA, and otherwise meet the accessibility requirements set forth in California Government Code Sections 7405 and 11135, Section 202 of the federal Americans with Disabilities Act (42 U.S.C. § 12132), and Section 508 of the federal Rehabilitation Act (29 U.S.C. § 794d) and the regulations promulgated thereunder (36 C.F.R. Parts 1193 and 1194) (collectively, the “Accessibility Requirements”). For any Work provided in PDF format, Contractor shall also provide an electronic version in the original electronic format (for example, Microsoft Word or Adobe InDesign). CARB may request documentation from the Contractor of compliance with the Accessibility Requirements and may perform testing to verify compliance. Contractor must bring into compliance, at no cost to CARB, any Work by Contractor or its subcontractors not meeting the Accessibility Requirements. If Contractor fails to bring its or its subcontractors’ Work into compliance with the Accessibility Requirements within five (5) business days of written notice from CARB, or within the time frame specified by CARB in its notice, Contractor will be responsible for all costs incurred by CARB in bringing Contractor’s or its subcontractors’ Work into compliance with the Accessibility Requirements. Contractor agrees to respond to and resolve any complaint brought to its attention regarding accessibility of deliverables provided under this Contract for a period of one year following delivery of the final deliverable under this Contract.

Deviations from the Accessibility Requirements are permitted only by written consent by CARB.

EXHIBIT A2

KEY PERSONNEL

Name	Institutional Affiliation	Role on Project
Principal Investigator (PI):		
Rebecca J. Schmidt, PhD	UCD	As the Principal Investigator for this project, Dr. Schmidt will be responsible for the scientific direction and overall conduct of the project. Dr. Schmidt will contribute to all phases of the project but will specifically play the lead on Tasks 2-6 in regard to child neurodevelopmental outcomes. Dr. Schmidt will also supervise study staff and coordinate across all investigators on this project to ensure all deliverables are met on time and will facilitate communications with CARB.
Co-Investigators:		
Anh Nguyen, MD, MPH	UCD	Dr. Nguyen will provide clinical expertise in allergic rhinoconjunctivitis and asthma and will lead the respiratory health outcomes aspects of the study, primarily for Task 3.
Kathryn Conlon, PhD	UCD	Dr. Conlon will oversee analysis and interpretation of the maternal mental health outcomes as well as cardiovascular-related outcomes of mothers and children.
Meghan Miller, PhD	UCD	As a licensed clinical psychologist, Dr. Miller will provide expertise on ASD and ADHD, will oversee clinical aspects for the project, and will advise on neurodevelopmental assessments

Daniel Tancredi, PhD	UCD	Dr. Tancredi will contribute statistical expertise in overseeing the specification, fitting, validation and interpretation of the regression models and estimation of health impact functions examination of interactions for Tasks 2-4.
Deborah Bennett, PhD	UCD	Dr. Bennett will provide environmental exposure expertise on wildfire $PM_{2.5}$ and metals exposure assessment for the project.
Michael Kleeman, PhD	UCD	Dr. Kleeman will provide expertise and assist in using the exposure fields he produced for wildfire $PM_{2.5}$ over California in analysis and interpretation
Sean Raffuse	UCD	Mr. Raffuse modeled wildfire emissions for the 2017-2021 California wildfires and will provide expertise on analysis and interpretation of the $PM_{2.5}$ estimates for this project.
Amanda Goodrich, PhD	UCD	Dr. Goodrich will lead Task 1 literature review, and work with the study team under the supervision of Drs. Schmidt and Tancredi on statistical analysis for Tasks 2-4 with a focus on wildfire $PM_{2.5}$.
Aaron Specht, PhD	Purdue University	Dr. Specht and his laboratory will oversee the processing, quality control, and interpretation of metals data collection, as well as participate in the analysis, interpretation, and dissemination of other metal exposure measures in the study.

EXHIBIT A3

KEY PERSONNEL

The following individuals are the authorized representatives for the State and the University under this Agreement. Any official Notices issued under the terms of this Agreement shall be addressed to the Authorized Official identified below, unless otherwise identified in the Agreement.

State Agency Contacts Agency Name: **CARB**	**University Contacts** University Name: **University of California, Davis**
Contract Project Manager (Technical) Name: Feng-Chiao Su Address: Research Division 1001 I Street, 7th Floor Sacramento, CA 95814 Telephone: (916) 440-8245 Email: feng-chiao.su@arb.ca.gov	Principal Investigator (PI) Name: Rebecca J. Schmidt Address: One Shields Avenue Davis, CA 95616 Telephone: (530) 752-3226 Email: rjschmidt@ucdavis.edu Designees to certify invoices under Section 14 of Exhibit C on behalf of PI: 1. Nicole Tardiff, Director, ndtardiff@ucdavis.edu 2. Mario Reina-Guerra, Associate Director, mreinaguerra@ucdavis.edu.edu 3. Tammy Castelli, Supervisor, tacastelli@ucdavis.edu

Authorized Official (contract officer) Name: Alice Kindarara, Branch Chief Address: Acquisitions Branch 1001 I Street, 20th Floor Sacramento, CA 95814 Telephone: (279) 216-0406 Email: alice.kindarara@arb.ca.gov ***Send notices to (if different):*** Name: Renee Carnes Address: Research Division 1001 I Street, 7th Floor Sacramento, CA 95814 Telephone: (279)-208-7754 Email: renee.carnes@arb.ca.gov	***Authorized Official*** Name: Denise Ehlen, Executive Associate Vice Chancellor for Research Address: One Shields Ave, Mrak Hall 4th Floor Davis, CA 95616 ***Send notices to (if different):*** Telephone: (530) 754-7700 Email: awards@ucdavis.edu
Administrative Contact Name: Renee Carnes Address: Research Division 1001 I Street, 5th Floor Sacramento, CA 95814 Telephone: (279)-208-7754 Email: renee.carnes@arb.ca.gov	***Administrative Contact*** Name: Alyssa Bunn Contract and Grant Analyst Sponsored Programs Office Address: One Shields Ave, Mrak Hall 4th Floor Davis, CA 95616 Telephone: (530) 754-7700 Email: awards@ucdavis.edu
Financial Contact/Accounting Name: Accounts Payable Address: P.O. Box 1436 Sacramento, CA 95814 Email: AccountsPayable@arb.ca.gov **Send courtesy copy to:** rd.invoices@arb.ca.gov	***Authorized Financial Contact/Invoicing*** Name: Mario Reina-Guerra, Associate Director Address: 1440 Research Park Drive Davis, CA 95618 Email: cga-invoices@ucdavis.edu Designees for invoice certification in accordance with Exhibit C – University Terms and Conditions, Section 14 on behalf of the Financial Contact: 1. Jenny Scales, Fund Mgr., Supervisor, jmscale@ucavis.edu 2. Lenora Bruce, Fund Mgr., Supervisor, labruce@ucdavis.edu

EXHIBIT A4

USE OF INTELLECTUAL PROPERTY & DATA

A. State: Preexisting Intellectual Property (IP)/Data to be provided to the University from the State or a third party for use in the performance in the Scope of Work.

☒ None or ☐ List:

B. University: Restrictions in Preexisting IP/Data included in Deliverables identified in Exhibit A1, Deliverables.

☐ None or ☒ List:

Owner (State Agency or 3rd Party)	Description	Nature of restriction:
University of California Davis	Participant addresses and geocodes.	Data will only be shared for participants who agree to have their data shared outside of UCD. No PII (including addresses and geocodes) will be shared.

C. Anticipated restrictions on use of Project Data.
If the University PI anticipates that any of the Project Data generated during the performance of the Scope of Work will have a restriction on use (such as subject identifying information in a data set), then list all such anticipated restrictions below. If there are no restrictions anticipated in the Project Data, then check "none" in this section.

☐ None or ☒ List:

Owner (State Agency or 3rd Party)	Description	Nature of restriction:
University of California Davis	PII, including participant names, dates of birth, addresses, geocodes.	PII will not be shared outside of University of California Davis.
University of California Davis	Participant data	De-identified data will only be shared for participants who agree to have their data shared outside of University of California Davis (in the consent form).

EXHIBIT A5

RÉSUMÉ / BIOSKETCH

See next pages

REBECCA J. SCHMIDT, PhD

Full Tenured Professor: Department of Public Health Sciences, School of Medicine, University of California Davis
Institute/Center Affiliations: MIND Institute, Environmental Health Sciences Core Center, Perinatal Origins of Disparities (POD) Center, Intellectual Developmental Disabilities Research Center

Education

1998	B.S.	Biology	University of Iowa, Iowa City, IA
2000	M.S.	Epidemiology	University of Iowa College of Public Health, Iowa City, IA
2007	Ph.D.	Epidemiology	University of Iowa College of Public Health, Iowa City, IA

Dissertation Title: "Maternal Caffeine Intake, Selected Metabolic Gene Variants, and Neural Tube Defects"

Professional Experience

2023-	Full Tenured Professor, Public Health Sciences, School of Medicine, UC Davis
2019-2023	Associate Tenured Professor, Public Health Sciences, School of Medicine, UC Davis
2015-2019	Assistant Tenure-Track Professor, Public Health Sciences, School of Medicine, UC Davis
2011-2015	Building Interdisciplinary Research Careers in Women's Health (BIRCWH) Scholar, UC Davis
2010-2015	Assistant Adjunct Professor, Public Health Sciences, School of Medicine, UC Davis
2008-2010	Postdoctoral Fellow, Autism Research Training Program, MIND Institute, School of Medicine, UC Davis
2003-2007	Research Fellow, Iowa Birth Defects Center for Research and Prevention, University of Iowa
2000-2001	Epidemiologist, State Center for Health Statistics, Iowa Department of Public Health (IDPH)

Scientific Appointments and Professional Memberships

2024-	Co-Chair, International Society for Children's Health and the Environment (ISCHE) Climate Change Workgroup
2022-	Observational Study Monitoring Board (OSMB) for HEALthy Brain and Child Development (HBCD) Study
2021-2023	Co-Chair, Neurodevelopmental Workgroup; Environmental Influences on Child Health Outcomes Program
2020-	Voting Member of the ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) GCP 44: Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events
2019-	Departmental Liaison for the Women in Medicine and Health Sciences (WIMHS) Program
2019-	Member of the Data Safety and Monitoring Board for the GROWell) Study led by Dr. Simmons
2017-	Building Interdisciplinary Research Careers in Women's Health (BIRCWH) Program Mentor
2015-	Translation Core Co-lead for the Environmental Health Sciences Core Center, UC Davis
2013-2018	Faculty Development Investigator, Center for Children's Environmental Health, UC Davis
2011- 2015	Building Interdisciplinary Research Careers in Women's Health (BIRCWH) Program Scholar
2010-	Faculty Member of the Graduate Group in Epidemiology (GGE), and Master of Public Health, UC Davis

Editorial Boards: *Autism Research* (2019-), *Environ Epigenetics* (2015-), *Journal of Nutritional Biochemistry* (2012-) *Memberships:* DoHAD Society (2019-), ISCHE (2019-), Pregnancy And Childhood Epigenetics (PACE) Consortium (2019-), Baby Siblings Research Consortium (2014-), Environmental Epidemiology Autism Research Network (2011-), Intl Society for Environmental Epidemiology (2011-), Intl Society for Autism Research (2008-), Society of Epidemiologic Research (2003-), Am Society for Nutrition (2010-14), Am Assoc for Adv of Science (2008-10), Society for Neuroscience (2008-9) **Honors and Awards**

2019/2024	Top 50 Ranking, NIH Funding to US Medical Schools – by Blue Ridge Institute for Medical Research
2019	National Institute of Environmental Health Sciences (NIEHS) Keystone Science Lecturer
2018	Top 20 most read paper / top downloaded article 2017-2018 in Autism Research - Wiley
2015-2017	Mentor for two graduate students awarded the Ellen B. Gold Fellowship
2015, 2018	Primary mentor for 2 graduate students selected for FUTURE Certificate Program, NIH BEST initiative
2012-2014	NIEHS travel awards for The Environmental Epidemiology of Autism Research Network Annual Meetings
2011	Paper selected as *Top Ten Science Autism Research Achievements of 2011* by Autism Speaks
2011	Paper recognized as a *2011 Paper of the Year* by the NIH NIEHS

Selected Current Funded Projects (of 12)

UG3OD035550	Schmidt (PI)	09/01/2023 – 08/31/2030
Prenatal Environment And Child Health (PEACH) in ECHO		Total: $16,363,488
UG3 OD023365	Hertz-Picciotto, Bennett, Schweitzer (MPI)	09/01/2023 – 08/31/2030
Revisiting ReCHARGE: ECHO Follow up on Middle Childhood and Adolescence. Role: Co-I		Total: $6,594,776
UG3 OD023342	Lyall, Volk (MPI)	09/01/2023 – 08/31/2030
Trajectories and Environments in Autism: a Multi-cohort Study (TEAMS) following autism families in ECHO Phase 2		
Role: Site PI		Total: $6,936,180
R01ES034554 Autism Center for Excellence	Volk, Ladd-Acosta (MPI)	07/01/2022 – 6/30/2027

GEARs: Combining advances in Genomics and Environmental science to accelerate Actionable Research and practice in

ASD. Role: Site/Sub-contract PI, Co-I Total: $11,722,281
CNPRC (California National Primate Research Center) Pilot Schmidt (PI) 06/01/2022 – 06/30/2024 "Wildfire Effects on Behavior and Blood Epigenetics (WEBB)" Total: $50,000
U24ES028533 Schmidt, Chambers (MPI) 12/01/2022 – 11/30/2027 *BUILDS MARBLES: Biorepository Upkeep and Infrastructure for Longitudinal Data Sharing for MARBLES* Total: $1,962,500 EPA STAR 84048401 Schmidt, Nuño (MPI) 10/01/2022 – 09/30/2025
Early Life Vulnerability to Climate-driven Wildfire Events on Pregnancy and Child Developmental Health Outcomes in Underserved Populations Total: $1,349,979
R01ES031701 Hertz-Picciotto/Bennett /Schmidt/Walker (MPI) 05/01/2020 – 01/31/2025 *The CHARGE Study Phase II: A Multifactorial Approach to Autism Etiology* Total: $11,150,360 2P30ES023513 PI: Hertz-Picciotto 04/1/2020 - 03/31/2025 *UC Davis Environmental Health Sciences Core Center*. Role: Co-Leader, Core 1 Total: $21,200,000 **Collaborative Research Track Record**

As an environmental and molecular epidemiologist with over 20 years experience in collaborative epidemiology studies of maternal and child health, my research largely focuses on gestational exposures in relation to neurodevelopment as they interact with psychosocial factors, genetics, metabolism, immune responses, and epigenetics. I successfully lead/co- lead several epidemiologic studies, including the B-SAFE wildfire pregnancy cohort, the CHARGE autism case-control study, the elevated-likelihood MARBLES pregnancy cohort of younger siblings of children with autism, the UCD site for the TEAMS ECHO cohort that follows MARBLES and EARLI children at older ages, and a pregnancy cohort (PEACH) in the national ECHO Program. I have led/co-led many transdisciplinary teams and mechanistic studies, including examinations of mitochondrial, epigenomic, transcriptomic, and metabolomic variations. I led an EPA community project studying populations vulnerable to early life wildfire exposure in association with birth and child neurodevelopmental outcomes using linked state-wide datasets. I oversee a biorepository with over 55,000 specimens. I have over 125 publications, including several on prenatal air pollution in relation to neurodevelopmental outcomes and wildfire impacts. I am sought out internationally for invited talks with nearly 50 accepted including as NIEHS Keystone Science Lecturer, ECHO Discovery Speaker, NIEHS Workshop speaker/panelist, and as speaker for many international scientific conference sessions, including for the: Organization of Teratology Information Specialists, American Public Health Association, Society for Birth Defects Research and Prevention, International Society for Environmental Epidemiology, Society for Toxicology, Japan, and the BC Lung Foundation. I am also sought out for leadership or participation on several panels, boards, and workgroups, demonstrating prominence in my research field. I bring leadership of cohort studies, expertise on study design, outreach and engagement, data collection and neurodevelopmental assessment tools, biospecimen management, analytic approaches, and interpretation of environmental and molecular epidemiology findings.

