Wildfire Smoke & Infant Health

Meeting #4
Tying it all together

PACIFIC NORTHWEST CENTER
for
Translational Environmental Health Research
NEXT STEPS

MEETING #1: Interest level, Feedback on study elements, Scheduling

MEETING #2: Chemicals of interest, Data collection tools

MEETING #3: Health outcomes, Timing of exposure

MEETING #4: Tying it all together

MEETING #5: Apply for pilot funding to collect preliminary data

https://ehsc.oregonstate.edu/outreach/wildfire-health
BACKGROUND

I. Klamath County – high rates of infant mortality, pre-term birth, low birthweight

II. Large number of ‘unhealthy’ days for wildfire smoke

III. Studies indicating association between exposure to wildfire smoke and poor infant health measures

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY 2021b. Wildfire Smoke Trends and the Air Quality Index. Oregon Department of Environmental Quality: Laboratory and Environmental Assessment Division.
## ELEMENTS OF A STUDY

<table>
<thead>
<tr>
<th>EXPOSURE</th>
<th>QUESTION &amp; CONCERN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildfire smoke</td>
<td>Concern over prenatal exposure to wildfire smoke and subsequent infant health outcomes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TARGET POPULATION</th>
<th>CHEMICALS OF INTEREST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant individuals</td>
<td>VOCs</td>
</tr>
<tr>
<td></td>
<td>SVOCs</td>
</tr>
<tr>
<td></td>
<td>Metals</td>
</tr>
<tr>
<td></td>
<td>PM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEALTH OUTCOMES</th>
<th>DATA COLLECTION TOOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant mortality</td>
<td>Personal sampling</td>
</tr>
<tr>
<td>Preterm birth</td>
<td>Environmental sampling</td>
</tr>
<tr>
<td>Low birthweight</td>
<td>Publicly available data</td>
</tr>
<tr>
<td>Others?</td>
<td>Surveys</td>
</tr>
<tr>
<td></td>
<td>Medical data</td>
</tr>
</tbody>
</table>
HEALTH OUTCOMES

- Difficulty conceiving
- Miscarriage
- Stillbirth / fetal death
- Gestational diabetes
- Hypertension
- Preeclampsia

- Preterm birth
- Gestational age at birth
- Low birth weight
- Small for gestational age
- NICU admissions
- Head circumference (OFC)
- Respiratory health (cough, wheeze)

- Infant mortality
- Growth (stunted / obesity)
- Immune dysregulation (IL-6, IL-8)
- Respiratory health
- Developmental outcomes
- Neurodevelopmental outcomes
- Cognitive outcomes (IQ, ADHD, etc.)
HEALTH OUTCOMES - LONGITUDINAL

- Difficulty conceiving
- Miscarriage
- Stillbirth / fetal death
- Gestational diabetes
- Hypertension
- Preeclampsia
- Preterm birth
- Gestational age at birth
- Low birth weight
- Small for gestational age
- NICU admissions
- Head circumference (OFC)
- Respiratory health (cough, wheeze)
- Infant mortality
- Growth (stunted / obesity)
- Respiratory health
- Developmental outcomes
- Neurodevelopmental outcomes
- Cognitive outcomes (IQ, ADHD, etc.)
- Immune dysregulation (IL-6, IL-8)

TO BE DETERMINED
(Meeting #5 and beyond)
# Health Outcomes - Pilot

- Difficulty conceiving
- Miscarriage
- Stillbirth / fetal death
- Gestational diabetes
- Hypertension
- Preeclampsia
- Respiratory health

- Preterm birth
- Gestational age at birth
- Low birth weight
- Small for gestational age
- NICU admissions
- Head circumference (OFC)
- Respiratory health (cough, wheeze)

