



CHAMACOS: Lessons from the fields

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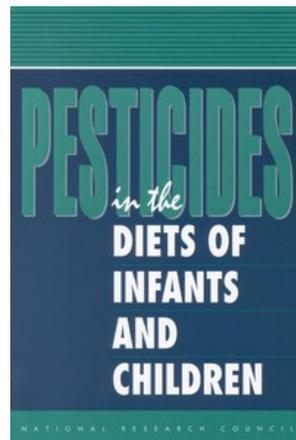
UC Berkeley



SOT Webinar February, 2015

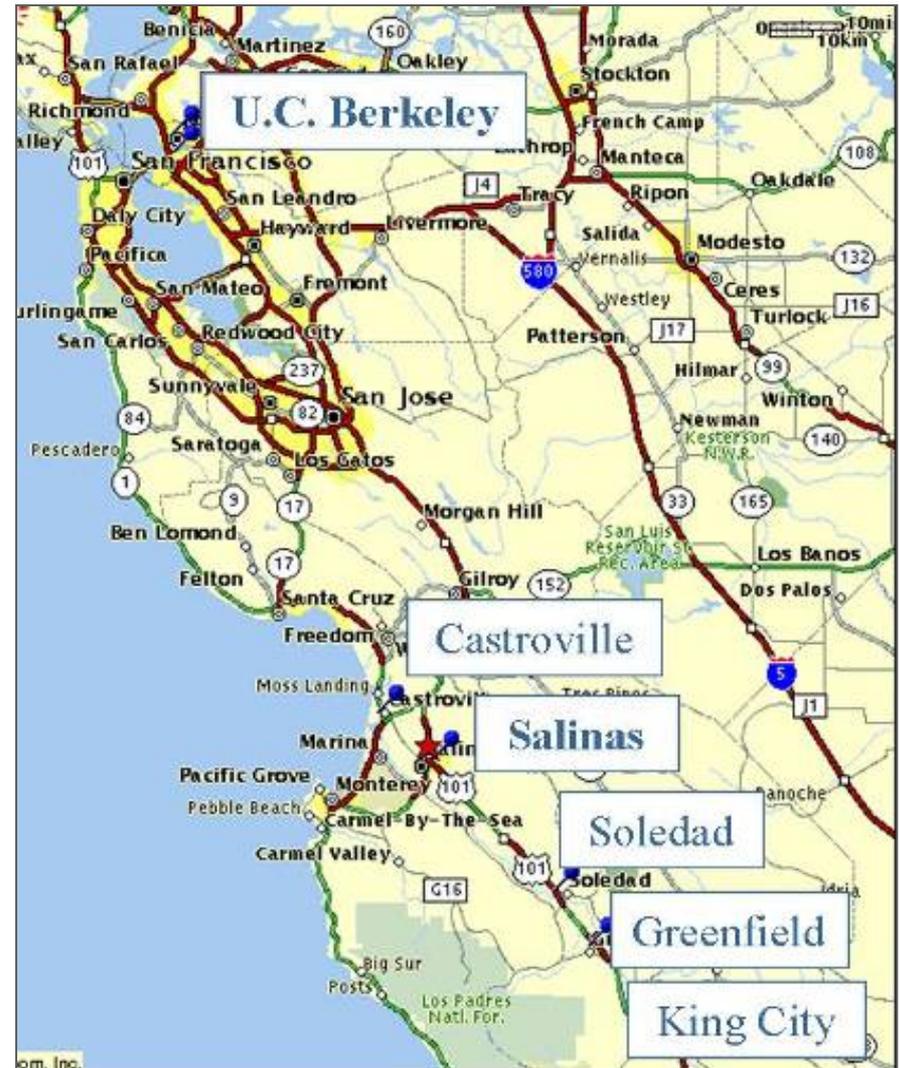
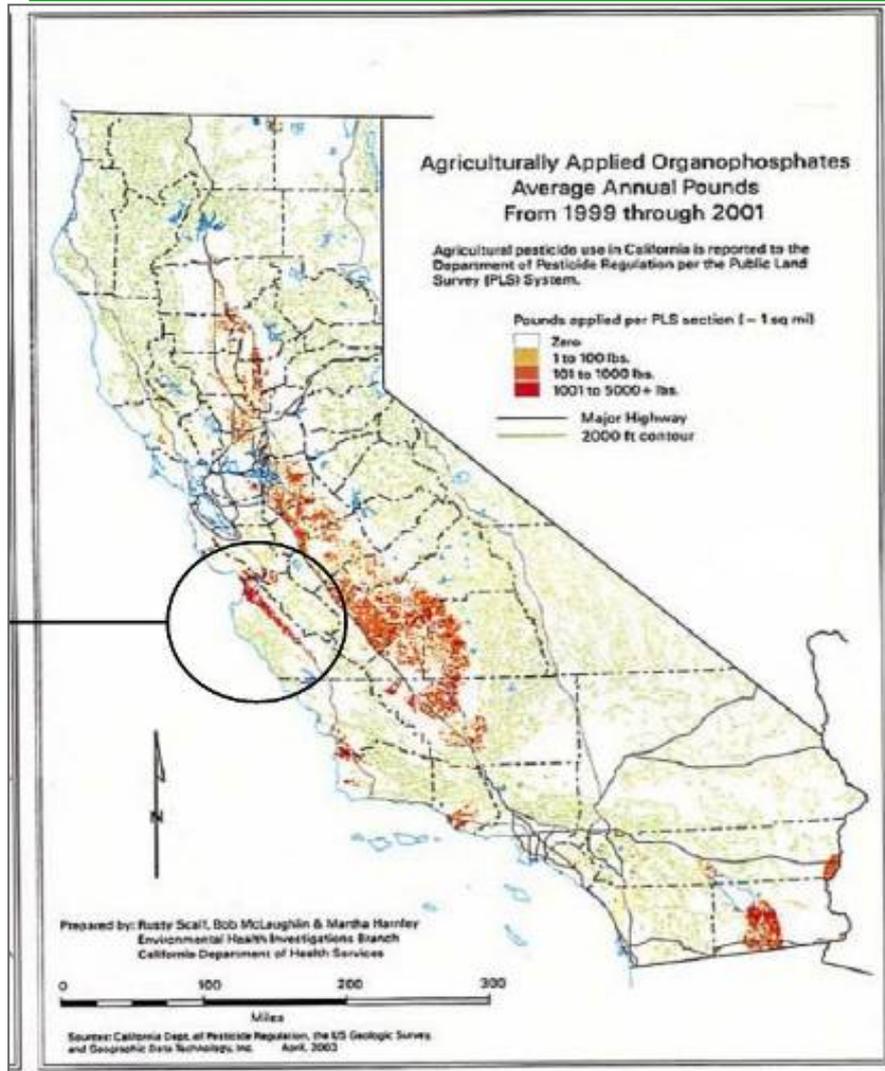
Food Quality Protection Act of 1996

