Air Pollution and Reproductive Health

Tracey J. Woodruff, PhD, MPH
British Columbia Lung Association’s Annual Air Quality & Health Workshop
February 10, 2016
Development and Periods of Susceptibility

Fertilized Egg → Embryo → Fetus → Infant → Child Teenager
Preterm Birth and Low Birthweight
Pregnancy outcomes

• **Immediate**
  - “low birthweight”
  - Preterm delivery
  - Birth defects

• **Short term**
  - Infant death
  - Childhood cancer
  - Neurodevelopmental outcomes

• **Long term**
  - Heart disease
  - Diabetes
Air pollution monitors
Pregnancy outcomes and outdoor air pollution: an ecological study in districts of the Czech Republic 1986–8

Martin Bobak, David A Leon

Table 2. Odds ratios for low birth weight (<2500 g) / 50 μg/m³ increase in air pollutants and for change from 25th to 75th percentile of socioeconomic variables

<table>
<thead>
<tr>
<th></th>
<th>Crude</th>
<th>Adjusted for socioeconomic factors</th>
<th>Fully adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended particulates</td>
<td>1.06 (0.97–1.17)</td>
<td>1.04 (0.96–1.12)</td>
<td>1.03 (0.95–1.11)</td>
</tr>
<tr>
<td>Sulphur dioxide</td>
<td>1.21 (1.13–1.30)**</td>
<td>1.10 (1.02–1.17)**</td>
<td>1.10 (1.01–1.20)*</td>
</tr>
<tr>
<td>Nitrogen oxides</td>
<td>1.14 (1.04–1.24)**</td>
<td>1.07 (0.98–1.16)</td>
<td>0.99 (0.89–1.10)</td>
</tr>
<tr>
<td>Births outside marriage (%)</td>
<td>1.17 (1.14–1.21)**</td>
<td>1.09 (1.03–1.16)**</td>
<td>1.08 (1.01–1.14)*</td>
</tr>
<tr>
<td>Abortions / 100 births</td>
<td>1.01 (0.96–1.06)</td>
<td>0.98 (0.94–1.03)</td>
<td>0.98 (0.94–1.00)</td>
</tr>
<tr>
<td>Divorces / 100 marriages</td>
<td>1.08 (1.03–1.13)**</td>
<td>1.04 (0.97–1.11)</td>
<td>1.02 (0.95–1.09)</td>
</tr>
<tr>
<td>Mean income (Czech Crowns)</td>
<td>1.03 (0.98–1.07)</td>
<td>0.99 (0.96–1.03)</td>
<td>0.99 (0.95–1.04)</td>
</tr>
<tr>
<td>Mean savings (Czech Crowns)</td>
<td>0.84 (0.80–0.88)</td>
<td>0.85 (0.79–0.91)***</td>
<td>0.85 (0.79–0.91)***</td>
</tr>
<tr>
<td>People / car (mean)</td>
<td>1.04 (0.98–1.10)</td>
<td>0.94 (0.88–1.00)*</td>
<td>0.93 (0.87–1.00)*</td>
</tr>
<tr>
<td>R² for model with pollutants</td>
<td>0.01–0.19 (SO₂)</td>
<td>0.50–0.52 (SO₂)</td>
<td>0.52</td>
</tr>
</tbody>
</table>

*p<0.05; **p<0.01; ***p<0.001.
R² =0.50 for socioeconomic factors only.

1.03 (0.95 – 1.11)
Preterm birth during steel mill closure – Utah Valley

Geneva Steel, Utah Valley, 1989 (PM$_{10}$ = 150 µg/m$^3$)

Parker, Mendola, Woodruff
Epidemiology 2008
Traffic-related Air Pollution and Fetal Weight/Placental Weight in Mice

Rocha e Silva et al. F&S 2008
Ambient air pollution, birth weight and preterm birth: A systematic review and meta-analysis

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Increased Odds of Low Birthweight PM10

Increased Odds of Preterm Birth PM10
Maternal Exposure to Particulate Air Pollution and Term Birth Weight:
A Multi-Country Evaluation of Effect and Heterogeneity