- Infant mortality
- Growth (stunted / obesity)
- Immune dysregulation (IL-6, IL-8)
- Respiratory health
- Developmental outcomes
- Neurodevelopmental outcomes
- Cognitive outcomes (IQ, ADHD, etc.)
<table>
<thead>
<tr>
<th>Chemical(s)</th>
<th>Wildfire smoke</th>
<th>Preterm birth</th>
<th>Low birthweight</th>
<th>Notes</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM2.5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Pregnancy loss, infertility</td>
<td>4.80</td>
</tr>
<tr>
<td>PAHs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Small for gestational age; ADHD</td>
<td>4.00</td>
</tr>
<tr>
<td>Pesticides</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>3.25</td>
</tr>
<tr>
<td>Endocrine disruptors</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Chemical-specific outcomes</td>
<td>3.25</td>
</tr>
<tr>
<td>Flame retardants</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Chemical-specific outcomes</td>
<td>2.75</td>
</tr>
<tr>
<td>Dioxins</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>Conflicting human data</td>
<td>2.50</td>
</tr>
<tr>
<td>Personal care</td>
<td>✓</td>
<td></td>
<td></td>
<td>Chemical-specific outcomes</td>
<td>2.25</td>
</tr>
<tr>
<td>Industrial chemicals (phthalates)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Pregnancy loss, infertility</td>
<td>2.00</td>
</tr>
<tr>
<td>PCBs</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Conflicting human data</td>
<td>0.00</td>
</tr>
</tbody>
</table>

✓ = Agreement in Literature

✓ = Has yet to be determined
DATA COLLECTION
TOOLS

Did you experience any of the following asthma symptoms today? Mark all that apply.

- [ ] Wheezing
- [ ] Coughing
- [ ] Shortness of breath
- [ ] Chest tightness or pain
<table>
<thead>
<tr>
<th>Questionnaire Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Questionnaires</td>
<td>(maternal/child health)</td>
</tr>
<tr>
<td>Sociodemographic Questions</td>
<td>(education, income)</td>
</tr>
<tr>
<td>Behavioral Questions</td>
<td>(smoking, exercise)</td>
</tr>
<tr>
<td>Access to information</td>
<td>(Internet, Facebook)</td>
</tr>
</tbody>
</table>
Area Deprivation Index
https://www.neighborhoodatlas.medicine.wisc.edu/
Develops neighborhood rankings by socioeconomic disadvantage (income, education, employment, and housing quality).

NOAA Hazard Mapping
https://www.ospo.noaa.gov/Products/land/hms.html
To assess prenatal exposure to wildfire smoke, we plan to recruit pregnant individuals before a wildfire, and again during a wildfire, to wear personal monitors that will measure PM2.5 and semi-volatile and volatile organic compounds (SVOCs; VOCs).

Hypothesis:
Short term wildfire events result in increased exposure to PM2.5, SVOCs and VOCs above that of baseline ambient exposures (non-wildfire).
To determine wildfire smoke composition and associated toxicity we will extract samples from personal and environmental monitors and assess for PM2.5 and 1,530 SVOCs and VOCs. These extracts will be tested in the zebrafish model to evaluate toxicity.

Hypothesis:

SVOCs and VOCs are a significant contributor to wildfire smoke-associated toxicity.
We will evaluate the impact of short-term air pollution events due to wildfire smoke on maternal respiratory health, as short-term exposures may be associated with adverse infant health outcomes to include preterm birth.

**Hypothesis:**

Prenatal exposure to acute wildfire events are associated with adverse maternal and infant health outcomes.

**Pilot project hypothesis**

Exposure to acute wildfire events are associated with adverse respiratory health in the pregnant individual.
To assess prenatal exposure to wildfire smoke, we plan to recruit pregnant individuals before a wildfire, and again during a wildfire, to wear personal monitors that will measure PM2.5 and semi-volatile and volatile organic compounds (SVOCs; VOCs).

$n = 20$
Access Sensor Technologies
PM + Filter

WILDFIRE before

WILDFIRE during
To determine wildfire smoke composition and associated toxicity we will extract samples from personal and environmental monitors and assess for PM2.5 and 1,530 SVOCs and VOCs. These extracts will be tested in the zebrafish model to evaluate toxicity.
We will evaluate the impact of short-term air pollution events due to wildfire smoke on maternal respiratory health, as short-term exposures may be associated with adverse infant health outcomes to include preterm birth.
Did you experience any of the following asthma symptoms today? Mark all that apply.

