Webinars
Series of scientific webinars that provide a forum for discourse on scientific issues.
Live and On-Demand
Case Conferences
Journal Clubs
Grand Rounds
CE Available

Online Courses
Evidence-based online courses on a variety of children's environmental health topics.
Interactive and Self-Paced
CE Available

Resource Catalog
Fact sheets, journal publications, reports, and other resources for parents, community members, patients and healthcare professionals
Topics included: Air Quality, Pesticides, Natural Disasters, BPA, Mold, Lead, Mercury
Riesgos Ambientales: Pesticidas
Environmental Risks: Pesticides

Beatriz Tapia, MD, MPH, EdD

*Adapted from Environmental Impacts on Reproductive Health: Pesticide Exposure
Objectives

- Discuss the impact of pesticide exposure during pregnancy.
- Identify critical windows of susceptibility for pesticide exposures.
- Describe pesticide exposures among pregnant women in South Texas.
- Identify resources to facilitate patient counseling of risk and risk reduction of hazardous exposures.
Pesticides Defined

Chemicals used against unwanted organisms:

- Insects
- Rodents
- Plants
- Fungi

Pesticide Use Is Widespread in United States

More than 1.2 billion pounds used annually

Kiely T, et al. 2004
US EPA, 2008
Lesson Learned: DDT

A well-known harmful pesticide

1874: DDT developed

1939: Insecticidal properties discovered

1940s: Used in WWII typhus epidemic

1945: Available as agricultural insecticide

1962: Silent Spring published

1972: Banned in US

more…
## Types of Pesticides

### Examples:

<table>
<thead>
<tr>
<th>Type of Pesticide</th>
<th>Target Organisms</th>
<th>Chemical Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insecticide</td>
<td>Aphids, fleas, beetles</td>
<td>Organophosphates, pyrethroids</td>
</tr>
<tr>
<td>Rodenticide</td>
<td>Mice, rats</td>
<td>Coumarins</td>
</tr>
<tr>
<td>Herbicide</td>
<td>Invasive grasses</td>
<td>Acetyl-coenzyme A carboxylase inhibitors</td>
</tr>
</tbody>
</table>

EPA, 2008
Sources of Pesticide Exposure

- Residues on food
- Community applications
- Occupational exposure
- Tap water
- Household use
- Personal use

EPA, 2008
NPIC, 2008
75% of US households use at least 1 pesticide product indoors.

May be used to:
- Eliminate insects and rodents
- Care for lawn and garden
- Prevent fleas and ticks

US EPA, 2008
Pesticides Contain Active and Inert Ingredients

Inert $\neq$ Benign

Cox C. Environ Health Perspect, 2006
PANNA, 2008
Some inert ingredients have been found to:

- Decrease heart rate and blood pressure
- Reduce mitochondrial activity
- Be toxic to human placenta cell cultures

Data come primarily from animal studies

Cox C. Environ Health Perspect, 2006
Routes of Exposure

1. Inhalation
2. Ingestion
3. Skin contact
4. In utero exposure (fetus)

Klaassen C. In: Casarett & Doull’s Toxicology: The Basic Science of Poisons. 7th ed. 2007
Acute vs. Chronic Pesticide Exposure

Acute exposure
• Increase likelihood to identify the source
• Initial insult can be responsible for various health effects

Chronic exposure
• Not obvious to patient thus less likely to be reported to physicians as a health concern
## Environmental Exposures and Adverse Pregnancy Outcomes