Selected Peer-Reviewed Publications (of 125)

High-Impact Publications

Parenti M, **Schmidt RJ**, Tancredi DJ, Hertz-Picciotto I, Walker CK, Slupsky CM. Neurodevelopment and Metabolism in the Maternal-Placental-Fetal Unit. ***JAMA Network Open*** 2024;7(5):e2413399.

Fu JM, Satterstrom FK,… **Schmidt RJ**, Smith M,…; ASC; Broad-CCDG; iPSYCH-BROAD Consortium; Cutler DJ, De Rubeis S, Buxbaum JD, Daly MJ, Devlin B, Roeder K, Sanders SJ, Talkowski ME. Rare coding variation provides insight into the genetic architecture and phenotypic context of autism. ***Nat Genet***. 2022 Sep;54(9):1320-1331. PMID: 35982160.

Dou JF, Middleton LYM, Zhu Y, Benke KS, Feinberg JI, Croen LA, Hertz-Picciotto I, Newschaffer CJ, LaSalle JM, Fallin MD*, **Schmidt RJ***, Bakulski KM*. (2022 Aug). Prenatal vitamin intake in first month of pregnancy and DNA methylation in cord blood and placenta in two prospective cohorts. ***Epigenetics & Chromatin*** 2;15(1):28. PMID:35918756. *co-senior

Mordaunt CE, Jianu JM, Laufer BI, Zhu Y, Hwang H, Dunaway KW, Bakulski KM, Feinberg JI, Volk HE, Lyall K, Croen LA,… Fallin MD, **Schmidt RJ**, LaSalle JM (2020). Cord blood DNA methylome in newborns later diagnosed with autism spectrum disorder reflects early dysregulation of neurodevelopmental and X-linked genes. ***Genome Medicine*** 12(88).

Satterstrom FK, Kosmicki JA,…ASC, **Schmidt R**, iPSYCH-Broad Consortium,… State MW, Cicek AE, Talkowski ME, Cutler DJ, Devlin B, Sanders SJ, Roeder K, Daly MJ, Buxbaum JD (2020). Large-Scale Exome Sequencing Study Implicates Both Developmental and Functional Changes in the Neurobiology of Autism. ***Cell*** 180(3): 568-584.e23.

Schmidt RJ, Iosif A-M, Guerrero Angel E, Ozonoff S (2019). Maternal Prenatal Vitamin Use and Risk for Autism Spectrum Disorder in the MARBLES Prospective Study of Enriched-risk Siblings. ***JAMA Pscychiatry*** 2019;76(4):391-398.

Zhu Y, Mordaunt CE, Yasui DH, Marathe R, Coulson RL, Dunaway KW, Walker CK, Ozonoff S, Hertz-Picciotto I, **Schmidt RJ**,* LaSalle JM*(2019 Aug 15). Placental DNA methylation levels at CYP2E1 and IRS2 are associated with child outcome and genetic or nutrient modifiers in a prospective autism study. ***Human Molec Genet*** 28(16):2659-2674. *co-senior

Mordaunt CE,* Park BY,* Bakulski KM, Feinberg JI,… LaSalle JM,** **Schmidt RJ**,** Fallin MD**(2019 Oct 24). A meta-analysis of two high-risk prospective cohort studies reveals autism-specific transcriptional changes to chromatin, autoimmune, and environmental response genes in umbilical cord blood. ***Molecular Autism*** 10(36). **co-senior

Schmidt RJ, Kogan V, Shelton JF, Delwiche L, Hansen RL, Ozonoff S, Ma CC, McCanlies EC, Bennett DH, Hertz-Picciotto I, Tancredi DJ, Volk HE (2017). Combined Prenatal Pesticide Exposure and Folic Acid Intake in Relation to Autism Spectrum Disorder. ***Environ Health Perspect***.125(9):097007. PMID 28934093.

Schmidt RJ, Hansen RL, Hartiala J, Allayee H, Schmidt L, Tancredi DJ, Tassone F, Hertz-Picciotto I (2011 Jul). Prenatal vitamins, functional one-carbon metabolism gene variants, and risk for autism in the CHARGE Study. ***Epidemiology*** 22(4): 476-485. Published Online, May 24, 2011. PMCID: PMC3116691

Air Pollution and Wildfire Smoke Publications

Bowman WS, **Schmidt RJ**, Sanghar GK, Thompson GR, Ji H, Zeki AA, Haczku A. 2024 Mar 7. "Air That Once Was Breath" Part 1: Wildfire-Smoke-Induced Mechanisms of Airway Inflammation – "Climate Change, Allergy and Immunology" Special IAAI Article Collection: Collegium Internationale Allergologicum Update 2023. *Int Arch Allergy Immunol* 1-17.

Raffuse S, O'Neill S, **Schmidt RJ**. A model for rapid wildfire smoke exposure estimates using routinely-available data - rapidfire v0.1.3. *EGUsphere* 06 Jul 2023.

Song AY, Feinberg JI, et al, **Schmidt RJ**, Ladd-Acosta C and Volk HE (2022) Prenatal Exposure to Ambient Air Pollution and Epigenetic Aging at Birth in Newborns. *Front. Genet*. 13:929416.

Goodrich AJ, et al, **Schmidt RJ.** (2023) Ultrafine particulate matter exposure during second year of life, but not before, associated with increased risk of autism spectrum disorder in BKMR mixtures model of multiple air pollutants.
Environmental Research, 242:117624.

Goodrich AJ, Volk HE, Tancredi DJ, McConnell R,… **Schmidt RJ**. (2018 Jan) Joint Effects of Prenatal Air Pollutant Exposure and Maternal Folic Acid Supplementation on Risk of Autism Spectrum Disorder. *Autism Research.* 11(1):69-80.

Goodrich AJ, Kleeman M,… **Schmidt RJ**. (2024) Pre-pregnancy ozone and ultrafine particulate matter exposure in 2nd year of life associated with decreased childhood cognitive and adaptive function. *Environmental Research*, 252:118854.

Epigenetics

Kotsakis Ruehlmann A, et al. Epigenome-wide meta-analysis of prenatal maternal stressful life events and newborn DNA methylation. *Mol Psychiatry*. 2023 Mar 10 PMID: 36899042.

Laufer B, Neier K, Valenzuela AE, Yasui DH, **Schmidt RJ**, Lein PJ, LaSalle JM. Placenta and fetal brain share a neurodevelopmental disorder DNA methylation profile in a mouse model of prenatal PCB exposure. ***Cell Reports*** 38(9):110442. * ***NIEHS Paper of the Month***

Zhu Y, et al, **Schmidt RJ**, Yasui DH, LaSalle JM. Placental methylome reveals a 22q13.33 brain regulatory gene locus associated with autism. *Genome Biology* 2022 23(46):1-32.

Mordaunt CE, Mouat JS, **Schmidt RJ**, LaSalle J. Comethyl: A network-based methylome approach to investigate the multivariate nature of health and disease. *Brief Bioinform* 2022;23(2):b554.

Breton C, Landon R, Kahn LG, et al. Exploring the evidence for epigenetic regulation of environmental influences on child health across generations. ***Nature Comm Biol***. 2021; 4:769.

Schroeder DI, **Schmidt RJ**, Crary-Dooley FK, et al, LaSalle JM. (2016 Dec 15). Placental methylome analysis from a prospective autism study. *Mol Autism*, 7(1):51. PMID: 28018572.

Schmidt RJ, Schroeder DI, et al. (2016) Self-Reported Pregnancy Exposures and Placental DNA Methylation in the MARBLES Prospective Autism Sibling Study. *Environ Epigenet* 2(4):1-10.

Dou J, **Schmidt RJ**, et al. (2018) Cord blood buffy coat DNA methylation is comparable to whole cord blood DNA methylation measures. *Epigenetics.* 13(1):108-116 PMID: 29451060.

Song A, Bakulski K, … **Schmidt RJ**, et al. Associations between accelerated parental biologic age, autism spectrum disorder, social traits, and developmental and cognitive outcomes in their children. *Autism Res*. 2022 Dec;15(12):2359-2370.

Mouat JS, Li X, Neier K, Zhu Y, Mordaunt CE, …, **Schmidt RJ**, LaSalle JM. 2023 Jan. Networks of placental DNA methylation correlate with maternal serum PCB concentrations and child neurodevelopment. *Environ Res* 220:115227

Environmental Epidemiology

*Parenti M, **Schmidt RJ**, et al. (2022) Maternal Serum and Placental Metabolomes in Association with Prenatal Phthalate Exposure and Neurodevelopmental Outcomes in the MARBLES cohort. *Metabolites* 12(9):829. ****Editor's Choice***

Welch BM, Keil AP, Buckley JP,… Hertz-Picciotto I, **Schmidt RJ**. Associations Between Prenatal Urinary Biomarkers of Phthalate Exposure and Preterm Birth: A Pooled Study of 16 US Cohorts. ***JAMA Pediatr***. 2022 Sep 1;176(9):895-905.

Hertz-Picciotto I, **Schmidt RJ**, et al. (2018 Nov). A Prospective Study of Environmental Exposures and Early Biomarkers in Autism Spectrum Disorder: Design, Protocols and Preliminary Data from the MARBLES Study. *EHP* 126(11):117004.

Choi JW, Oh J,… **Schmidt RJ**, Shin HM. Prenatal exposure to per- and polyfluoroalkyl substances and child behavioral problems. *Environ Res*. 2024 Feb 21;251(Pt 1):118511.

Dou JF, **Schmidt RJ**, et al. Exposure to heavy metals in utero and autism spectrum disorder at age 3: A meta-analysis of two longitudinal cohorts of siblings of children with autism. *Environ Health*. 2024; 23: 62. PMID: 3897005.

Oh J, et al. Prenatal exposure to per- and polyfluoroalkyl substances in association with autism spectrum disorder in the MARBLES study. *Environment International*. 2021 Feb;147:106328.

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Nguyen, Anh Phuong

eRA COMMONS USER NAME (credential, e.g., agency login): APHNGUYEN

POSITION TITLE: Associate Professor of Pediatrics, Division of Allergy, Immunology and Rheumatology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of California, Los Angeles	B.S.	06/2009	Physiology
Univ. of Texas, School of Medicine at San Antonio	M.D.	05/2015	Doctor of Medicine
Univ. of Texas, School of Public Health at Houston	M.P.H.	05/2015	Master of Public Heath
University of California, Davis Medical Center	Residency	06/2018	Internal Medicine
University of California, Davis Health	Fellowship	07/2020	Allergy and Immunology

A. Personal Statement

I am a Pediatric Allergist and Immunologist with a passion for clinical and environmental research to improve children's respiratory health and atopic conditions. Throughout my medical training including my M.P.H., Internal Medicine residency and Allergy and Immunology Fellowship, I've been honing my scientific skills with the goal of contributing to health discoveries, preventing diseases, and addressing environmental health issues. For the past several years, I've been researching asthma pathophysiology and exploring the environmental determinants of respiratory disease. As a pediatric allergist and immunologist, I specialize in helping children from infancy through adolescent age with respiratory conditions including asthma, immunologic disorders, and atopic conditions clinically. As part of the diagnostic workup, I routinely interpret lung function tests, radiographic images, serum testing to determine the best treatment for my patients.
Additionally, given the broad spectrum of my expertise in immunodeficiency and allergic disorders, I've extensive experience working with many pediatric patients with neurodevelopmental disabilities and their families (especially those with 22q11.1 deletion syndrome).

In addition to my clinical asthma and other respiratory conditions experience, I have also worked on different respiratory and allergy research projects. I collaborated with pulmonary and engineering departments in projects that used exhaled breath to non-invasively assess airway inflammation. Currently I am a co- investigator with Dr. Kenyon in the 5-year study funded by National Heart, Lung, and Blood PrecISE (Precision Interventions for Severe or Exacerbation-prone Asthma) aiming to personalize treatment for severe asthmatics. In collaboration with Drs. Hertz-Picciotto and Schmidt, I am a co-Investigator for ReCHARGE (Re-Childhood Autism Risks from Genetics and Environment) and the PEACH (Prenatal Environment And Child Health) ECHO cohorts in the national ECHO Program by providing my clinical pulmonary expertise. I receive pilot funding from University of

California Davis Environmental Health Sciences Center (EHSC) under Award Number P30ES023513 of the National Institute of Environmental Health Sciences on my proposal with Dr. Schmidt examining effect of prenatal wildfire exposure on respiratory and allergic conditions in the B-SAFE cohort.

For this project, I will provide my expertise on pediatric asthma throughout this study, including administering the Respiratory Questionnaire. Given my public health and respiratory health expertise, experience with neurodevelopmentally disabled patients, motivation, and previous successes with administering projects and collaborations, I am confident that I will provide my expertise in evaluating pediatric respiratory and allergic conditions and successfully carry out the proposed research project.

B. Positions, Scientific Appointments,

and Honors <u>Positions and Employment</u>

2020 – Present Associate Professor, Department of Pediatrics, Division of Allergy, Immunology and Rheumatology, UCD Health
2018 – 2020 Clinical Fellow, Department of Internal Medicine, Division of Allergy, and Immunology, UCD Health
2015 – 2018 Clinical Trainee, Internal Medicine Residency, UCD Health
2010 – 2011 Post-bachelor Research Assistant, Barth Lab, Department of Pharmacology, Baylor College of Medicine
2008 – 2009 Student Research Assistant, Wang Lab, Department of Cardiology, UCLA 2006 – 2009 Peer Advisor/Tutor, Higher Opportunity Program for Education (HOPE), UCLA

<u>Other Experience and Professional Memberships</u>
2020 – Present Member, AAAAI Environmental Exposure and Respiratory Health Committee 2020 – Present Member, AAAAI Committee on the Underserved
2020 – Present Member, AAAAI Health Informatics, Technology and Education Committee 2020 – Present Member, AAAAI Asthma Committee
2019 – Present Member, European Academy of Allergy and Clinical Immunology 2018 – Present Member, American College of Allergy, Asthma, and Immunology 2018 – Present Member, American Academy of Allergy, Asthma & Immunology 2018 – Present Member, Clinical Immunology Society
2011 – 2018 Member, American Medical Association

<u>Honors/Awards</u>
2022 AAAAI Faculty Development Program Awardee, AAAAI
2022 Environmental Health Sciences Pilot Awardee, UC Davis NIEHS award #P30ES023513 2021 Friends of Nursing Excellence Award, UC Davis Health
2020 Clinical Immunology Society Diagnostic School Scholar
2019 American College of Allergy, Asthma, and Immunology Fellow Scholarship 2019 American Academy of Allergy, Asthma & Immunology Fellow Scholarship 2018 American College of Allergy, Asthma, and Immunology Fellow Scholarship 2018 American Academy of Allergy, Asthma & Immunology Travel Scholarship 2015 UT Health Sciences Community Service-Learning Midi-Grant Award
2013 UT Health Sciences MESA Scholars Research Scholarship
2013 UT Health Sciences Medical Students Summer Research Scholarship 2012 University of Utah Scaife Scholarship Grant
2009 Bachelor of Science in Physiology, *cum laude*
2009 UCLA Center for Academic Research Excellence Fellows Award 2008 UCLA Undergraduate Research Fellow Program Scholarship

C. Contributions to Science

1. Asthma is one of the most common chronic childhood illnesses, affecting as many as 300 million individuals worldwide. Exposure to indoor allergens, including dust mites, cockroach, pet allergens have been found to induce airway inflammation. Similarly, exposure to pollutants such as particle pollution ($PM_{2.5}$ and PM_{10}), carbon monoxide, volatile organic compounds, and other air pollutants is associated with reduced airway function and adversely affect respiratory health. While the association between allergens, air pollutants and airway inflammation have been identified, there has not been a method to noninvasively measure the direct effect of these irritants in the airway. To help uncover the effect of environmental triggers on airway inflammation, I collaborated with the pulmonary and engineering department in a project that designed a non- invasive breath diagnostic tool that measures exhaled breath metabolites in real-time and longitudinally. The detected targeted metabolites generated from the COX pathway, from the 5-, 12- and 15-LOX pathways as well as o-tyro-sine formed by oxidation stress of proteins were all lower in asthmatics compared to non- asthmatics. The prototype device showed that wide array of chemicals can be detected using exhaled breath and this can be used to monitor respiratory health. In addition to this study, I was also a collaborator and co- author in another exhaled breath research study which examined the role of aldehydes measured non- invasively in exhaled human breath as biomarkers of oxidative stress. These studies can be used to further advance non-invasive personal health monitoring technology. Lastly, I've collaborated with others from other institutions and co-authored a workgroup report that explore methods to ensure equitable access to guideline- based asthma care.