- Charged U.S. EPA to determine safe levels of pesticide residues in food:
 - consider *dietary and non-dietary* sources
 - address the *specific vulnerabilities of children*



NRC, 1993

California, the leading agricultural state in the nation



Salinas Valley

The “Salad Bowl” of the Nation



Center for the Health Assessment of Mothers and Children of Salinas



**CENTER FOR THE HEALTH ASSESSMENT OF
MOTHERS AND CHILDREN OF SALINAS**

A birth cohort study investigating the health effects of environmental exposures in low income Mexican-American children living in an agricultural community.

Community Involvement: Our Biggest Challenge and Strength



CHAMACOS
Participants

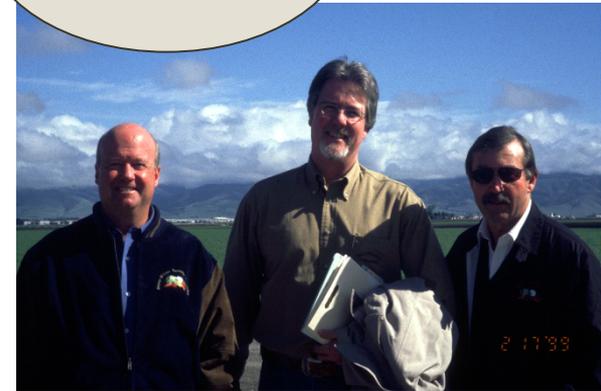


Youth

Farmworkers



Growers



CAB
Community Advisory
Board

CHAMACOS is...