### Table 1. Selected Studies Showing Environmental Links to Adverse Birth Outcomes

<table>
<thead>
<tr>
<th>Birth Outcome</th>
<th>Pollutant</th>
<th>Author and Year Published</th>
<th>Study Type</th>
<th>Exposure Characterization</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fetal growth</td>
<td>Particulates</td>
<td>Wang et al&lt;sup&gt;29&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 74,671</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bobak et al&lt;sup&gt;29&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 73,148</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Djeomek et al&lt;sup&gt;30&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 4883</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ha et al&lt;sup&gt;31&lt;/sup&gt;</td>
<td>Time series</td>
<td>Ambient monitoring</td>
<td>n = 276,763</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wilhelm and Ritz&lt;sup&gt;32&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 498,235</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parker et al&lt;sup&gt;33&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 18,247</td>
</tr>
<tr>
<td></td>
<td>Organophosphate insecticides</td>
<td>Perera et al&lt;sup&gt;41&lt;/sup&gt;</td>
<td>Prospective cohort</td>
<td>Serum levels</td>
<td>n = 263</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Levario-Carrillo et al&lt;sup&gt;42&lt;/sup&gt;</td>
<td>Case-control</td>
<td>Residential history</td>
<td>n = 371</td>
</tr>
<tr>
<td></td>
<td>Triazine herbicides</td>
<td>Munger et al&lt;sup&gt;43&lt;/sup&gt;</td>
<td>Cross sectional</td>
<td>Drinking water monitoring</td>
<td>n = 9551</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dabrowski et al&lt;sup&gt;44&lt;/sup&gt;</td>
<td>Case-control</td>
<td>Residential and occupational history</td>
<td>n = 494</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Villanueva et al&lt;sup&gt;45&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Municipal drinking water monitoring</td>
<td>n = 9721</td>
</tr>
<tr>
<td>Preterm birth</td>
<td>SO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Bobak et al&lt;sup&gt;29&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 73,148</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sagiv et al&lt;sup&gt;46&lt;/sup&gt;</td>
<td>Time series</td>
<td>Ambient monitoring</td>
<td>n = 187,997</td>
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<tr>
<td></td>
<td></td>
<td>Huybrechts et al&lt;sup&gt;39&lt;/sup&gt;</td>
<td>Matched case-control</td>
<td>Ambient monitoring</td>
<td>n = 42,692</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wilbur and Ritz&lt;sup&gt;38&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 108,263</td>
</tr>
<tr>
<td></td>
<td>CO&lt;sub&gt;2&lt;/sub&gt;</td>
<td>Liu et al&lt;sup&gt;38&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 229,085</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Liu et al&lt;sup&gt;38&lt;/sup&gt;</td>
<td>Retrospective cohort</td>
<td>Ambient monitoring</td>
<td>n = 229,085</td>
</tr>
<tr>
<td>Congenital abnormalities</td>
<td>Chlorophenoxy herbicides</td>
<td>Garry et al&lt;sup&gt;50&lt;/sup&gt;</td>
<td>Cross sectional</td>
<td>Occupational history</td>
<td>n = 210,723</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Garry et al&lt;sup&gt;51&lt;/sup&gt;</td>
<td>Cross sectional</td>
<td>Occupational history</td>
<td>n = 1532&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Basso 1999&lt;sup&gt;52&lt;/sup&gt;</td>
<td>Cohort</td>
<td>Occupational history</td>
<td>n = 8671</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schreinemachers&lt;sup&gt;53&lt;/sup&gt;</td>
<td>Ecologic</td>
<td>Pesticide use and proximity</td>
<td>n = 43,634</td>
</tr>
<tr>
<td></td>
<td>Other pesticides</td>
<td>Rull 2006&lt;sup&gt;54&lt;/sup&gt;</td>
<td>Case-control</td>
<td>Pesticide use and proximity</td>
<td>n = 1671</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toledano et al&lt;sup&gt;52&lt;/sup&gt;</td>
<td>Cohort</td>
<td>Monitored tap water extrapolated to populations</td>
<td>n = 920,571</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DDT</td>
<td>Korrick et al(^6^3)</td>
<td>Case–control</td>
<td>Serum levels</td>
<td>(n = 30)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Longnecker et al(^6^4)</td>
<td>Prospective cohort</td>
<td>Serum levels</td>
<td>(n = 1717)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Law et al(^6^5)</td>
<td>Prospective cohort</td>
<td>Serum levels</td>
<td>(n = 390)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cocco et al(^6^6)</td>
<td>Retrospective cohort</td>
<td>Occupational history</td>
<td>(n = 105)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Venners et al(^6^7)</td>
<td>Prospective cohort</td>
<td>Serum levels</td>
<td>(n = 388)</td>
</tr>
<tr>
<td></td>
<td>Bisphenol-A</td>
<td>Sugiura-Ogasawara et al(^6^8)</td>
<td>Case–control</td>
<td>Serum levels</td>
<td>(n = 45)</td>
</tr>
</tbody>
</table>

\(^a\) Ambient monitoring for the common air pollutants is assumed to be a reasonable surrogate for individual level exposures.