a) Alexander J. Schmidt, Borras Eva, **Anh Nguyen**, Nicholas J. Kenyon, Cristina E. Davis. C. *Journal of Breath Research*. 2020 Jan 23;14(2):026001.

b) **Anh Nguyen**, Alexander J. Schmidt, Nicholas J. Kenyon, Cristina E. Davis. Portable Diagnostic Health Sensor Device- A Novel Method To Monitor Asthma in Children. *Annal Allergy Asthma Immunology*. 2019, Nov;123(5): S54.

c) Mitchell M. McCartney, Carina J. Thompson, Lauren R. Klein, Josephine H. Ngo, Jacqueline D. Seibel, Fauna Fabia, Eva Borras, **Anh P. Nguyen**, Leslie A. Simms, Nicholas J. Kenyon, Terence H. Risby, Helen Crampin, Cristina E. Davis. Breath carbonyl levels in a human population of seven hundred participants. *Journal of Breath Research*. 2020 Jul 21;14(4):046005.

d) Nanda A, Siles R, Park H, Louisias M, Ariue B, Castillo M, Anand MP, **Nguyen A**, Jean T, Lopez M, Altisheh R, Pappalardo AA. Ensuring Equitable Access to Guideline-Based Asthma Care Across the Lifespan: Tips and Future Directions to the Successful Implementation of the New NAEPP 2020 Guidelines, A Work Group Report of the AAAAI Asthma, Cough, Diagnosis and Treatment Committee. J Allergy Clin Immunol. 2023 Jan 28:S0091-6749(23)00121-5. doi: 10.1016/j.jaci.2023.01.017

e) Miller RL, Schuh H, Chandran A, Habre R, Angal J, Aris IM, Aschner JL, Bendixsen CG, Blossom J, Bosquet-Enlow M, Breton CV, Camargo CA Jr, Carroll KN, Commodore S, Croen LA, Dabelea DM, Deoni SCL, Ferrara A, Fry RC, Ganiban JM, Geiger SD, Gern JE, Gilliland FD, Gogcu S, Gold DR, Hare ME, Harte RN, Hartert TV, Hertz-Picciotto I, Hipwell AE, Jackson DJ, Karagas MK, Khurana Hershey GK, Kim H, Litonjua AA, Marsit CJ, McEvoy CT, Mendonça EA, Moore PE, **Nguyen AP**, Nkoy FL, O'Connor TG, Oken E, Ownby DR, Perzanowski M, Rivera-Spoljaric K, Sathyanarayana S, Singh AM, Stanford JB, Stroustrup A, Towe- Goodman N, Wang VA, Woodruff TJ, Wright RO, Wright RJ, Zanobetti A, Zoratti EM, Johnson CC; ECHO Cohort Consortium. Child Opportunity Index at Birth and Asthma with Recurrent Exacerbations in the U.S. ECHO Program. J Allergy Clin Immunol. 2025 Mar 13:S0091-6749(25)00273-8. doi: 10.1016/j.jaci.2025.02.036. Epub ahead of print. PMID: 40089117.

2. In addition to these contributions above, I've written case reports and presented clinical conundrums at national conferences to bring awareness to different challenging aspects of clinical practice. I aim to continue to share my clinical knowledge with the medical community with the hope of improving patient outcomes.

a) **Anh Nguyen.** How Palliative Care Transform My Perspective of Medicine. *Journal of Palliative Medicine.* 2011 Feb; 14(2): 244.

b) **Anh Nguyen**, Suzanne Teuber. Mast Cell Activation Disorder Masquerading as a Nervous Breakdown. *Case Reports in Internal Medicine*. 2017, Jul; 4(3): 51-56.

c) **Anh Nguyen**, Wesley Hoffman, Bennett H. Penn, Suzanne Teuber. Successful treatment of neurocysticercosis with albendazole desensitization. *Asian Pacific Journal of Allergy and Immunology*. 2021 Feb 21.

d) **Anh Nguyen**, James Kong, Suzanne Teuber. Severe Topical Corticosteroid Withdrawal from OTC Steroids.
Journal of Allergy Immunology: In Practice. 2021 Sep 3; S2213-2198(21)00829-1. **Complete List of Published Work in MyBibliography:**
https://www.ncbi.nlm.nih.gov/myncbi/anh.nguyen.17/bibliography/public/

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Conlon, Kathryn Carter

eRA COMMONS USER NAME (credential, e.g., agency login):

kcconlon POSITION TITLE: Associate Professor (Tenure-Track)

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Michigan, Ann Arbor	B.A.	04/2005	Environmental Policy
Emory University, Atlanta, GA	M.P.H.	05/2007	Environmental & Occupational Health
University of Michigan, Ann Arbor	Ph.D.	08/2013	Environmental Health Sciences
US Centers for Disease Control and Prevention, Atlanta GA	Postdoc	09/2015	Epidemiology

A. Personal Statement

I am an environmental epidemiologist exploring environmental exposures and vulnerable populations. My research focuses on the complex relationships between a changing climate, human and environmental health. I explore the ways adaptation to climate change can protect health. I incorporate traditional environmental epidemiological study designs, mixed-methods for social and behavioral epidemiology, and implementation and evaluation science. I have experience using spatio-temporal models for exposure assessment for extreme heat. I have a strong track record of conducting epidemiological studies, focusing on extreme events (e.g., extreme heat, wildfires) amongst society's most at-risk populations, including pregnant individuals and children. Additionally, I have a contract with the California Department of Public Health (CDPH)'s Climate, Healthy, and Equity program for which I conduct the implementation and evaluation regarding climate and health interventions (e.g., home weatherization to protect against extreme heat) being implemented in the Central Valley. I have also published a book chapter that details how design, implementation, and evaluation of climate and health interventions are critical to protecting health.

I am excited to continue working with Dr. Schmidt on the B-SAFE cohort. I will support the project by conducting analyses on the long-term cardiovascular health effects of wildfire smoke exposure in mothers, fathers, and children. We will use respondent-reported height and weight data, doctor-reported cardiovascular conditions, supplemented with a survey adopting BRFSS questions to assess cardiovascular impacts amongst those exposed to wildfire smoke. I have experience coordinating multidisciplinary teams of scientists, policymakers, students, and advocates in my professional experiences as a federal scientist and as an academic. I am the Principal Investigator of an NIH-R01 environmental epidemiology study exploring the relationship between Alzheimer's Disease and Related Dementias (ADRD) and environmental exposures, including climate-driven extreme heat events. Until recently, I was also a Co-Investigator on Dr. Schmidt's EPA STAR grant (terminated as of April 2025) where I provided expertise on community-level indicators of environmental health disparities to better understand how structural disadvantage may contribute to adverse neurodevelopmental outcomes in children exposed to wildfire smoke.

Key Publications:

1. Synder M, Miles M, Hertz-Piccioto I, **Conlon KC**. 2025. Household needs among wildfire survivors in the 2017 Northern California wildfires. *Environmental Research: Health*, *3*(1), 015008. PMID: 39803630.

2. Gronlund CJ, Yang AJ, **Conlon KC**, Bergmans RS, Le HQ, Batterman SA, Wahl RL, Cameron L, O'Neill MS. 2020. Total and direct associations between high temperatures and preterm births in Detroit, Michigan. BMJ Open, 10(2): e032476. PMCID: PMC7045030
3. Bell JE, Brown CL, **Conlon KC,** Herring S, Kunkel KE, Lawrimore J, Luber G, Schreck C, Smith A, Uejio C. 2018. Change in extreme events and the potential impacts on human health. J Air Waste Manag Assoc, 68(4): 265-287. PMCID: PMC9039910
4. **Conlon KC**, Rajkovich NB, White-Newsome JL, Larsen L, O'Neill MS. 2011. Preventing cold-related morbidity and mortality in a changing climate. Maturitas, 69(3): 197-202. PMCID: PMC3119517

Ongoing research I would like to highlight includes:

NIH/NIA R01 AG074347 (Conlon, PI) 06/15/22-03/31/27
Extreme Weather-Related Events and Environmental Exposures in the Risk for Alzheimer's Disease and Related Dementias

California Department of Public Health (Conlon, PI) 06/01/22-03/31/27 CalBRACE Evaluation

B. Positions, Scientific Appointments,

and Honors <u>Positions and Scientific</u>

<u>Appointments</u>

2023-present Associate Professor, Department of Public Health Sciences, UC Davis
2018-2023 Assistant Tenure-Track Professor, Department of Public Health Sciences, UC Davis 2018-2022 Lecturer, Yale School of Public Health, Yale University
2017 Epidemiologic and Surveillance Task Force Lead, Hurricane Maria Response, US CDC 2016-present Field Editor, International Journal of Biometeorology
2016 Syndromic Surveillance Data Lead, 2016 Puerto Rico Zika Response, US CDC
2015-present Contributing author, National Climate Assessment, US Global Climate Research Program 2015-2018 Epidemiologist, Climate and Health Program, National Center for Environmental Health, US Centers for Disease Control and Prevention
2013-2015 Postdoctoral Research Fellow, National Center for Atmospheric Research, Boulder CO; National Center for Environmental Health, US Centers for Disease Control and Prevention
2011-2013 Environmental Health Scientist, Oneida Total Integrated Enterprises, Oak Ridge TN 2009-2013 Graduate Student Research Assistant, University of Michigan School of Public Health
2007-2009 Environmental Health Research Fellow, Associations of Schools and Programs of Public Health, Exposure Modeling Research Branch, Office of Research and Development, US EPA
2005-2007 Research Assistant, Pesticide Exposure and Risk Laboratory, Rollins School of Public Health, Emory University, Atlanta GA

Reviewer: NOAA Climate Program Office RFA "Climate and Societal Interactions" (2018)

Journal Reviewer: Environmental Health Perspectives, American Journal of Public Health, Weather Climate and Society, International Journal of Environmental Research and Public Health

Memberships: International Society for Environmental Epidemiology (2009-), American Public Health Association (2006-), American Geophysical Union (2019-), American Association for the Advancement of Science (2019-), Society for Epidemiologic Research (2011-).

C. Contributions to Science

1. **Climate change impacts on human health.** I have contributed to the growing literature on climate change and health impacts through a variety of mechanisms, including national assessments, peer-reviewed publications, and federal technical guidance documents. I have identified targeted climate change and health interventions that could protect at-risk populations to extreme events. I have designed and implemented analytical approaches for estimating population-level exposure to extreme temperature (i.e., heat waves) and wildfire smoke.
   a. Hauser N, **Conlon KC**, Desai A, Kobziar LN. 2021.Climate Change and Infections on the Move in North America. Infect Drug Resist, 30(14): 57111-5723. PMCID: PMC8722568
   b. Schramm PJ, Brown C, Saha S, **Conlon KC**, Manangan, AP, Bell JE, Hess JJ. 2021. A systematic review of the effects of temperature and precipitation on pollen concentrations and season timing, and implications for human health. International Journal of Biometeorology, 65(10): 1615-1628. PMCID: PMC9016682
   c. **Conlon KC**, Mallen E, Gronlund CJ, Berrocal VJ, Larsen L, O'Neill MS. 2020. Mapping human vulnerability to extreme heat: A critical assessment of heat vulnerability indices created using principal components analysis. Environ Health Perspec, 128(9): 97001. PMCID: PMC7466325
   d. Angel J, Swanston C, Boustead BM, **Conlon KC**, Hall KC, Jorns JL, Kunkel KE, Lemos MC, Lofgren B, Ontl TA, Posey J, Stone K, Takle G, Todey D. 2018. Chapter 21: Midwest. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. In: Reidmiller DR, Avery CW, Easterling DR, Kunkel KE, Lewis KLM, Maycock TK, Stewart BCUS, Global Change Research Program, Washington, DC, pp. 872–940. https://nca2018.globalchange.gov/chapter/21/
   e. **Conlon KC,** Monaghan A, Hayden M, Wilhelmi O. 2016. Modeling intra-urban extreme heat exposure with fine-scale land use data in Houston, Texas. PLoS ONE, 11(2): e0148890. PMCID: PMC4749320

2. **At-risk population research**. My research on vulnerable populations has added to our knowledge of how individual- and community-level characteristics mediate or confound the relationship between climate- related exposures and adverse health outcomes. This research led to further investigating what social and behavioral factors contribute to the use or rejection of protective actions. The results have supported the explicit need for a better understanding of the complex nature of risk communication and behavior related to climate exposures.
   a. Vargo J, Lappe B, Mirabelli MC, **Conlon KC.** 2023. Wildland fire smoke exposures across vulnerable communities in the United States, 2011-2018. American Journal of Public Health, 113(7): 759-767. PMCID: PMC10262248
   b. Gamble JL, Balbus J, Berger M, Bouye K, Campbell V, Chief K, **Conlon KC**, Crimmins A, Flanagan B, Gonzalez-Maddux C, Hallisey E, Hutchins S, Jantarasami L, Khoury S, Kiefer M, Kolling J, Lynn K, Manangan A, McDonald M, Morello-Frosch R, Redsteer MH, Sheffield P, Thigpen Tart K, Watson J, Whyte KP, Wolkin AF. 2016. Ch. 9: Populations of Concern. *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment.* U.S. Global Change Research Program, Washington, DC, pp. 247-286. doi: 10.7930/J0Q81B0T
   c. Gronlund CJ, Berrocal VJ, White-Newsome JL, **Conlon KC**, O'Neill MS. 2015. Vulnerability to extreme heat by socio-demographic characteristics and area green space among the elderly in Michigan, 1990 – 2007. Environmental Research, 136: 449-461. PMCID: PMC4282170
   d. Sampson NR, Gronlund CJ, Buxton MA, Catalano L, White-Newsome JL, **Conlon KC**, O'Neill MS, McCormick S, Parker EA. 2013. Staying cool in a changing climate: Reaching vulnerable populations during heat events. Global Environmental Change, 23(2): 475-484. PMCID: PMC5784212

3. **Climate change, adaptation and health.** My research also investigates the ways in which climate change-related exposures impacts health via systemic and individual-level adaptation.
    a. Sparks MS, Farahbakhsh I, Anand M, Bauch CT, **Conlon KC**, East JD, Li T, Lickley M, Garcia- Menendez F, Monier E, Saari RK. 2024. Health and equity implications of individual adaptation to air pollution in a changing climate. Proceedings of the National Academy of Sciences, 121(5): e2215685121. PMCID: PMC10835109
    b. Patel L, **Conlon KC**, Sorensen C, McEachin S, Nadeau K, Kakkad K, Kizer KW. 2022. Climate change and extreme heat events: How health systems should prepare. NEJM Catalyst, 3(7). doi: 10.1056/CAT.21.0454
    c. **Conlon KC**, Austin CM. 2020. Climate change and public health interventions. In: Pinkerton KE, Rom WN (eds.), *Global Climate Change and Public Health*. 2nd Edition.

Complete List of Published Work
https://www.ncbi.nlm.nih.gov/pubmed/?term=conlon+kathryn

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person.

NAME: Miller, Meghan

eRA COMMONS USER NAME (credential, e.g., agency login): meghanmiller

POSITION TITLE: Professor

EDUCATION/TRAINING

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
San Diego State University	B.A.	05/2006	Psychology
University of California, Berkeley	M.A.	05/2009	Psychology
Oregon Health & Science University	Internship	07/2013	Clinical Psychology
University of California, Berkeley	Ph.D.	12/2013	Clinical Psychology
University of California, Davis MIND Institute	Postdoctoral	08/2017	Autism Research

A. Personal Statement

My research and clinical training make me ideally suited to serve as a Co-Investigator on the proposed project. I am a Professor and Vice Chair of Psychology in the Department of Psychiatry & Behavioral Sciences and core faculty member within the MIND Institute at UC Davis. I have been working in the field of neurodevelopmental conditions for more than 15 years with a focus on ADHD and autism, publishing numerous papers in these areas. I have particular expertise in characterizing the early phenotypes of neurodevelopmental disorders, particularly ADHD and autism; the intersection of ADHD and autism; and in identifying longitudinal mechanisms underlying long-term, multi-domain outcomes in neurodevelopmental disorders and child behavioral and neurodevelopmental outcomes. I have been continuously funded by NIMH since 2015 and have been collaborating with the PI and her team for more than 5 years. As part of the proposed project, I will provide clinical expertise related to neurodevelopmental (e.g., autism, ADHD) and neurocognitive (e.g., executive functioning) outcomes, as well as other developmental and behavioral outcomes. This will involve ensuring appropriate measurement of symptomatology, neurocognitive functioning, and other relevant child developmental/behavioral dimensions as well as interpretation of results. I will regularly communicate with the PI to facilitate the smooth implementation of the proposed investigation.