☐ Wheezing
☐ Coughing
☐ Shortness of breath
☐ Chest tightness or pain

Google Fit app
respiratory rate – heart rate
The Zebrafish as a Research Tool

Zebras as a research model
- There are thousands of chemicals in our environment.
- We are always exposed to mixtures of chemicals.
- Humans and zebrafish share >70% similar genes.
- 84% of human disease genes are also in zebrafish.
- Humans and zebrafish have many of the same organs.
- Zebrafish develop very quickly – from a single cell to swimming fish in 5 days.

Zebras as a chemical screening tool
- Zebrafish are small and easy to use, allowing us to rapidly assess thousands of chemicals.
- Some chemicals can affect DNA and cell signaling to change the way animals develop.
- Changes in zebrafish development identifies chemicals that may be hazardous to humans. We measure dozens of effects in these chemical screens.

Can Evaluate
- Which chemicals may pose a higher risk than others to human health
- Effects of individual and real-world mixtures of chemicals.

Cannot Evaluate
- The actual effect of a chemical on the human body
- The precise amount of a chemical that may cause a harmful effect in humans
### STUDY DESIGN - OUTCOMES

<table>
<thead>
<tr>
<th>Wristbands</th>
<th>PM2.5&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Zebrafish</th>
<th>Health&lt;sup&gt;2&lt;/sup&gt;</th>
<th>PM2.5</th>
<th>PSD</th>
<th>Zebrafish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Fire</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>During-Fire</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Analyzed</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Archived</td>
<td>30</td>
<td>40</td>
<td>30</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<sup>1</sup>Will include filters to be archived. Can be tested for SVOCs and VOCs later if funded

<sup>2</sup>Monitor and/or survey data evaluating respiratory health
NEXT STEPS

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OVERALL AIMS

I. Characterize constituents of wildfire smoke
II. Compare individual exposure to ambient exposure
   I. E.g. what impact does wildfire smoke have on indoor and individual exposures? (Ghetu et al paper, in progress)
III. Identify drivers of toxicity in wildfire smoke
   I. Justification: We know PM is a problem, but what chemicals or chemical groups are causing toxicity?
   II. Design:
       I. Risk Assessment
       II. Outdoor samplers for exposure modeling
       III. Indoor samplers (personal monitoring)
       IV. Adverse health outcomes
           I. Zebrafish model
           II. Infant / child health

IV. Inform public health policy and practice
   I. Interventions
       I. When to close windows (i.e. AQI at a certain level)
       II. How to create a clean room
       III. When to use a DIY box fan + HEPA filters
       IV. Prescriptions for pregnant people to have AC in wildfire-impacted regions

I. Build a Cohort
II. Sample during Wildfires
III. Inform Public Health Policy & Practice
<table>
<thead>
<tr>
<th>NATIONAL VITAL STATISTICS</th>
<th>ELECTRONIC HEALTH RECORDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-variates</td>
<td>Medical History</td>
</tr>
<tr>
<td>Maternal characteristics</td>
<td>Medications</td>
</tr>
<tr>
<td>Prenatal care</td>
<td>Allergies</td>
</tr>
<tr>
<td>Health care</td>
<td>Diagnoses</td>
</tr>
<tr>
<td>Birth rates</td>
<td>Lab &amp; test results</td>
</tr>
<tr>
<td>Fertility rates</td>
<td></td>
</tr>
<tr>
<td>Preterm birth rates</td>
<td></td>
</tr>
<tr>
<td>Birth weight</td>
<td></td>
</tr>
<tr>
<td>Infant mortality rates</td>
<td></td>
</tr>
</tbody>
</table>

https://www.cdc.gov/nchs/nvss/births.htm
A Fractionalized Exhaled Nitric Oxide level test measures the amount of nitric oxide that is exhaled from a breath. Increased levels of nitric oxide are associated with swelling of lung airways.