\(^b\) The study evaluated families with children with birth defects, the \(n\) is for the number of children in the study.
## NHANES: Chemicals in Pregnant Women

<table>
<thead>
<tr>
<th>Chemical class</th>
<th>Blood</th>
<th>Serum</th>
<th>Urine</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotinine</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Environmental phenols</td>
<td></td>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Metals</td>
<td></td>
<td>4</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td><strong>Organochlorine pesticides</strong></td>
<td></td>
<td>13</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td><strong>Organophosphate insecticides</strong></td>
<td></td>
<td>6</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Perchlorate</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Phthalates</td>
<td></td>
<td>13</td>
<td></td>
<td>13</td>
</tr>
<tr>
<td>PBDEs and other brominated flame retardants</td>
<td>11</td>
<td></td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>PCBs and dioxin-like chemicals</td>
<td></td>
<td>55</td>
<td></td>
<td>55</td>
</tr>
<tr>
<td>PAHs</td>
<td></td>
<td>10</td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>PFCs</td>
<td></td>
<td>12</td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>VOCs</td>
<td>33</td>
<td></td>
<td></td>
<td>33</td>
</tr>
</tbody>
</table>

See Supplemental Material, Table 1 (doi:10.1289/ehp.1002727), for individual chemical analytes included in each chemical class.

Figure 3. Number of chemicals detected by chemical class in U.S. pregnant women, NHANES subsample B [metals, cotinine, organochlorine (OC) pesticides, phthalates, brominated flame retardants (PBDEs), and PAHs], 2003–2004 (n = 54). Each vertical bar represents one study participant. Other subsamples showed similar results.

“…every child conceived today in the Northern hemisphere is exposed to pesticides from conception throughout gestation and lactation regardless of where it is born.”

Colborn T.  
*Environ Health Perspect.* 2006
Research Question:
How do pesticide exposures of pregnant women living in the Lower Rio Grande Valley compare with those of pregnant women living in New York City (NYC)?
(in partnership with U.S. Hispanic Nutrition Research and Education Center)

• Inner city of NYC has highest pesticide application rates in NY State, principally used for roach control in low-income housing.
• Measured pesticides in dust, air, maternal blood, etc.

Results: Babies born to mothers exposed to organophosphate pesticides had decreased birth length and head circumference. Currently assessing cognitive/behavioral measures up to age seven. N=314

Whyatt, et al. Environ Health Perspect, 2004
Study Population:

25 pregnant Hispanic Women, 18-35 y/o, 30-34 weeks gestation, recruited from maternity clinics in Hidalgo County

Inclusion criteria:

- Stable residency within drivable distance
- Non smoker/no illicit drugs/moderate drinker
- No major health problems (DM, AHT, HIV, NS)
- Homemakers who spend majority day in home
Pesticide Exposure in South Texas

Methods:

- Questionnaire covering demographics, home characteristics, residential history, and lifestyle
- Installation of PUF sampler in home
- Two weeks later - follow-up questionnaire
- All samples (air and dust) sent for analysis
### Pesticides analyzed in home air and dust (~45 total)

**Organophosphates**
- Azinophos-methyl
- **Chlorpyrifos**
- Diazinon
- Ethyl Parathion
- Malathion
- Methyl parathion
- Propetamophos