B. Positions, Scientific Appointments, and Honors Positions and Scientific Appointments

2024-present	Professor, Department of Psychiatry & Behavioral Sciences, UC Davis
2023-present	Vice Chair of Psychology, Department of Psychiatry & Behavioral Sciences, UC Davis
2022-2023	Chief of Psychology, Department of Psychiatry & Behavioral Sciences,
UC Davis 2021-2024	Associate Professor, Department of Psychiatry & Behavioral Sciences,
MIND	
	Institute, UC Davis Medical Center
2021-present	Associate Director, Clinical Psychology Training Programs, MIND Institute, UC Davis Medical Center
2020-2022	Associate Director, Mentoring Academy for Research Excellence Clinical Translational Science Center, UC Davis

2018-present	Affiliated Faculty, Graduate Group in Psychology, Department of Psychology, UC Davis
2017-2021	Assistant Professor, Department of Psychiatry & Behavioral Sciences, MIND Institute, UC Davis Medical Center
2015-2017	K99-funded Postdoctoral Fellow, Department of Psychiatry & Behavioral Sciences, MIND Institute, UC Davis Medical Center
2015-present	Licensed Psychologist, State of California, #PSY27146
2013-2015	NIMH T32 Postdoctoral Fellow, Department of Psychiatry & Behavioral Sciences, MIND Institute, UC Davis Medical Center

Honors

Fellowships

2013-2015	NIMH Ruth L. Kirschstein National Research Service Award (T32), Autism Research Training Program, UC Davis MIND Institute

Honors/Awards (selected)

2020	INSAR Young Investigator Award
2019	Association for Psychological Science Rising Star
2015	CHADD Young Scientist Research Award
2014	American Psychological Association Early Career Achievement Award
2011-2012	P.E.O. Scholar Award, P.E.O. International
2006	Phi Beta Kappa Society

C. Contributions to Science

1. **Early identification of autism and ADHD.** Although autism can be reliably diagnosed as early as 18 months of age, the average age at diagnosis in the community remains around 4.5 years. This is much earlier than ADHD which, on average, is not typically diagnosed until around 7 years despite the fact that it is widely believed that symptoms emerge very early in life. This body of work has sought to identify early markers of ASD and ADHD and documents the ways in which the early detection methods pioneered in ASD can be applied to other conditions, namely ADHD. Publications include one of the first prospective longitudinal studies of infants at familial risk for ADHD. My role on these projects included data collection, data analysis, conceptualization of research questions, and writing.
   a. **Miller, M.**, Iosif, A., Young, G.S., Hill, M.M., & Ozonoff, S. (2016). Brief report: Early detection of ADHD: Insights from infant siblings of children with autism. *Journal of Clinical Child & Adolescent Psychology, 47,* 737-744. PMCID: PMC5436956.
   b. **Miller, M.**, Sun, S., Iosif, A.M., Young, G.S., Belding, A., Tubbs, A., & Ozonoff, S. (2021). Repetitive behavior with objects in infants developing autism predicts diagnosis and later social behavior as early as 9 months. *Journal of Abnormal Psychology, 130,* 665-675. PMCID: PMC8480432.
   c. **Miller, M.,** Iosif, A.M., Bell, L.J., Farquhar-Leicester, A., Hatch, B., Hill, A., Hill, M.M., Solis, E., Young, G.S., & Ozonoff, S. (2021). Can familial risk for ADHD be detected in the first two years of life? *Journal of Clinical Child & Adolescent Psychology, 50,* 619-631. PMCID: PMC7365744.
   d. Reetzke, R., Iosif, A., Ozonoff, S., Hatch, B., de la Paz, L., Chuang, A., & **Miller, M.** (2022). Patterns of objectively measured motor activity among infants developing ASD and concerns for ADHD. *Journal of Child Psychology & Psychiatry, 63,* 663-673. PMCID: PMC8841001.
2. **Overlap between ADHD and autism.** ADHD and autism are two highly prevalent neurodevelopmental disorders that co-occur at rates well above chance and that are believed to share some common mechanisms. This work cited below has aimed to better understand the relationship between these two conditions, demonstrating the first evidence of later-born sibling cross-aggregation of autism and ADHD in a design that addresses methodological problems of prior work (i.e., stoppage effects), providing further support for the hypothesis that autism and ADHD share common genetic influences, and describing further rationale for the investigation of

autism and ADHD in a transdiagnostic framework. Work in this area has also constituted the first published studies examining similarities and differences between autism and risk for ADHD in infancy. My role on these projects included data collection, data analysis, conceptualization of research questions, and writing.

a. Ray, S., **Miller, M.,** Karalunas, S., Robertson, C., Grayson, D.S., Cary, R.P., Hawkey, E., Painter, J.G., Kriz, D., Fombonne, E., Nigg, J.T., & Fair, D.A. (2014). Structural and functional connectivity of the human brain in autism spectrum disorder and attention-deficit/hyperactivity disorder: A rich-club organization study. *Human Brain Mapping, 35,* 6032-6048. PMCID: PMC4319550.
b. **Miller, M.,** Musser, E.D., Young, G.S., Olson, B., Steiner, R., & Nigg, J.T. (2019). Sibling recurrence and cross-aggregation of attention-deficit/hyperactivity disorder and autism spectrum disorder. *JAMA Pediatrics, 173,* 147-152. PMCID: PMC6439602.
c. **Miller, M.,** Austin, S., Iosif, A., de la Paz, L., Chuang, A., Hatch, B., & Ozonoff, S. (2020). Shared and distinct developmental pathways to ASD and ADHD phenotypes among infants at familial risk. *Development & Psychopathology, 32,* 1323-1334. PMCID: PMC7891894.
d. Hatch, B., Iosif, A., Chuang, A., de la Paz, L., Ozonoff, S., & **Miller, M.** (2021). Longitudinal differences in response to name among infants developing ASD and risk for ADHD. *Journal of Autism & Developmental Disorders, 51,* 827-836. PMCID: PMC7375942.

3. **Longer-term outcomes and manifestations of atypical development among infants and children at familial risk for neurodevelopmental disorders.** Younger siblings of children with autism are at heightened risk for a range of developmental concerns, the most well-known being autism. Yet it is becoming apparent that this population is also at greater risk for other atypical outcomes, including ADHD and other behavior problems, learning difficulties, and subclinical social communication difficulties. The work listed below used a sibling risk model and has contributed to a better understanding of both early atypicalities in this high-risk population as well as later-developing concerns, with implications for clinical screening and monitoring. My role on these projects included data collection, data analysis, conceptualization of research questions, and writing.
   a. Ozonoff, S., Young, G.S., Hill, M., Hill, A., Hutman, T., Johnson, S., **Miller, M.,** Rogers, S.J., Schwichtenberg, A.J., Steinfeld, M., & Iosif, A. (2014). The broader autism phenotype in infancy: When does it emerge? *Journal of the American Academy of Child & Adolescent Psychiatry, 53,* 398-407. PMCID: PMC3989934.
   b. **Miller, M.**, Iosif, A.M., Young, G.S., Hill, M., Phelps-Hanzel, E., Hutman, T., Johnson, S., & Ozonoff, S. (2016). School-age outcomes of infant siblings of children with autism spectrum disorder. *Autism Research, 9,* 632-642. PMCID: PMC4826645.
   c. Schwichtenberg, A.J., Young, G.S., **Miller, M.,** & Ozonoff, S. (2019). Mothers of children with autism spectrum disorder: Play behaviors with infant siblings and social responsiveness. *Autism, 23,* 821-833. PMCID: PMC6274601.
   d. **Miller, M.,** Iosif, A., Young, G.S., Bell, L.J., Schwichtenberg, A.J., Hutman, T., & Ozonoff, S. (2019). The dysregulation profile in preschoolers with a family history of autism spectrum disorder. *Journal of Child Psychology & Psychiatry, 60,* 516-523. PMCID: PMC6458078.
4. **Neurocognitive impairments and risk factors in children with ADHD and autism.** Children with ADHD or autism have been shown to experience neurocognitive skills deficits (e.g., executive function impairments). Both populations are also at heightened risk for developing long-term impairments across many functional domains. Understanding similarities and differences in neurocognitive impairments, as well as the ways in which such impairments predict longer-term outcomes, is a priority in order to determine the best ways to prevent suboptimal outcomes. The work cited below implicated neurocognitive skills (executive function, EF) in the prediction of functional outcomes and also showed that the development of EF may underlie improvements in ADHD symptoms over time. This body of work has also highlighted both shared and distinct neurocognitive impairments between autism and ADHD. My role on these projects included follow-up data collection, conceptualization of research questions, data analysis, and writing.

a. **Miller, M.** & Hinshaw, S.P. (2010). Does childhood executive function predict adolescent functional outcomes in girls with ADHD? *Journal of Abnormal Child Psychology, 38,* 315-326. PMCID: PMC2839522.
b. **Miller, M.**, Nevado, A.J., & Hinshaw, S.P. (2012). Childhood executive function continues to predict outcomes in young adult females with and without childhood-diagnosed ADHD. *Journal of Abnormal Child Psychology, 40,* 657-668. PMCID: PMC3974898.
c. **Miller, M.,** Loya, F., & Hinshaw, S.P. (2013). Executive functions in girls with and without childhood ADHD: Developmental trajectories and associations with symptom change. *Journal of Child Psychology & Psychiatry, 54,* 1005-1015. PMCID: PMC3732514.
d. Karalunas, S., Hawkey, E., Gustafsson, H., **Miller, M.,** Greiser-Painter, J., Langhorst, M., Fair, D., & Nigg, J.T. (2018). Overlapping and distinct cognitive impairments in attention-deficit/hyperactivity disorder and autism spectrum disorder without intellectual disability. *Journal of Abnormal Child Psychology, 46,* 1704-1716.

Complete List of Published Work in MyBibliography:
http://www.ncbi.nlm.nih.gov/sites/myncbi/meghan.miller.1/bibliograpahy/45843465/public/

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person.

NAME: Tancredi, Daniel Joseph

eRA COMMONS USER NAME (credential, e.g., agency login): DJTANCREDI

POSITION TITLE: Professor in Residence of Pediatrics

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE (if applicable)	END DATE MM/YYYY	FIELD OF STUDY
University of Chicago	BA	08/1988	Behavioral Sciences
University of Illinois at Chicago	MS	05/1995	Mathematics (Probability & Statistics)
University of Illinois at Chicago	PHD	07/2006	Mathematics (Mathematical Statistics)

A. Personal Statement

I am a medical statistician on the faculty in the Department of Pediatrics at the University of California, Davis. I have three decades of experience in developing, applying, and teaching methods to address significant statistical design, measurement, analysis and reporting challenges that arise in clinical trials, complex surveys, health services research, observational epidemiological studies and in biomedical laboratory sciences. I am heavily invested in multi-disciplinary research and am highly sought after for the independent statistical leadership that I contribute to team science. My research is represented by a significant body of peer reviewed publications, with more than 350 journal articles published from the time of my faculty appointment in 2007.
Before joining the faculty, I had acquired over a decade of research experience as the senior statistical and database programmer for research teams at UC Davis and Rush University engaged in health services research and in population- and clinic-based studies of aging, including numerous studies utilizing neuropsychological and cognitive assessments and/or evaluating environmental exposures. In addition, I acquired significant expertise in complex survey design and analysis and in the design and analysis of experimental studies as a graduate student and dissertation advisee of UIC Distinguished Professor Samad Hedayat, which I have further developed in my own professional practice. Currently, I direct the Statistics Core for the UC Davis NIH CounterACT Center of Excellence. The combination of intensive experience as the lead statistical programmer and rigorous training and experience as a doctoral-level mathematical statistician enables me to select and help implement practical, robust, and efficient analysis strategies for complex research projects, including the design and statistical analysis of observational epidemiological studies. A highly treasured role for me is to serve as a research mentor for early-stage investigators, which was recognized by the UC Davis School of Medicine with the 2016 Dean's Award for Excellence in Research Mentoring. I have long-standing and very successful collaboration with Dr. Schmidt (a former research mentee of mine), Dr. Bennett, and Dr. Goodrich and look forward to providing statistical leadership on this project, ensuring rigorous and useful results to inform decision making.

1. Goodrich AJ, Kleeman MJ, Tancredi DJ, Ludeña YJ, Bennett DH, Hertz-Picciotto I, Schmidt RJ. Pre- pregnancy ozone and ultrafine particulate matter exposure during second year of life associated with decreased cognitive and adaptive functioning at aged 2-5 years. Environ Res. 2024 Jul 1;252(Pt 1):118854. PubMed Central PMCID: PMC11697945.
2. Goodrich AJ, Kleeman MJ, Tancredi DJ, Ludeña YJ, Bennett DH, Hertz-Picciotto I, Schmidt RJ. Ultrafine particulate matter exposure during second year of life, but not before, associated with increased risk of autism spectrum disorder in BKMR mixtures model of multiple air pollutants. Environ Res. 2024 Feb 1;242:117624. PubMed Central PMCID: PMC10872511.

3. Bennett DH, Moran RE, Krakowiak P, Tancredi DJ, Kenyon NJ, Williams J, Fisk WJ. Reductions in particulate matter concentrations resulting from air filtration: A randomized sham-controlled crossover study. Indoor Air. 2022 Feb;32(2):e12982. PubMed Central PMCID: PMC11174346.
4. Garcia J, Bennett DH, Tancredi D, Schenker MB, Mitchell D, Mitloehner FM. A survey of particulate matter on california dairy farms. J Environ Qual. 2013 Jan-Feb;42(1):40-7. PubMed PMID: 23673737.

B. Positions, Scientific

Appointments and Honors Positions

and Scientific Appointments

2020 -	Professor in Residence of Pediatrics, UC Davis, Sacramento, CA
2014 - 2020	Associate Professor in Residence of Pediatrics, UC Davis, Sacramento, CA
2007 - 2014	Assistant Professor in Residence of Pediatrics, University of California, Davis, Sacramento, CA
2002 - 2007	Senior Statistician, Spvr., University of California, Davis, Center for Health Services Research in Primary Care (now Center for Healthcare Policy and Research), Sacramento, CA
1999 - 2001	Senior Research Associate, Rush University, Rush Institute for Healthy Aging, Chicago, IL
1995 - 1999	Biostatistician, Rush University, Rush Institute for Healthy Aging, Chicago, IL
1989 - 1995	Project Manager, Rush University, Department of Health Systems Management, Chicago, IL

Honors

2012 - 2018	Outstanding Faculty Member for Journal Club (2012, 13, 16, 18), UC-Davis Pediatrics Physician Residency Program
2016	Dean's Award for Excellence in Research Mentoring, UC Davis Health System

C. Contribution to Science

1. There are large gaps in our knowledge of risk factors for autism. As a co-investigator, I provide statistical expertise in measurement validation, study design and multivariate regression strategies for large autism epidemiological studies. An innovative registry cohort study of 5 million California births provided a definitive assessment of the role of advancing maternal and paternal age for increased autism risk. In this work, my expertise in clustered survey data analysis was required in order to develop sensitivity analyses that can assess the impacts of missing information on cluster (household) identifiers and on such important confounders as maternal educational attainment. I also contributed original and significant clustered survey data and multivariate regression analyses approaches to high impact autism epidemiology papers assessing the joint effects of genetic and environmental risk factors.

    a. Goodrich AJ, Volk HE, Tancredi DJ, McConnell R, Lurmann FW, Hansen RL, Schmidt RJ. Joint effects of prenatal air pollutant exposure and maternal folic acid supplementation on risk of autism spectrum disorder. Autism Res. 2018 Jan;11(1):69-80. PubMed Central PMCID: PMC5777535.
    b. Schmidt RJ, Tancredi DJ, Ozonoff S, Hansen RL, Hartiala J, Allayee H, Schmidt LC, Tassone F, Hertz- Picciotto I. Maternal periconceptional folic acid intake and risk of autism spectrum disorders and developmental delay in the CHARGE (CHildhood Autism Risks from Genetics and Environment) case- control study. Am J Clin Nutr. 2012 Jul;96(1):80-9. PubMed Central PMCID: PMC3374734.

c. Wang LW, Tancredi DJ, Thomas DW. The prevalence of gastrointestinal problems in children across the United States with autism spectrum disorders from families with multiple affected members. J Dev Behav Pediatr. 2011 Jun;32(5):351-60. PubMed PMID: 21555957.

d. Shelton JF, Tancredi DJ, Hertz-Picciotto I. Independent and dependent contributions of advanced maternal and paternal ages to autism risk. Autism Res. 2010 Feb;3(1):30-9. PubMed Central PMCID: PMC4068119.