Payam Dadvand,1,2,3 Jennifer Parker,4 Michelle L. Bell,5 Matteo Bonzini,6 Michael Brauer,7
Lyndsey A. Darrow,8 Ulrike Gehring,9 Svetlana V. Glinianaia,10 Nelson Gouveia,11 Eun-hee Ha,12
Jong Han Leem,13 Edith H. van den Hooven,14,15 Bin Jalaludin,16,17,18 Bill M. Jesdale,19 Johanna Lepeule,20,21,22
Rachel Morello-Frosch,19,23 Geoffrey G. Morgan,24,25 Angela Cecilia Pesatori,26 Frank H. Pierik,15 Tanja Pless-Mulloli,10
David Q. Rich,27 Sheela Sathyanarayana,28 Juhee Seo,12 Remy Slama,21,22 Matthew Strickland,8 Lillian Tamburic,29
Daniel Wartenberg,30 Mark J. Nieuwenhuijsen,1,2,3 and Tracey J. Woodruff31

~ 3 million births from

PM2.5 - OR = 1.10; 95% CI: 1.03, 1.18
10-μg/m3 increase
20 ug/m3 increase in PM2.5 -> 18 g (95% CI: –32 g, 3 g), decreases in birth weight among term births..’.
LBW & Preterm

- Effects are small but exposure ubiquitous and high in certain areas
  - For LBW ~ 30 grams reduction in BW for 10 ug/m³ increase in particulate matter air pollution in CA
    - ETS (20-30 grams) (Windham et al. 1999)

- Other pollutants may play role
  - Studies typically find at least one pollutant associated, not always the same one

- Variable critical window

1999
1.03 (0.95 – 1.11)
(about 50 ug/m³ increase suspended particles)

2013
PM2.5 - OR = 1.10; 95% CI: 1.03, 1.18
10-µg/m³ increase

14 years
“I’m afraid there’s not much I can do for you now. You should’ve come in sooner, before you got sick.”
I. Reproductive Health Professionals

• Influential allies

• Can intervene early in children’s health

• Pregnancy – a teachable moment
An Official Statement on Environmental Toxins and Pregnancy

This week the American Congress of Obstetricians and Gynecologists issued a strong warning about the risks of environmental toxins to pregnant women and fetuses.

GRACE RUBENSTEIN | SEP 26, 2013
Box 1
Adverse health outcomes linked with preconception and prenatal exposure to environmental chemicals.\(^a\)

**Fertility and pregnancy**

- Decreased semen quality with PCBs [54]
- Spontaneous abortion and fetal loss with solvents [55–58]
- Impaired fetal growth with pesticides [59]
- **Fetal loss, low birth weight, and preterm delivery with air pollutants** [60–66]
- Decreased fetal and birth weight, and congenital malformations with toluene [67–69]
- Shortened gestational age with phthalates [70]
- Low birth weight with PCBs [71]
- Reduced birth weight and fetal growth with perfluorinated compounds [72,73]
Recommendation 1: Advocate for policies to prevent exposure to toxic environmental chemicals

Recommendation 2: Work to ensure a healthy food system for all

Recommendation 3: Make environmental health part of health care

Recommendation 4: Champion environmental justice
Program on Reproductive Health and the Environment

Science-Based Decision-Making in Clinical Care and Public Policy

Navigation Guide Systematic Review Methodology

In vitro Evidence

Animal Evidence

Human Evidence

Peer-Reviewed Articles

Scientific “Bottom Line”

Health Professionals  Policy Makers

BRIDGING CLINICAL & ENVIRONMENTAL HEALTH

By Tracey J. Woodruff, Patrice Sutton, and The Navigation Guide Work Group

An Evidence-Based Medicine Methodology To Bridge The Gap Between Clinical And Environmental Health Sciences

ABSTRACT Physicians and other clinicians could help educate patients about hazardous environmental exposures, especially to substances that could affect their reproductive health. But the relevant scientific evidence is voluminous, of variable quality, and largely unfamiliar to health professionals caring for people of childbearing age. To bridge this gap between clinical and environmental health, we created a methodology to...
- Pregnancy should be considered a time of vulnerability to air pollution
  - Ex. EPA’s Endangerment Finding for greenhouse gases affects on public health “the very young” as among the most vulnerable groups to climate-related health effects.

- Air pollution effects are a concern of all reproductive health professionals
- We need to continue to implement approaches to shorten time from science to decision.

Linda C. Giudice, MD, PhD, President American Society for Reproductive Medicine and Jeanne C. Conry, MD, PhD, President, American Congress of Obstetricians and Gynecologists – October 2013, Washington, DC
THINK OF HOW MANY HEALTHCARE-RELATED JOBS WE'RE CREATING.
Recent Past (1990 – 2008)

$2 trillion dollars by 2020
Mission: To create a healthier environment for human reproduction and development by advancing scientific inquiry, clinical care, and health policies that prevent exposures to harmful chemicals in our environment.