**Carbamates**
- Bendiocarb
- Carbaryl
- Carbofuran
- Fenoxycarb (also IGR)
- **Propoxur**

**Synergists**
- MGK 264
- Piperonyl butoxide

**Fungicides**
- Captan

**Synthetic Pyrethroids**
- Bioallethrin
- Bifenthrin
- Cis-permethrin
- Cyfluthrin
- Cypermethrin
- Deltamethrin/tralomethrin
- Fenvalerate
- Lamda-cyhalothrin
- Prallethrin
- Sumithrin
- Tetramethrin
- **Trans-permethrin**
Pesticides Analyzed (continued)

Insect Growth Retardant (IGR)
- Fenoxycarb (also carbamate)
- Hydroprene
- Methoprene

Organochlorines
- 4,4’-DDD
- 4,4,’-DDE
- 4,4’-DDT
- Alpha-chlordane
- Dieldrin
- Gamma-chlordane
- Heptachlor
- Lindane

Herbicides
- Atrazine
- Metolachlor
- Pendimethalin
- Simazinc
- Trifluralin

Others
- Fipronil
- Ortho-phenylphenol
- Sulfluramid
Results:

- 68% of these households reported pesticide use vs. 85% of previously studied NYC households.
- 35% used two or more pest control methods.
- 14 pesticides detected including several organophosphates: ortho-phenylphenol in 92% of home air samples, followed by chlorpyrifos in 80%, propoxur in 76%, diazinon in 72%, and trifluralin in 60%.
Pest control methods used and target pests for Texas women who reported pest control measures used in their homes during pregnancy. N=17
Household pesticide exposures during pregnancy in South Texas were similar to those in NYC.

In both Hidalgo County and NYC, the principal reason for organophosphate pesticide use were roaches.

Offspring of mothers exposed in NYC showed significant neurodevelopmental problems.

Neurodevelopmental studies among South Texas children exposed to pesticides are lacking.
Limitations impeding research:
- Human trials precluded by ethical considerations
- Difficulties in assessing impacts
- Difficulties in measuring outcomes
Many Complex Factors Interact to Affect the Impact of Exposures

Adapted from Hubbs-Tait, et al. Psychological Science in the Public Interest, 2005
Environmental Exposures and Critical Windows of Susceptibility

Reproduction-Related Effects: Women

Pesticide exposure

Effects on fertility

- Spontaneous abortion
- Stillbirth
- Premature birth
- Low birth weight/small for gestational age
- Developmental defects
- Reproductive system

Mechanisms of action

Changes in Menstrual Cycle (1.5 ↑ odds)

- Longer cycles
- Missing periods
- Bleeding mid cycle

Consequently affecting Fertility!

Pesticides: Lindane, atrazine and mancozeb

Reproduction-Related Effects: Men

• Testicular damage:
  - Azoospermia, oligospermia
  - Damage to germinal epithelium
  - Genetic alterations in sperm
  - Reduced fertility

• Altered hormone function

Delayed Effects of Exposure

Critical windows of susceptibility:
- Preconception
- Prenatal
- Postnatal (lactation)
- Childhood and adult cancer
- Delayed development
- Childhood asthma and allergies
- Infections
- Postnatal growth effects

“Exposures to adverse insults during critical...windows of development can permanently reprogram normal physiologic responses, and thus give rise to...disorders later in life.”


Strong evidence implicating pesticides and developmental disorders, including PDD-NOS

Organochlorine exposure *in utero*

- > abnormal reflexes in neonates
- ↓ Psychomotor ↓ mental at 12 months
- ↓ General cognitive, memory, verbal and executive functions at 4 years

• Parkinson Disease
  • ↑ evidence that the environment plays a major role
  • Animal studies of faulty neurochemistry in offspring are linked to low level exposure of pesticides.
  • Alterations to the CNS may induce a “silent” state of dopamine dysfunction leaving individuals vulnerable

Science regarding environmental exposures and reproductive health is:
- Primarily based on animal studies
- Warrants guidance to limit/avoid exposure

Approach patients on case-by-case basis

Exposure is unavoidable, but specific changes can make a difference

Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health, 2009
Insect Control and Pesticide Use

- Pesticides can be highly toxic.
- Seal or caulk crevices to keep insects and rodents out.
- Use boric acid or traps to control pests.