2. I contribute statistical leadership to pre-clinical and clinical research studies aimed at improving our understanding of brain injury in a variety of contexts, including the onset and treatment of diabetic ketoacidosis and acute exposures to chemical threat agents. Expert application of statistical study design and and multivariate analysis methods for comparative experiments with repeated measurements permit efficient and robust inferences regarding complex disease processes.

   a. Flannery BM, Bruun DA, Rowland DJ, Banks CN, Austin AT, Kukis DL, Li Y, Ford BD, Tancredi DJ, Silverman JL, Cherry SR, Lein PJ. Persistent neuroinflammation and cognitive impairment in a rat model of acute diisopropylfluorophosphate intoxication. J Neuroinflammation. 2016 Oct 12;13(1):267. PubMed Central PMCID: PMC5062885.

   b. Pessah IN, Rogawski MA, Tancredi DJ, Wulff H, Zolkowska D, Bruun DA, Hammock BD, Lein PJ. Models to identify treatments for the acute and persistent effects of seizure-inducing chemical threat agents. Ann N Y Acad Sci. 2016 Aug;1378(1):124-136. PubMed Central PMCID: PMC5063690.

   c. Glaser N, Little C, Lo W, Cohen M, Tancredi D, Wulff H, O'Donnell M. Treatment with the KCa3.1 inhibitor TRAM-34 during diabetic ketoacidosis reduces inflammatory changes in the brain. Pediatr Diabetes. 2017 Aug;18(5):356-366. PubMed PMID: 27174668.

   d. Lo W, O'Donnell M, Tancredi D, Orgain M, Glaser N. Diabetic ketoacidosis in juvenile rats is associated with reactive gliosis and activation of microglia in the hippocampus. Pediatr Diabetes. 2016 Mar;17(2):127-39. PubMed PMID: 25594864.

3. Developing rigorous evidence for non-pharmacological interventions in vulnerable populations presents special challenges for statistical inference. Longitudinal measurement protocols give rise to incomplete or otherwise imperfect measurement of study variables. In addition, the hierarchical arrangement of the study units (e.g. patients nested within clinics; students nested within schools) or of the study variables (e.g. multiple items from within the same content domain) implies that observations from within the same cluster may share measured and unmeasured sources of variation in study outcomes, exposures and/or covariates. I provide statistical leadership to successful intervention research programs, including programs aimed at reducing violence and programs designed to improve the detection, treatment and management of burdensome diseases. Our statistically rigorous study designs and analysis strategies support the development of high-quality evidence on the effectiveness of these interventions.

   a. Wintemute G.J., Beckett L., Kass P.H., Tancredi D., Studdert D., Pierce G., Braga A.A., Wright M.A., Cerd\'a M.. Evaluation of California's Armed and Prohibited Persons System: Study protocol for a cluster-randomised trial. Injury Prevention. 2016. DOI: 10.1136/annrheumdis-2016-042194

b. Epstein RM, Duberstein PR, Fenton JJ, Fiscella K, Hoerger M, Tancredi DJ, Xing G, Gramling R, Mohile S, Franks P, Kaesberg P, Plumb S, Cipri CS, Street RL Jr, Shields CG, Back AL, Butow P, Walczak A, Tattersall M, Venuti A, Sullivan P, Robinson M, Hoh B, Lewis L, Kravitz RL. Effect of a Patient-Centered Communication Intervention on Oncologist-Patient Communication, Quality of Life, and Health Care Utilization in Advanced Cancer: The VOICE Randomized Clinical Trial. JAMA Oncol. 2017 Jan 1;3(1):92-100. PubMed Central PMCID: PMC5832439.

c. Miller E, Tancredi DJ, Decker MR, McCauley HL, Jones KA, Anderson H, James L, Silverman JG. A family planning clinic-based intervention to address reproductive coercion: a cluster randomized controlled trial. Contraception. 2016 Jul;94(1):58-67. PubMed Central PMCID: PMC4884549.

d. Tancredi DJ, Silverman JG, Decker MR, McCauley HL, Anderson HA, Jones KA, Ciaravino S, Hicks A, Raible C, Zelazny S, James L, Miller E. Cluster randomized controlled trial protocol: addressing reproductive coercion in health settings (ARCHES). BMC Womens Health. 2015 Aug 6;15:57. PubMed Central PMCID: PMC4527212.

Complete List of Published Work in My Bibliography (350+ publications; Google h-index=82, as of 2025Feb16): https://www.ncbi.nlm.nih.gov/myncbi/daniel.tancredi.1/bibliography/public/

DEBORAH HALL BENNETT, Ph.D.

Professor, Department of Public Health Sciences Email: *dhbennett@ucdavis.edu* School of Medicine, University of California, Davis Telephone: 510-504-3918 One Shields Avenue, Davis, CA 95616

My research focuses understanding human exposure to pollutants in the environment, both in the context of epidemiology studies as well as to predict and reduce exposures. I have a particular interest on exposures that occur through multiple exposure pathways, typical of compounds used in consumer products with multiple applications. I have a long history of working with pesticides and in farmworker communities. I am also very interested in how we can incorporate less studied compounds in both epidemiology studies and risk assessments. A lack of knowledge on both the exposure and toxicity has limited the range of compounds studied, but I am working to change that landscape. Ultimately, the goal of my work is to develop tools to help policy makers reduce our exposure, and subsequent health effects, to pollutants in the environment. My work includes modeling and measurements of exposures, conducting intervention studies, and working to support environmental epidemiology projects conducted by others.

I am an internationally recognized exposure scientist and have published over 120 papers. My publications are presented in high impact journals in this field. I have received funding from NIEHS, EPA, American Chemistry Council, and the California Air Resources Board. I have served on the EPA Charter Science Advisory Board as well as other EPA advisory boards, a National Academy of Science Committee, and Project TENDR, an advocacy group.

Education

1993 Mechanical Engineering, *Magna cum Laude* B.S. University of California, Los Angeles 1996 Mechanical Engineering

M.S. University of California, Berkeley

1999 Mechanical Engineering Ph.D. University of California, Berkeley

Positions and Employment

2015-present Professor, Department of Public Health Sciences, UC Davis, Davis CA

2015-2019 Acting Division Chief in Occupational and Environmental Health, UC Davis, Davis CA

2009-2015 Associate Professor, Department of Public Health Sciences, UC Davis, Davis CA 2005-2009 Assistant Professor, Department of Public Health Sciences, UC Davis, Davis, CA 2001-2004 Assistant Professor of Environmental Health, Harvard School of Public Health, Boston, MA

2000-2001 Scientist, Lawrence Berkeley Lab, Environmental Energy Technology Division, Berkeley,

1999-2000 Postdoctoral Researcher, Lawrence Berkeley Lab

1993-1995 Member of Technical Staff, Hughes Aircraft Company, El Segundo, California

Select Other Experience, Advisory Committees, Professional Memberships and Honors

2024-2025 Environmental influences on Child Health Outcomes (ECHO) Consortium's Biospecimen Assay Task Force (BATF) Co-Chair; Developed recommendations for biochemical assays, study design, and biospecimen utilization strategy for the ECHO biospecimens

2024 Panel Member, NAS, Review of Texas Commission on Environmental Quality's Ethylene Oxide Development Support Document

2023 The Cooking Electrification and Ventilation Improvements for Children's Asthma (CEVICA) Technical Advisory Committee, Lawrence Berkeley National Laboratory

2002-present International Society of Exposure Assessment (Elected Councilor 2002-2005, Treasurer 2006-2009, Finance Committee 2006-present, Strategic Planning Committee 2007-2010, Chair of Awards Committee 2010-2017)

2015-present Member, Project TENDR (Targeting Environmental Neuro-Developmental Risks), a collaboration of scientists, health professionals and environmental advocates.

2020 Panel Member, NAS, Evaluation of the US EPA TSCA Systematic Review Process 2017-2020 Board Member, EPA Charter Science Advisory Board

2016, 2025 Synthetic Turf Advisory Panel, California Office of Environmental Health Hazard Assessment

2014 Member, Healthy Zero Energy Buildings Technical Advisory Group. LBNL.

2012 Invited participant at an Indoor Air Institute meeting to develop research needs for evaluating exposures to SVOCs in the indoor environment

2002-2005 ISEA Early Career Award 1997-1999 EPA STAR Fellow

Select Publications out of over 130 publications:

1. Bennett DH, McKone TE, Kastenberg WE, Matthies M. General Formulation of Characteristic Travel Distance for Semi-Volatile Organic Chemicals in a Multimedia Environment. *Environmental Science and Technology*. 1998; 32:4023-4030. doi.org/10.1021/es980328g

2. Liu C, **Bennett DH**, Kastenberg WE, McKone TE, Browne DG. A Multimedia, Multiple Pathway Risk Assessment of Atrazine: Fate, Transport, and Uncertainty Analysis. *Reliability Engineering and System Safety*. 1999; 63:169-184. doi.org/10.1016/S0951-8320(98)00045-3

3. Bennett DH, McKone TE, Evans JS, Nazaroff WW, Margni MD, Jolliet O. Defining Intake Fraction. *Environmental Science and Technology*. 2002; 36:206A-211A. doi.org/10.1021/es0222770

4. Bennett DH, Koutrakis, P. Determining the Infiltration of Outdoor Particles in the Indoor Environment Using a Dynamic Model. *Journal of Aerosol Science*. 2005; 37:766-785. doi.org/10.1016/j.jaerosci.2005.05.020

5. Nishioka Y, Levy JI, Norris GA, **Bennett DH**, Spengler JD. A Risk-based Approach to Health Impact Assessment for Input-output Analysis – Part 1: Methodology. *International Journal of Life Cycle Analysis*. 2005; 10:193-199. doi.org/10.1065/lca2004.10.186.1

6. Sax SN, **Bennett DH,** Chillrud SN, Ross J, Kinney P, Spengler JD. A Cancer Risk Assessment of Inner-City Teenagers Living in New York City and Los Angeles. *Environmental Health Prospectives*. 2006; 114:1558-1566. doi.org/10.1289/ehp.8507

7. Loh MM, Levy JI, Spengler JD, Houseman EA, **Bennett DH**. Ranking Cancer Risks of Organic Hazardous Air Pollutants in the United States. *Environmental Health Perspectives*. 2007; 115:1160- 1168. doi.org/10.1289/ehp.9884

8. Cisneros R, Schweizer D, Zhong S, Hammond K, Perez MA, Guo Q, Traina S, Bytnerowicz A, and **Bennett DH**. Analyzing the effects of the 2002 McNally fire on air quality in the San Joaquin Valley and southern Sierra Nevada, California. *International Journal of Wildland Fire*. 2012; 21:1065-1075. doi.org/10.1071/WF11025
9. Shin HM, McKone T, **Bennett DH**. Intake Fraction for the Indoor Environment: A Tool for Prioritizing Indoor Chemical Sources. Environmental Science & Technology. 2012, 46(18): 10063-
72. PubMed PMID: 22920860
10. Wu XM, Apte MG, **Bennett DH**. Indoor Particle Level in Small and Medium Sized Commercial Buildings. *Environmental Science and Technology*. 2012; 46:12355-12363.
11. Shin, HM, McKone TE, **Bennett DH.** Contribution of low vapor pressure-volatile organic compounds (LVP-VOCs) from consumer products to ozone formation in urban atmospheres. *Atmospheric Environment*. 2015; 108:98–106. doi.org/10.1016/j.atmosenv.2015.02.067
12. Shin HM, Ernstoff A, Arnot JA, Wetmore BA, Csiszar SA, Fantke P, Zhang X, McKone TE, Jolliet O, **Bennett DH**. Risk-Based High-Throughput Chemical Screening and Prioritization using Exposure Models and in Vitro Bioactivity Assays. *Environmental Science & Technology* 2015, 49(11):6760-71 PubMed PMID: 25932772.
13. Mitchell DC, Armitage TL, Schenker MB, **Bennett DH**, Tancredi DJ, Langer CE, Reynolds SJ, Dooley G, Mehaffy J, Mitloehner FM. Particulate Matter, Endotoxin, and Worker Respiratory Health on Large Californian Dairies. *Journal of Occupational & Environmental Medicine*. 2015; 57:152-158.
14. Shin HM, Schmidt RJ, Tancredi DJ, Barkoski J, Ozonoff S, **Bennett DH,** Hertz-Picciotto I. Prenatal exposure to phthalates and autism spectrum disorder in the MARBLES study. *Environmental Health*. 2018; 17:85.
15. Pellizzari ED, Woodruff TJ, Boyles RR, Kannan K, Beamer PI, Buckley JP, Wang A, Zhu Y, **Bennett DH.** (Environmental influences on Child Health Outcomes) Identifying and Prioritizing Chemicals with Uncertain Burden of Exposure: Opportunities for Biomonitoring and Health- Related Research. *Environmental Health Perspectives*. 2019; 127:126001.
16. Barkoski JM, Philippat C, Tancredi D, Schmidt RJ, Ozonoff S, Barr DB, Elms W, **Bennett DH,** Hertz-Picciotto I. In utero pyrethroid pesticide exposure in relation to autism spectrum disorder (ASD) and other neurodevelopmental outcomes at 3 years in the MARBLES longitudinal cohort. *Environmental Research*. 2021; 194:110495. doi.org/10.1016/j.envres.2020.110495.
17. **Bennett DH**, Moran RE, Krakowiak P, Tancredi DJ, Kenyon NJ, Williams J, Fisk WJ. Reductions in particulate matter concentrations resulting from air filtration: A randomized sham-controlled crossover study. Indoor Air. 2022; 32(2)
18. Oh J, Shin HM, Kannan K, Busgang SA, Schmidt RJ, Schweitzer JB, Hertz-Picciotto I, **Bennett DH**. Childhood exposure to per- and polyfluoroalkyl substances and neurodevelopment in the CHARGE case-control study. Environmental Research, 2022.
19. **Bennett DH**, Busgang SA, Kannan K, Parsons PJ, Takazawa M, Palmer CD, Schmidt RJ, Doucette JT, Schweitzer JB, Gennings C, Hertz-Picciotto I. Environmental exposures to pesticides, phthalates, phenols and trace elements are associated with neurodevelopment in the CHARGE study. *Environment International*. 2022; 161:107075. doi: 10.1016/j.envint.2021.107075.

20. Goodrich AJ, Kleeman MJ, Tancredi DJ, Ludeña YJ, **Bennett DH**, Hertz-Picciotto I, Schmidt RJ. Ultrafine particulate matter exposure during second year of life, but not before, associated with increased risk of autism spectrum disorder in BKMR mixtures model of multiple air pollutants. Environ Res. 2023 Nov 11:117624. doi.org/10.1016/j.envres.2023.117624. PMID: 37956751.

21. Goodrich, A.J., Kleeman, M.J., Tancredi, D.J., Ludeña, Y.J., **Bennett, D.H**., Hertz-Picciotto, I. and Schmidt, R.J., 2024. Pre-pregnancy ozone and ultrafine particulate matter exposure during second year of life associated with decreased cognitive and adaptive functioning at aged 2–5 years. *Environmental Research*, *252*, p.118854.

NAME Kleeman, Michael J	POSITION TITLE Professor
eRA COMMONS USER NAME MJKLEEMAN	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
University of Waterloo, Canada	B.A.Sc.	1993	Mechanical Engineering
California Institute of Technology, Pasadena	M.S.	1994	Env. Eng. Science
California Institute of Technology, Pasadena	Ph.D.	1998	Env. Eng. Science

A. Personal Statement

Dr. Kleeman is a recognized expert in urban / regional air pollution problems with experience acting as Principal Investigator for more than $20M of externally-funded research and co- Investigator for another +$40M of externally-funded research during his 27 year career. Dr. Kleeman has pioneered measurement methods for ultrafine particles and developed source apportionment techniques to quantify the ambient ultrafine contributions from different source types. He has also pioneered the development of source apportionment techniques for primary and secondary particulate matter within regional chemical transport models. Using these methods, Dr. Kleeman has conducted extensive studies on the health effects of ultrafine particles in California and across the United States. Dr. Kleeman has published more than 170 manuscripts in leading scientific journals that have been cited more than 18,000 times.

Selected major contributions:

a. 2000 **Kleeman, M.J**., J.J. Schauer, and G.R. Cass. Size and Composition Distribution of Fine Particulate Matter Emitted from Motor Vehicles. Environmental Science, and Technology, 34:1132-1142.
b. 2008 **Kleeman, M.J.,** Riddle, S.G., Robert, M.A., Jakober, C.A., Fine, P.M., Hays, M.D., Schauer, J.J. and Hannigan, M.P. Source Apportionment of Fine (PM1.8) and Ultrafine (PM0.1) Airborne Particulate Matter During a Severe Winter Pollution Episode. Environmental Science and Technology, DOI: 10.1021/es800400.
c. 2015 J. Hu, H. Zhang, Q. Ying, S. Chen, F. Vandenberghe, and **M.J. Kleeman**. Long-term Particulate Matter Modeling for Health Effects Studies in California – Part I: Model Performance on Temporal and Spatial Variations. Atmospheric Chemistry and Physics, 15(6), pp3445-3461.
d. 2019 X. Yu, M. Venecek, A. Kumar, J. Hu, S. Tanrikulu, S. Soon, C. Tran, D. Fairley, and **M.J. Kleeman**. Regional Sources of Airborne Ultrafine Particle Number and Mass Concentrations in California. Atmospheric Chemistry and Physics, 19, pp 14677-14702.
e. 2022 Y. Li., A. Kumar, Y. Li, and **M.J. Kleeman**. Adoption of Low-Carbon Fuels Reduced Race/Ethnicity Disparities in Air Pollution Exposure in California. Science of the Total Environment, 15;834:155230. doi: 10.1016/j.scitotenv.2022.155230. Epub 2022 Apr 12. PMID: 35427611.

B. Positions and Honors

Positions

1999–2003 Assistant Professor, Department of Civil and Environmental Engineering, UC Davis, Davis CA.
2003–2006 Associate Professor, Department of Civil and Environmental Engineering, UC Davis, Davis CA.
2006–pres. Professor, Department of Civil and Environmental Engineering, UC Davis, Davis CA.

Honors

1993-1994 California Institute of Technology Knapp Fellowship
2007 California Air Resources Board Silver Superior Accomplishment Award 2008 United States Environmental Protection Agency Scientific and Technological Achievement Award Level III

C. Contributions to Science

1. Dr. Kleeman has carried out a series of emissions characterization experiments to measure the size and composition distribution of airborne particles immediately after release from dominant sources. These measurements provide vital input data for chemical transport models and they also provide the basis for chemical fingerprints that can be recognized in the downwind atmosphere. The source profile measurements that he has made are used by the California Air Resources Board for atmospheric simulations and planning in the heavily polluted San Joaquin Valley and the South Coast Air Basin surrounding Los Angeles. Collectively, these regions account for 7 of the top 10 polluted cities in the US. The source profile measurements have contributed to our improved understanding of the air pollution problem and the design of effective control strategies.

References:

1999 Kleeman, M.J., J.J. Schauer, and G.R. Cass. Size and Composition Distribution of Fine Particulate Matter Emitted from Wood Burning, Meat Charbroiling and Cigarettes.
Environmental Science, and Technology, Environmental Science, and Technology, 33:3516- 3523.

2000 Kleeman, M.J., J.J. Schauer, and G.R. Cass. Size and Composition Distribution of Fine Particulate Matter Emitted from Motor Vehicles. Environmental Science, and Technology, 34:1132-1142.

2007 Robert, M.A., C.A. Jakober, and M.J. Kleeman. Size and Composition Distribution of Particulate Matter 2. Heavy -duty Diesel Vehicles. Journal of the Air and Waste Management Association, 57, pp1429-1438.

2007 Robert, M.A., C.A. Jakober, S. VanBergen, and M.J. Kleeman, Size and Composition Distribution of Particulate Matter 1. Light-duty Gasoline Vehicles. Journal of the Air and Waste Management Association, 57, pp1414-1428.

2008 Kleeman, M.J., M.A. Robert, S.G. Riddle, P.M. Fine, M.D. Hays, J.J. Schauer, and M.P. Hannigan. Size Distribution of Trace Organic Species Emitted From Biomass Combustion and Meat Charbroiling. Atmospheric Environment, 42 pp3059-3075.

2. Dr. Kleeman has developed and applied receptor-based source apportionment calculations for ultrafine particles (Dp<0.1μm) through a series of source profile measurements and community monitoring. By developing new methods to chemically analyze particles in the ultrafine size range, he was able to extend the source apportionment tools traditionally used for PM2.5 into the PM0.1 size fraction. This included the development of molecular marker libraries used in Chemical Mass Balance (CMB) models and the development of efficient elemental analysis techniques for Inductively Coupled Plasma Mass Spectrometry (ICPMS) that can be used to support Positive Matrix Factorization (PMF) models. These source apportionment methods for ultrafine particles have been demonstrated in roadside and community receptor environments throughout California.

References:

2007 Riddle SG, M.A. Robert, C.A. Jakober, M.P. Hannigan, M.J. Kleeman. Size distribution of trace organic species emitted from light duty gasoline vehicles. Environmental Science and Technology, 41, pp7464-7471.

2008 Kleeman, M.J., S.G. Riddle, and C.A. Jakober. Size Distribution of Particle-Phase Molecular Markers During a Severe Winter Pollution Episode. Environmental Science and Technology, 42, pp4697-4703.

2008 Kleeman, M.J., Riddle, S.G., Robert, M.A., Jakober, C.A., Fine, P.M., Hays, M.D., Schauer, J.J. and Hannigan, M.P. Source Apportionment of Fine (PM1.8) and Ultrafine (PM0.1) Airborne Particulate Matter During a Severe Winter Pollution Episode.
Environmental Science and Technology, DOI: 10.1021/es800400.

2013 T. Kuwayama, C.R. Ruehl, and M.J. Kleeman. Daily Trends and Source Apportionment of Ultrafine Particulate Mass (PM0.1) over and Annual Cycle in a Typical California City.
Environmental Science and Technology, dx.doi.org/10.1021/es403235c.

Complete List of Published Work in MyBibliography:
http://faculty.engineering.ucdavis.edu/kleeman/publications/

BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Raffuse, Sean M

eRA COMMONS USER NAME (credential, e.g., agency login):

SRAFFUSE POSITION TITLE: Associate Director

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Lewis & Clark College	B.A.	05/2001	Chemistry
Washington University in St. Louis	B.S.	05/2001	Chemical Engineering
Washington University in St. Louis	M.S.	05/2003	Environmental Engineering

A. Personal Statement

My research has focused on developing, improving, and applying fire and smoke models through the use of new data sets, research, and information systems; developing and using satellite-derived data products; and development of data management for national-scale air quality monitoring networks. I am an expert on the modeling of pollutant emissions from fires, and have produced wild and prescribed fire emissions inventories for the U.S. Environmental Protection Agency (EPA), the U.S. Fish and Wildlife Service, and the U.S. Department of the Interior. I served as Co-Investigator on the Smoke and Emissions Model Intercomparison Project (SEMIP), which assessed uncertainties in current wildland fire emissions and air quality modeling. I have also developed high-resolution ground-level concentration estimates for use in exposure studies, specifically during wildfire events in California. I am the principal investigator for UC Davis's operation of the EPA's Chemical Speciation Network (CSN), which measures the chemical components of particulate matter at over 130 locations nationwide.

Ongoing or recently completed projects that I would like to highlight include:

24-JV-11261985-039 USDA Forest Service-UC Davis Air Quality Research Center Joint Venture PI: Raffuse (08/17/16 – 06/20/25)
Improving Fire Activity and Smoke Emission Modeling

68HERH23D0004 US EPA
PI: Raffuse (03/07/2023 – 03/06-2027)
Support for the Chemical Speciation of PM Filter Samples

23RD006 California Air Resources Board PI: Kleeman
(05/01/2024 – 04/30/2027)

Understanding the Air Quality Impacts of Wildfires and Prescribed Burns in Urban Environments of California

84048401 US EPA
PI: Schmidt (09/01/2022 – 08/31/2025)
Early Live Vulnerability to Climate-driven Wildfire Events on Pregnancy and Child Developmental Health Outcomes in Underserved Populations

B. Positions, Scientific Appointments, and Honors

Positions and Employment

2003 – 2016, Atmospheric Scientist/Group Manager, Sonoma Technology, Inc., Petaluma, CA 2013 –, Associate Director – Software and Data, UC Davis Air Quality Research Center, Davis, CA

Professional Memberships

American Geophysical Union
International Association of
Wildland Fire Association of Fire
Ecology
Air & Waste Management Association

C. Contributions to Science

1. A primary thread of relevance to the proposed study is in the use of ground measurements, smoke modeling, and satellite data in the **development of pollutant concentration fields for use in exposure modeling**. California presents many unique challenges for the use of satellite-derived estimates of particulates during wildfires, and the standard NASA products are not always up to the challenge. I led the development of a high-resolution surface aerosol derived from satellite that has been employed in exposure assessments. More recently, I have contributed my expertise in satellite data to efforts to estimate exposure using statistical and machine learning techniques.

    a. **Raffuse, S.M.**, O'Neill, S., Schmidt, R. (2024) A model for rapid $PM_{2.5}$ exposure estimates in wildfire conditions using routinely-available data: rapidfire v.0.1.3. *Geoscientific Model Development*, 17, 381-
    297. https://doi.org/10.5194/gmd-17-381-2024
    b. O'Neill, S., Diao, M., **Raffuse, S.M.**, Al-Hamdan, M., Barik, M., Jia, Y., Reid, S., Zou, Y, Tong, D., West, J., Wilkins, J.,Marsha, A., Freedman, F., Vargo, J., Larkin N., Alvarado, E., Loesche, P. (2021). A Multi-Analysis Approach for Estimating Regional Health Impacts from the 2017 Northern California Wildfires. *Journal of the Air & Waste Management Association*. PMID: 33630725.
    c. **Raffuse, S. M.**, McCarthy, M. C., Craig, K. J., DeWinter, J. L., Jumbam, L. K., Fruin, S., Lurmann, F.
    W. (2013). High-resolution MODIS aerosol retrieval during wildfire events in California for use in exposure assessment. *Journal of Geophysical Research: Atmospheres*, *118*(19), 11,242-11,255.
    d. Yao, J., **Raffuse, S. M.**, Brauer, M., Williamson, G. J., Bowman, D. M. J. S., Johnston, F. H., & Henderson, S. B. (2018). Predicting the minimum height of forest fire smoke within the atmosphere using machine learning and data from the CALIPSO satellite. *Remote Sensing of Environment*, *206*, 98–106.

e. Yao, J., Brauer, M., **Raffuse, S. M.**, & Henderson, S. B. (2018). Machine Learning Approach To Estimate Hourly Exposure to Fine Particulate Matter for Urban, Rural, and Remote Populations during Wildfire Seasons. *Environmental Science & Technology*, *52*(22), 13239–13249.
f. Clelend, S. E., West, J. J., Jia, Y., Reid, S., **Raffuse, S.M.**, O'Neill, S., Serre, M.L. (2020) Estimating wildfire smoke concentrations during the October 2017 California fires through BME space/time data fusion of observed, modeled, and satellite-derived PM2.5. *Environmental Science & Technology*, 54 (21), 13439-13447

2. Core to this and other studies is the **understanding of the air pollution measurements** that underpin air quality and exposure modeling. As the PI for UC Davis's laboratory analysis of samples from the Chemical Speciation Network (CSN), and Co-I for our operation of the Interagency Monitoring of Protected Visual Environments (IMPROVE) network, I am intimately familiar with the nuances and uncertainties within chemically-resolved particle measurements.
   a. Hand, J.L., Prenni, A.J., **Raffuse, S.M.**, Hyslop, N.P., Malm, W.C., Schictel, B.A. (2024). Spatial and seasonal variability of remote and urban speciated fine particulate matter in the United States. *Journal of Geophysical Research: Atmospheres*. Accepted.
   b. White, W.H., Copeland, S.A., Giacomo, J.A., Hyslop, N.P., Kline, L.M., Malm, W.C., **Raffuse, S.M.**, Schictel, B.A., Spada, N.J., Wallis, C.D, Zhang, X. (2024). Absorption photometry of patterned deposits on IMPROVE PTFE filters. *Journal of the Air & Waste Management Association*. Accepted.
   c. Zhang, X., Trzepla, K., White, W., **Raffuse, S.**, and Hyslop, N. P. (2021). Intercomparison of thermal– optical carbon measurements by Sunset and Desert Research Institute (DRI) analyzers using the IMPROVE_A protocol, *Atmospheric Measurement Techniques*, 14, 3217–3231, https://doi.org/10.5194/amt-14-3217-2021.
   d. Gorham, K.A., **Raffuse, S.M.**, Hyslop, N.P., White, W.H., Comparison of recent speciated PM2.5 data from collocated CSN and IMPROVE measurements. (2021). *Atmospheric Environment,* 244 117977 https://doi.org/10.1016/j.atmosenv.2020.117977

3. Another component of my research is the **modeling and analysis of pollutant emissions from wild and prescribed fires**. My early involvement was as a key contributor to the development and improvement of the BlueSky-SmartFire smoke modeling framework, which is currently used to produce daily smoke forecasts as well as retrospective emission inventories. This work has shown that methods used to estimate fire emissions globally underrepresent fire emissions, particularly from small fires, in the United States.

   a. Larkin, N.K., **Raffuse, S. M.**, Huang, S., Pavlovic, N., Lahm, P., Rao, V. (2020) The Comprehensive Fire Information Reconciled Emissions (CFIRE) Inventory: Wildland Fire Emissions Developed for the 2011 and 2014 U.S. National Emissions Inventory. *Journal of the Air & Waste Mgmt Assoc*, 1- 21.
   b. Mueller, S.; Tarnay, L.; O'Neill, S.; **Raffuse, S.** Apportioning Smoke Impacts of 2018 Wildfires on Eastern Sierra Nevada Sites. (2020). *Atmosphere*, 11, 970.
   c. Larkin, N. K., **Raffuse, S. M.**, & Strand, T. M. (2014). Wildland fire emissions, carbon, and climate:
      U.S. emissions inventories. *Forest Ecology and Management*, *317*, 61–69.
   d. **Raffuse, S. M.**, Craig, K. J., Larkin, N. K., Strand, T. T., Sullivan, D. C., Wheeler, N. J. M., & Solomon,
      R. (2012). An Evaluation of Modeled Plume Injection Height with Satellite-Derived Observed Plume Height. *Atmosphere*, *3*(1), 103–123.
   e. Larkin, N. K., O'Neill, S. M., Solomon, R., **Raffuse, S.**, Strand, T., Sullivan, D. C., Ferguson, S. A. (2009). The BlueSky smoke modeling framework. *International Journal of Wildland Fire*, *18*(8), 906.