Insect Control and Pesticide Uses

Pesticides
- Pesticides are chemical products that include herbicides, rodenticides, and insecticides. They can be extremely toxic.

Harm they produce:
- Chronic exposure to pesticides may cause learning and developmental problems in children as well as autism. Adults may develop cancer.

Prevention:
- Seal or caulk crevices where insects can enter your home.
- Avoid leaving food or dishes to be washed lying out in your kitchen.
- Take out garbage daily.
- Use insect traps and baits instead of sprays wherever possible.
- Use boric acid powder to help control cockroaches in your kitchen. Place it behind the refrigerator, stove, etc., keeping it away from places children or pets can reach.
- Minimize "haborage," or clutter, where insects tend to hide and breed.
- Roaches often obtain water from condensation on pipes, so insulate cold water lines with foam wrap and seal wrap with tape.
- Keep flour and sugar in resealable plastic bags.
- If you have many cockroaches, even if they are coming from neighboring residences, consider hiring a professional exterminator who uses Integrated Pest Management (IPM). Baits and traps are preferable to insecticides that add chemicals to the air. Explain your child’s condition to the pest control service before allowing anyone to treat you house.
Illegal Pesticides

What are they?
- Illegal pesticides may be more toxic than legal ones and they may even have unknown chemicals as part of their formula.
- Legal pesticides are the ones registered and approved by the U.S. Environmental Protection Agency.
- For example, the "Chinese Chalk" registered with EPA.
- Manufacturer states that the "any harm to humans or pets.

Harm they produce:
- Children may confuse "Chinese Chalk" with vomit, abdominal pain.

Prevention
- Do not purchase illegal pests your house.

Illegal Pesticides

Airplane Powder
- Airplane powder is a very powerful pesticide.
- Chronic exposure may cause irreversible damage to the nervous, cardiovascular, and reproductive organs. It has been reported that it may also cause Parkinson’s and Alzheimer’s.

How to know if a pesticide is legal?
- Check for the EPA registration number on the product’s label.
- Purchase products only from authorized vendors and never from a street vendor.
- In the U.S. call the National Pesticide Information Center at 1-800-858-7378 if you have questions or need more information.
- In Mexico call your local Red Cross or local Health Community Center.
Focus on Windows of Susceptibility

- For male and female adolescents
- For male and female patients who experience unintended pregnancy
- For women and men during pregnancy planning
- For pregnant women
- For male and female patients with newborns and children

Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health, 2009
The Environmental Health History

**How?**
Incorporate into reproductive health history

**Why?**
Identify and reduce or eliminate potentially harmful exposures

**When?**
Vulnerable Stages:
- Early childhood
- Puberty
- Adolescence
- Preconception planning (men & women)
- Pregnancy

Guide patients in making decisions

Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health, 2009
Identifying and reducing exposures to potentially harmful toxicants now, when couples plan (or not) a pregnancy, increase the likelihood of a successful outcome.

Expert Medical Advisory Committee on Environmental Impacts on Reproductive Health, 2009
Association of Reproductive Health Professionals (ARHP) Resources

• Learn more at the ARHP Website:
  • Click on Environmental and Reproductive Health topic area
  • [www.arhp.org/topics/enviro-repro-health](http://www.arhp.org/topics/enviro-repro-health)
    ▪ Fact Sheet: Environmental and Reproductive Health Resources for Health Care Providers
    ▪ Patient handout: Health Matters: The Connection Between Your Health and the Environment
Pesticide Resources

- Fact sheets from CDC’s National Agricultural Safety Database (http://nasdonline.org/)
- National Pesticide Information Center (http://npic.orst.edu/)
- EPA’s Pesticides Information Web site (includes information for children) (www.epa.gov/pesticides)
- Pesticide Action Network (PAN) database (www.pesticideinfo.org)
Questions?

Thank you!