BIOGRAPHICAL SKETCH

NAME: Goodrich,
Amanda Jo

eRA COMMONS USER NAME (credential, e.g., agency login):

agoodrich POSITION TITLE: Assistant Project Scientist

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
California State Polytechnic University, Pomona	BS	06/2008	Biotechnology
California State Polytechnic University, Pomona	MS	06/2010	Biology
University of Southern California	PhD	05/2017	Epidemiology
University of California, Davis	Postdoctoral	12/2022	Autism/Environmental Exposures

B. Personal Statement

I am an environmental and perinatal epidemiologist with over a decade of experience in the design and implementation of epidemiologic studies and complex statistical analyses related to neurodevelopmental outcomes. My research focuses on air pollution, pesticides, and other environmental toxicants, particularly in relation to child neurodevelopment, maternal mental and cardiopulmonary health, and structural and social modifiers of risk. I have led and contributed to numerous studies using complex exposure modeling and advanced statistical methods, including Bayesian kernel machine regression (BKMR), and effect modification analyses across social determinants of health. A major focus of my work has involved the application and interpretation of chemical transport models (CTMs) to estimate ambient and wildfire-related air pollutant exposures across California. I have worked extensively with the CTM data products generated by Dr. Michael Kleeman and colleagues, using these exposure fields in both the CHARGE and B-SAFE studies, and across the entire CA state birth record, to evaluate associations between particulate matter – including ultrafine particulate matter (PM) and wildfire-specific PM– and a range of health outcomes. I have published multiple first-author manuscripts using CTM-modeled $PM_{2.5}$ and $PM_{0.1}$ to assess neurodevelopmental and cognitive outcomes in children, and I have applied these methods in mixtures frameworks to account for complex multi- pollutant exposures.

I have worked extensively with Drs. Schmidt, Tancredi, and Bennett over the past 10 yeas, and with the other CO-Is over the last several years. In this project, I will lead the systematic review on long-term health effects of prenatal wildfire smoke exposure (Task 1), analyze exposure disparities by sociodemographic and neighborhood factors (Task 2), and conduct statistical modeling to estimate health impact functions for maternal and child outcomes associated with wildfire $PM_{2.5}$ and metal exposures (Tasks 3 and 4). My deep familiarity with CTM-generated air pollution data and their epidemiologic application uniquely positions me to advance the project's goals of quantifying long-term, post-wildfire health effects in vulnerable populations and informing risk-reduction strategies. I will also lead in manuscript preparation for tasks 2-4.

- Park W, Shen Q, Zhang Z, O'Brien C, **Goodrich AJ**, Angel EE, Hertz-Picciotto I, Tancredi DJ, Raffuse S, Bennett DH, Schmidt RJ, Taha AY. (2025) *Gestational exposure to particulate matter from urban wildfires is associated with changes in circulating oxylipins but not flame retardants 7 to 13 months post-exposure*. Environmental International. EPub ahead of print.

- **Goodrich AJ**, Kleeman M, Tancredi DJ, Ludeña Y, Bennett D, Hertz-Picciotto I, Schmidt RJ. (2024) "Pre- pregnancy ozone and ultrafine particulate matter exposure in 2nd year of life associated with decreased childhood cognitive and adaptive function". Environmental Research, 252:118854. PMID: 38574983.
- **Goodrich AJ**, Kleeman M, Tancredi DJ, Ludeña Y, Bennett D, Hertz-Picciotto I, Schmidt RJ. (2023) "Ultrafine particulate matter exposure during second year of life, but not before, associated with increased risk of autism spectrum disorder in BKMR mixtures model of multiple air pollutants". Environmental Research, 242:117624.
- **Goodrich AJ**, Volk HE, Tancredi DJ, McConnell R, Lurmann FW, Hansen RL, Schmidt RJ (2018). Joint Effects of Prenatal Air Pollutant Exposure and Maternal Folic Acid Supplementation on Risk of Autism Spectrum Disorder. *Autism Research, 11(1):69-80.* PMID 29120534.

C. Positions, Scientific Appointments, and Honors <u>Positions and Employment</u>

2022-Current Asst. Project Scientist, Public Health Sciences, University of California, Davis (UC Davis) 2017-2022 Postdoctoral Fellow, Public Health Sciences, UC Davis
2020-2021 Part-time Lecturer, Department of Anesthesia, University of Southern California (USC) 2017-2021 Part-time Lecturer, Department of Preventive Medicine, USC
2011-2017 Research Assistant, Department of Preventive Medicine, USC 2010-2017 Teaching Assistant, Department of Preventive Medicine, USC
2008-2010 Teaching Associate, Dept of Biology, California State Polytechnic University (Cal Poly), Pomona 2008-2010 Graduate Research Assistant, Dept of Biology, Cal Poly, Pomona
2007-2008 Undergraduate Research Assistant, Dept of Biology, Cal Poly, Pomona

<u>Honors and Awards</u>

2007-2008 Howard Hughes Medical Institute Undergraduate Research Fellowship, 2006-2010 Golden Key International Honour Society Member
2005-2008 Dean's Honor List

D. Contributions to Science

Air pollution and risk for neurodevelopment in the child. The bulk of my research to date has assessed the role of gestational air pollution exposure on the risk of autism. As first author, I published the first study to show effect modification between maternal intake of folic acid near conception and air pollution (near roadway air pollution and criteria pollutants), such that the increased risk of autism observed with increasing air pollution exposure among mothers whose folic acid intake was low was negated among mothers whose folic acid intake was high. I was also the first to publish on ultrafine particulate matter in relation to autism and cognitive/adaptive functioning. I am currently collaborating with Dr. Schmidt on the prospective B-SAFE cohort study to assess the risk of wildfire smoke exposure during pregnancy on birth outcomes and neurodevelopmental disorders.

- **Goodrich AJ**, Kleeman M, Tancredi DJ, Ludeña Y, Bennett D, Hertz-Picciotto I, Schmidt RJ. (2024) "Pre- pregnancy ozone and ultrafine particulate matter exposure in 2nd year of life associated with decreased childhood cognitive and adaptive function". Environmental Research, 252:118854. PMID: 38574983.
- **Goodrich AJ**, Kleeman M, Tancredi DJ, Ludeña Y, Bennett D, Hertz-Picciotto I, Schmidt RJ. (2023) "Ultrafine particulate matter exposure during second year of life, but not before, associated with increased risk of autism spectrum disorder in BKMR mixtures model of multiple air pollutants". Environmental Research, 242:117624.
- **Goodrich AJ**, Volk HE, Tancredi DJ, McConnell R, Lurmann FW, Hansen RL, Schmidt RJ (2018). Joint Effects of Prenatal Air Pollutant Exposure and Maternal Folic Acid Supplementation on Risk of Autism Spectrum Disorder. *Autism Research, 11(1):69-80.* PMID 29120534.

Prenatal nutrients and neurodevelopmental outcomes in the child. My research has advanced the understanding of how prenatal nutritional factors—particularly folic acid and related methyl-donor nutrients— contribute to child neurodevelopment and modulate environmental risk. I was the first author of one of the earliest studies to demonstrate that maternal folic acid supplementation prior to and during early pregnancy can attenuate the adverse effects of prenatal air pollution on the risk of ASD. This study provided foundational evidence for nutrient-environment interactions in neurodevelopmental epidemiology and underscored the potential for modifiable maternal behaviors to buffer against environmental toxicants. In subsequent and ongoing studies within the MARBLES and CHARGE cohorts, I have investigated the reliability of maternal self-reported nutrient intake, the association between maternal serum folate and child neurodevelopmental trajectories, and interactions between maternal serum folate and MTHFR genotypes. These studies leverage detailed dietary data, prenatal supplement use, and newborn dried blood spot assays to examine folate and related micronutrients in relation to behavioral phenotypes and diagnostic outcomes. I also contributed to recent work linking maternal folic acid intake to DNA methylation changes in placenta and cord blood tissues, offering mechanistic insights into how nutrient availability during early gestation may influence gene regulation pathways implicated in ASD. Through integration of nutritional epidemiology, environmental exposures, and emerging epigenetic data, my research contributes to identifying actionable targets for early intervention and public health strategies aimed at optimizing prenatal nutrition to improve child developmental outcomes.

- **Goodrich**, AJ, Volk, HE, Tancredi, DJ, McConnell, R, Lurmann, FW, Hansen, RL, & Schmidt, RJ. (2018*). Joint effects of prenatal air pollutant exposure and maternal folic acid supplementation on risk of autism spectrum disorder. Autism Research,* 11(1), 69-80. PMID: 29120534. PMCID: PMC5777535.
- Schmidt RJ[1], **Goodrich AJ[1]**, Yao J, Delwiche L, Hansen RL, Ozonoff S, Pfeiffer CM, Tancredi D, Volk HE. (2024) *Newborn Dried Blood Spot Folate in Relation to Maternal Self-reported Folic Acid Intake, Autism Spectrum Disorder, and Developmental Delay*. *Epidemiology,* 35(4):527-541. PMID: 38912713.
- Schmidt RJ, Granillo L, Huang Y, Krakowiak P, Widaman A, Dienes JE, **Goodrich AJ**, Bennett D, Walker CK, Ozonoff S, Tancredi DJ. (2024). *Reliability of a Short Diet and Vitamin Supplement Questionnaire for Retrospective Collection of Maternal Nutrient Intake. Global Epidemiology*, p. 100150. PMID: 38983951
- Logan Williams, Julia Mouat, **Amanda Goodrich**, Elizabeth Angel, Sean Raffuse, Janine LaSalle, Rebecca Schmidt. (2022). “Prenatal wildfire exposure associates with differential placental DNA methylation and pregnancy traits", *34th Annual Conference of the International Society for Environmental Epidemiology,* Athens, Greece.

Mixtures analyses for highly correlated exposures. Using BKMR, I was co-author on the first study to simultaneously evaluate a number of correlated and combined nutrient exposures from supplements taken before and across pregnancy in relation to autism in the child. From this analysis we found the strongest evidence for a protective association of supplemental folic acid in months 1 and 2 and that Vitamins A, C, E and zinc in months 1 and 2, and vitamin E in month 3 also showed evidence in the protective direction. I am currently using BKMR to examine air pollution and pesticides together in relation to autism in the CHARGE study.

- **Goodrich AJ**, Kleeman M, Tancredi DJ, Ludeña Y, Bennett D, Hertz-Picciotto I, Schmidt RJ. (2024) "Pre- pregnancy ozone and ultrafine particulate matter exposure in 2nd year of life associated with decreased childhood cognitive and adaptive function". Environmental Research, 252:118854. PMID: 38574983.
- **Goodrich AJ**, Kleeman M, Tancredi DJ, Ludeña Y, Bennett D, Hertz-Picciotto I, Schmidt RJ. (2023) “Ultrafine particulate matter exposure during second year of life, but not before, associated with increased risk of autism spectrum disorder in BKMR mixtures model of multiple air pollutants“. Environmental Research, 242:117624.

- Schmidt RJ, **Goodrich AG**, Bakulski KM, Losif AM, Ozonoff S, Hamra GB, Tancredi DJ, (2021 May). Maternal Supplemental Nutrient Mixtures across Pre-conception and Pregnancy in Relation to Autism Spectrum Disorder in the Child. *International Society for Autism Research (INSAR)* - Annual Meeting, Virtual.

Air pollution and cytokine profile. My research on air pollution and cytokine and chemokine levels during pregnancy has added to our knowledge of how air pollution is associated with immune markers

- **Amanda Goodrich**, Chelsea Kelland, Heather Volk, Judy Van De Water, Rebecca Schmidt. “Fine particulate matter shown to influence cytokine and chemokine levels during pregnancy“. *34th Annual Conference of the International Society for Environmental Epidemiology, Athens, Greece.* 2022.

EXHIBIT A6

CURRENT & PENDING SUPPORT

PI: Schmidt, Rebecca J.					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	R01ES03170 1	NIH/NIEHS	The CHARGE Study Phase II: A Multifactorial Approach to Autism Etiology	5/2020	1/2026
Active	P30ES02351 3	NIH/NIEHS	UC Davis Environmental Health Sciences Core Center	6/2020	3/2025
Active	P50HD10325 6	NICHD	MIND Institute Intellectual and Developmental Disabilities Research Center	7/2020	6/2025
Active	U24ES92853 3	NIH/NIEHS	BUILDS MARBLES: Biorepository Upkeep and Infrastructure for Longitudinal Data Sharing for MARBLES	12/2022	10/2027
Active	R01ES03454 4	NIH/Johns Hopkins	GEARS: Combining advances in Genomics and Environmental Science to accelerate Actionable Research and Practice in ASD	9/2022	8/2027
Active	UG3OD035550	NIH/OD	Prenatal Environment and Child Health (PEACH) in ECHO	9/2023	5/2030
Active	UG3OD023342	NIH/Drexel University	Trajectories and Environments in Autism: A Multi-cohort Study (TEAMS)	9/2023	5/2030
Active	UG3OD023365	NIH/OD	Revisiting ReCHARGE: ECHO Follow up on Middle Childhood and Adolescence	9/2023	5/2030
Active	R01HD10748 9	NIH	Folic Acid, B12, and Neurodevelopmental Risk	6/2022	4/2027
Pending	R01ES03703 2	NIH	Molecular and Neurodevelopmental Alterations Associated with Prenatal Wildfire Exposures	8/2025	7/2030

Pending	Not Assigned	NIH/Baylor	Prenatal Exposure to Lithium and Autism Spectrum Disorder	12/2025	11/2027
Pending	Not Assigned	NIH/University of North Texas	Engineered brain organoids for autism modeling	12/2025	11/2029
Pending	Not Assigned	NIH/Florida International University	Investigation of epitranscriptomic crosstalks related to autism using real patients and brain organoids	12/2025	11/2030

Co-I: Bennett, Deborah					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	P30ES023513	NIH/NIEHS	UC Davis Environmental Health Sciences Core Center	6/2020	3/2025
Active	R01ES03170 1	NIH/NIEHS	The CHARGE Study Phase II: A Multifactorial Approach to Autism Etiology	5/2020	1/2026
Active	U24ES92853 3	NIH/NIEHS	BUILDS MARBLES: Biorepository Upkeep and Infrastructure for Longitudinal Data Sharing for MARBLES	12/2022	10/2027
Active	A23-3861	Vanguard Charitable Endowment	Pregnancy Health and Autism Study (PRISM)	6/2023	5/2025
Active	UG3OD035550	NIH/OD	Prenatal Environment and Child Health (PEACH) in ECHO	9/2023	5/2030
Active	UG3OD023342	NIH/OD	Trajectories and Environments in Autism: A Multi-cohort Study (TEAMS)	9/2023	5/2030
Active	UG3OD023365	NIH/OD	Revisiting ReCHARGE: ECHO Follow up on Middle Childhood and Adolescence	9/2023	5/2030
Pending	Not Assigned	CARB/Social and Environmental Entrepreneurs	Personal Air Monitoring for Agricultural Pesticides	6/2025	12/2027
Pending	R01ES03703 2	NIH	Molecular and Neurodevelopmental Alterations	8/2025	7/2030

			Associated with Prenatal Wildfire Exposures		
Pending	P50MD021195	NIH	UC Davis Health and Exposome Research and Action on Environmental Disparities (HERALD) Center	9/2025	8/2030

Co-I: Conlon, Kathryn					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	R01AG074347	NIH/NIA	Extreme weather-related events and environmental exposures in the risk for Alzheimer's disease and related dementias	06/2022	05/2027
Active	U24ES928533	NIH/NIEHS	BUILDS MARBLES: Biorepository Upkeep and Infrastructure for Longitudinal Data Sharing for MARBLES	12/2022	10/2027
Active	23-10731	California Department of Public Health	CalBRACE Evaluation	4/2023	8/2026
Pending	P50MD021195	NIH	UC Davis Health and Exposome Research and Action on Environmental Disparities (HERALD) Center	9/2025	8/2030

Co-I: Goodrich, Amanda					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	R01AG074347	NIH/NIA	Extreme weather-related events and environmental exposures in the risk for Alzheimer's disease and related dementias	6/2022	5/2027

Active	R01ES031701	NIH/NIEHS	The CHARGE Study Phase II: A Multifactorial Approach to Autism Etiology	5/2020	1/2026
Active	UG3OD035550	NIH/OD	Prenatal Environment and Child Health (PEACH) in ECHO	9/2023	5/2030
Pending	R01ES037032	NIH	Molecular and Neurodevelopmental Alterations Associated with Prenatal Wildfire Exposures	8/2025	7/2030

Co-I: Kleeman, Michael					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	22IDS010	CARB	Evaluation of Air Toxics, Metals, and VOCs Found in Biogas, Biomethane, and their Combustion Products	6/2023	5/2026
Active	23RD006	CARB	Using Integrated Observations and Modeling to Better Understand Current and Future Air Quality Impacts of Wildfires and Prescribed Burns	5/2024	6/2027
Active	R01ES031701	NIH/NIEHS	The CHARGE Study Phase II: A Multifactorial Approach to Autism Etiology	5/2020	1/2026
Active	Unknown	LA Department of Public Health/UCLA	Aliso Canyon Community Exposure and Health Study	11/2022	10/2025
Active	23RD019	CARB/UCLA	O3 Exposure and Respiratory Effects – School absenteeism, Asthma-related symptoms, and Asthma-related ED visits and hospitalization	1/2024	12/2026
Active	K387D06	US Department of Agriculture	Smoke taint risk from vineyards exposed to wildfire smoke: Assignment and management strategies	1/2022	12/2026
Active	R01AG074347	NIH/NIA	Extreme weather-related events and environmental exposures in	6/2022	5/2027

			the risk for Alzheimer's disease and related dementias		
Active	R01ES033413	NIEHS/City of Hope	Extreme weather, air pollution, and stroke among an aging female population	4/2022	3/2027
Pending	Not Assigned	NIH	Do atmospheric ultrafine particles lodge in the brain and cause cognitive decline leading to Alzheimer's disease related dementias?	12/2025	11/2027
Pending	R01ES037032	NIH	Molecular and Neurodevelopmental Alterations Associated with Prenatal Wildfire Exposures	8/2025	7/2030

Co-I: Miller, Meghan					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	R01MH121416	NIMH	An Investigation of Transdiagnostic Mechanisms Underlying ASD and ADHD Traits Among Infants at Risk	07/2020	04/2026
Active	R01MH104438	NIMH	Neural and Developmental Trajectories of Females with Autism Spectrum Disorder	4/2022	3/2027
Active	U24ES928533	NIH/NIEHS	BUILDS MARBLES: Biorepository Upkeep and Infrastructure for Longitudinal Data Sharing for MARBLES	12/2022	10/2027
Active	UG3OD035550	NIH/OD	Prenatal Environment and Child Health (PEACH) in ECHO	9/2023	5/2030
Active	R03MH135307	NIH/MIMH	Understanding Early Developmental Trajectories of, and Mechanisms Underlying, Sensory Reactivity in Infants at Familial risk for ASD and ADHD	7/2024	6/2026
Active	R01MH137613	NIH/MIMH	Early Dyadic Synchrony and Middle Childhood Outcomes Among Infants at Genetic Risk for ADHD or Autism	4/2025	3/2030

Active	14336714	Health Resources and Services Administration (HRSA)	Expanding the Behavioral Health Workforce in Northern California's Underserved Communities through Telehealth and Team-Based Care: The UC Davis MIND Institute Clinical Psychology Training Program	7/2025	6/2029
Pending	R01ES037032	NIH	Molecular and Neurodevelopmental Alterations Associated with Prenatal Wildfire Exposures	8/2025	7/2030

Co-I: Nguyen, Anh					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Pending	R01ES037032	NIH	Molecular and Neurodevelopmental Alterations Associated with Prenatal Wildfire Exposures	8/2025	7/2030

Co-I: Raffuse, Sean					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	23RD006	CARB	Using Integrated Observations and Modeling to Better Understand Current and Future Air Quality Impacts of Wildfires and Prescribed Burns	5/2024	6/2027
Active	68HERH23D0004	US EPA	Support for the Chemical Speciation of PM Filter Samples	3/2023	3/2027
Active	14P21D0004	National Park Service	IMPROVE Operations and Filter Analysis	1/2021	1/2026
Pending	R01ES037032	NIH	Molecular and Neurodevelopmental Alterations	8/2025	7/2030

			Associated with Prenatal Wildfire Exposures		
Pending	Not Assigned	National Science Foundation	Atmospheric Science and Chemistry mEasurement NeTwork (ASCENT): Operation, Management, and Scientific Studies	5/2025	3/2030

Co-I: Specht, Aaron					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	263798-51295221	JPB Foundation	JPB Environmental Health Fellowship Program Cohort III	3/2023	2/2026
Active	PO-0100064432	State of Washington	Proviso University of Washington	7/2024	06/2025
Active	112242-5125543	NIH/Harvard	Child and adult Metal exposures, gene expression and neuropathologically confirmed Alzheimer's Disease	9/2023	8/2025
Pending	24123958	NIH	Role of Metal Exposure in Psychopathology of Veterans and Active Duty Servicemembers	4/2025	3/2030
Pending	5078475	NIH	Impact of Strontium on Long-Term Bone Health	7/2025	6/2027
Pending	FP80003032	NIH/Johns Hopkins	BLUHD: Blood Levels of Unmeasured Hazards & Dementia	12/2025	11/2027
Pending	25036658	NIH/Northern Arizona University	Reducing Metal Exposures and Overdose Risks Among Native Americans Who Inject Methamphetamine: An Environmental Harm Reduction Approach and Intervention	7/2025	6/2030
Pending	25036684	NIH/University of Virginia	Determining the interplay of lifespan lead exposure with later risk for Alzheimer's disease and related dementias	8/2025	7/2030
Pending	FP80000856	NIH/University of Chicago	Enhancing the Pathology, Alzheimer's and Related Dementias Study to Understand	7/2025	6/2030

			Ancestry, Pollution Exposure, and AD/ADRD (PARDoS APEX)		
Pending	14296885	DOD	Kinetics of metals in bone during heightened periods of bone loading in U.S. Army Personnel	10/2025	09/2028
Pending	FP800001531	NIH/University of Virginia	Welding Fume-Related Mixed Metal and Lead (Pb) Exposure in Alzheimer's and Related Disorders	7/2025	6/2030
Pending	FP80002622	NIH/Harvard	Early life and adult fluoride exposure and adult cognitive function	12/2025	11/2030
Pending	FP80002639	NIH/Mount Sinai	Combined exposures to noise, air pollutants, and heavy metals in Accra: Assessing health effects in children, tracing exposure sources, and identifying the role of sleep patterns	12/2025	11/2030
Co-I: Tancredi, Daniel					
Status	**Award #**	**Source**	**Project Title**	**Start Date**	**End Date**
Pending	25RD003	CARB	Assessing Long-Term Health Effects of Wildfire Smoke Exposure: Insights from an Established Birth Cohort Study	TBD	TBD
Active	U54NS127758	NIH/NINDS	UC Davis CounterACT Center of Excellence: Developing Therapeutic Strategies for Mitigating the Chronic Neurological Consequences of Acute Organophosphate Intoxication	7/2022	6/2027
Active	R01HD102571	NIH/NICHD	A randomized controlled trial of abdominal ultrasound (FAST) in children with blunt torso trauma	9/2022	8/2027
Active	U01CE003573	Center for Disease Control and Prevention (CDC)	Development and Validation of a Clinical Tool to Predict Mental Health Sequelae After Mild Traumatic Brain Injury in Adolescents	9/2023	9/2028
Active	R01AG078283	NIH/NIA	The Effects of Visit Characteristics on Patient-Clinician Interactions and Health Outcomes in Knee Osteoarthritis	9/2023	6/2028

Active	R01HD072929	NIH/NIA	Oxygenation in Neonatal Lung Injury	8/2023	4/2028
Active	UG3OD035550	NIH/OD	Prenatal Environment and Child Health (PEACH) in ECHO	9/2023	5/2030
Active	R01ES031701	NIH/NIEHS	The CHARGE Study Phase II: A Multifactorial Approach to Autism Etiology	5/2020	1/2026
Active	R01HS029884	Agency for Healthcare Research and Quality	Clinical Care of Newborns with Prenatal Substance Exposure: A National Study	9/2024	6/2029
Active	R01AG085572	R01AG085572	Neuropathology and inflammation in a nonhuman primate model of insulin resistance/metabolic syndrome	2/2024	11/2028
Active	R01CE003673	Center for Disease Control and Prevention (CDC)	Rigorous Evaluation of California Policies to Disseminate Emergency Department-based Services for Opioid Use Disorder	9/2024	9/2027
Pending	R01ES037032	NIH	Molecular and Neurodevelopmental Alterations Associated with Prenatal Wildfire Exposures	8/2025	7/2030

EXHIBIT A7

THIRD PARTY CONFIDENTIAL INFORMATION

CONFIDENTIAL NONDISCLOSURE AGREEMENT

Exhibit A7 is not applicable for this Agreement.

EXHIBIT B2

SUBAWARDEE BUDGET(S)

Exhibit B2 will be added in when the contract has been finalized by the Research Division staff.

EXHIBIT B3

INVOICE ELEMENTS

In accordance with Section 14 of Exhibit C – Payment and Invoicing, the invoice, summary report and/or transaction/payroll ledger shall be certified by the University's Financial Contact and the PI (or their respective designees).

Invoicing frequency

☒ Quarterly ☐ Monthly

Invoicing signature format

☐ Ink ☒ Facsimile/Electronic Approval

Summary Invoice – includes either on the invoice or in a separate summary document – by approved budget category (Exhibit B) – expenditures for the invoice period, approved budget, cumulative expenditures and budget balance available[1]

- Personnel
- Equipment
- Travel
- Subawardee – Consultants
- Subawardee – Subcontract/Subrecipients
- Materials & Supplies
- Other Direct Costs
    - TOTAL DIRECT COSTS (if available from system)
- Indirect Costs
    - TOTAL

Detailed transaction ledger and/or payroll ledger for the invoice period [2]

- University Fund OR Agency Award # (to connect to invoice summary)
- Invoice/Report Period (matching invoice summary)
- GL Account/Object Code
- Doc Type (or subledger reference)
- Transaction Reference#
- Transaction Description, Vendor and/or Employee Name
- Transaction Posting Date
- Time Worked
- Transaction Amount

---

[1] If this information is not on the invoice or summary attachment, it may be included in a detailed transaction ledger.

[2] For salaries and wages, these elements are anticipated to be included in the detailed transaction ledger. If all elements are not contained in the transaction ledger, then a separate payroll ledger may be provided with the required elements.

EXHIBIT D

ADDITIONAL REQUIREMENTS ASSOCIATED WITH FUNDING SOURCES

Exhibit E is not applicable for this Agreement.

EXHIBIT E

SPECIAL CONDITIONS FOR SECURITY OF CONFIDENTIAL INFORMATION

Exhibit E is not applicable for this Agreement.

EXHIBIT F

ACCESS TO STATE FACILITIES OR COMPUTING RESOURCES

Exhibit F is not applicable for this Agreement.

EXHIBIT G

NEGOTIATED ALTERNATE UTC TERMS

I. Exhibit C, UTC – 220 Section 14 – Payment & Invoicing is hereby amended to incorporate the following:

Add Item 6 to Section 14. A. to read as follows:

6) CARB shall withhold payment equal to 10 percent after the Contractor has been compensated for 90 percent of the total agreement amount. The 10 percent shall be withheld until completion of all work and submission to CARB by the University of a final report approved by CARB in accordance with Exhibit A1, Schedule of Deliverables, Section 2. It is the University's responsibility to submit one (1) original and one (1) copy of the final invoice.

Amend Section 14. C.2 – Invoicing to read as follows:

2) Invoices shall be submitted in arrears not more frequently ~~than monthly and not less frequently~~ than quarterly to the State Financial Contact, identified in Exhibit A3. Invoices may be submitted electronically by email. If submitted electronically, invoice must include the following certification for State certification to the State Controller's Office, in compliance with SAM 8422.1

This bill has been checked against our records and found to be the original one presented for payment and has not been paid. We have recorded this payment so as to prevent later duplicate payment.

Signed: _____
State Agency Accounting Officer

Add Item E: to Section 14, to read as follows:

E. Advance Payment

1) Nothing herein contained shall preclude advance payments pursuant to Title 2, Division 3, Part 1, Chapter 3, Article 1 of the Government Code of the State of California.

2) Upon termination or completion of this Agreement, Contractor shall refund any excess funds to the CARB. Contractor will reconcile total Agreement costs to total payments received in advance and any remaining advance will be refunded to the CARB's Accounting Office. In the event the Agreement is terminated, total project costs incurred prior to the effective date of termination (including close-out costs) will be reconciled to total project payments received in advance and any remaining advance will be refunded to the CARB. In either event Contractor shall return any balance due to CARB within sixty (60) days, of expiration or earlier termination.

Amend Section 14.B –Budget Flexibility to read as follows:

B. Budget revisions between identified budget categories in cost reimbursement agreements that are within the total Agreement amount, comply with the Prior Approval Requirements, above and do not change the Scope of Work or substitute Key Personnel, as defined in this Agreement, are allowed as described below:

1) Up to 10% ~~of each annual budget amount or $10,000, whichever is less,~~ is allowed with approval of the State's Contract Project Manager, or as otherwise agreed to by the Parties and documented on Exhibit B.

2) Exceeding 10% ~~or $10,000, whichever is less,~~ of the last approved budget require the State's Contract Project Manager's prior approval and may require a formal amendment to this Agreement. The University will submit a revised budget to the State for approval. Budget transfers that would cause any portion of the funds to be used for purposes other than those consistent with the original intent of this Agreement are not allowed.

II. Add the following sections to the UTC-220 to incorporate additional required provisions:

Add Section 31 to read as follows:

31. GenAI Disclosure Obligations:

A. The following terms are in addition to the defined terms and shall apply to the Contract:

1) "Generative AI (GenAI)" means an artificial intelligence system that can generate derived synthetic content, including text, images, video, and audio that emulates the structure and characteristics of the system's training data. (Gov. Code § 11549.64.)

B. Contractor shall immediately notify the State in writing if it: (1) intends to provide GenAI as a deliverable to the State; or (2), intends to utilize GenAI, including GenAI from third parties, to complete all or a portion of any deliverable that materially impacts: (i) functionality of a State system, (ii) risk to the State, or (iii) Contract performance. For avoidance of doubt, the term "materially impacts" shall have the meaning set forth in State Administrative Manual (SAM) § 4986.2 Definitions for GenAI.

C. Notification shall be provided to the State designee identified in this Contract.

D. At the direction of the State, Contractor shall discontinue the provision to the State of any previously unreported GenAI that results in a material impact to the functionality of the System, risk to the State, or Contract performance, as determined by the State.

E. If the use of previously undisclosed GenAI is approved by the State, then Contractor will update the Deliverable description, and the Parties will amend the Contract accordingly, which may include incorporating the GenAI Special Provisions into the Contract, at no additional cost to the State.

F. The State, at its sole discretion, may consider Contractor's failure to disclose or discontinue the provision or use of GenAI as described above, to constitute a material breach of Contract when such failure results in a material impact to the functionality of the System, risk to the State, or Contract performance. The State is entitled to seek any and all remedies available to it under law as a result of such breach, including but not limited to termination of the contract.

Add Section 32 to read as follows:

32.Health and Safety

Contractors are required to, at their own expense, comply with all applicable health and safety laws and regulations. Upon notice, Contractors are also required to comply with the state agency's specific health and safety requirements and policies.

Contractors agree to include in any subcontract related to performance of this Agreement, a requirement that the subcontractor comply with all applicable health and safety laws and regulations, and upon notice, the state agency's specific health and safety requirements and policies.

Add Section 33 to read as follows:

33. Executive Order N-6-22 – Russia Sanctions

On March 4, 2022, Governor Gavin Newsom issued Executive Order N-6-22 (the EO) regarding Economic Sanctions against Russia and Russian entities and individuals. "Economic Sanctions" refers to sanctions imposed by the U.S. government in response to Russia's actions in Ukraine, as well as any sanctions imposed under state law. The EO directs state agencies to terminate contracts with, and to refrain from entering any new contracts with, individuals or entities that are determined to be a target of Economic Sanctions. Accordingly, should the State determine Contractor is a target of Economic Sanctions or is conducting prohibited transactions with sanctioned individuals or entities, that shall be grounds for termination of this agreement. The State shall provide Contractor advance written notice of such termination, allowing Contractor at least 30 calendar days to provide a written response. Termination shall be at the sole discretion of the State.