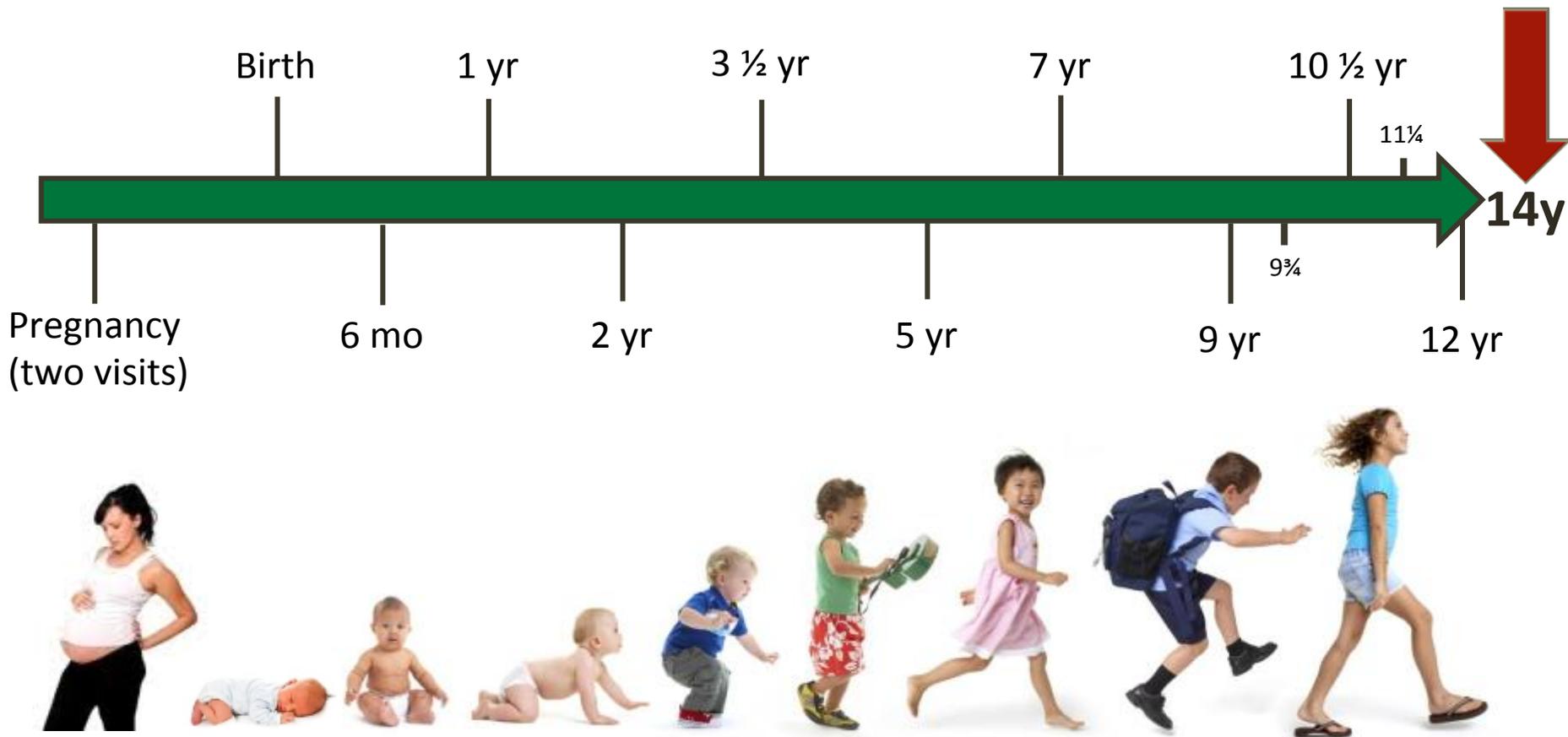
- A community-based participatory research project
- Studying the impact of environmental chemicals on women and children's health
- Four main activities:
 - 1) A study to examine:
 - Neurobehavioral development
 - Growth: fetal and child
 - Respiratory disease
 - Pubertal onset
 - 2) Exposure studies
 - 3) Mechanistic studies
 - 4) Community outreach and translation activities



In 1999-2000, we enrolled 601 pregnant women from clinics serving farm workers

- 92% Spanish-speaking
- 85% born in Mexico
- 54% < 5 years in U.S.
- 96% living within 200% of poverty
- 44% 6th grade education or less
- 44% worked in agriculture during pregnancy
- 84% other agricultural workers in home

CHAMACOS is a longitudinal birth cohort study (N=600-900)



www.123rf.com; www.raisingchildren.net.au

We followed the children...

They are 14 years old now!

	1 st Tri	2 nd Tri	Delivery	6M	1Y	2Y	3½ Y	5Y	7Y	9Y	10½Y	12Y
Maternal Questionnaire	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Physical Exam			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Neurodevelopment Assessment			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Home Inspection	✓			✓	✓	✓	✓	✓				
Lung Function Tests								✓	✓			
School Performance									✓	✓		
Tanner Stage										✓	✓	✓

CHAMACOS Biological Specimen Collection

	1 st Tri	2 nd Tri	Delivery	6M	1Y	2Y	3½ Y	5Y	7Y	9Y	10½Y	12Y
Maternal Urine	✓	✓	✓	✓								
Paternal Urine			✓		Over 150,000 Stored Samples							
Maternal Blood		✓	✓							✓		
Cord Blood			✓									
Breast Milk			✓	✓								
Child Urine				✓	✓	✓	✓	✓		✓		
Child Blood					✓	✓		✓	✓	✓		✓
Child Teeth									✓	✓	✓	
Child Saliva							✓	✓				
Child Hair											✓	
House Dust	✓			✓	✓							

Chemical Exposures of Interest

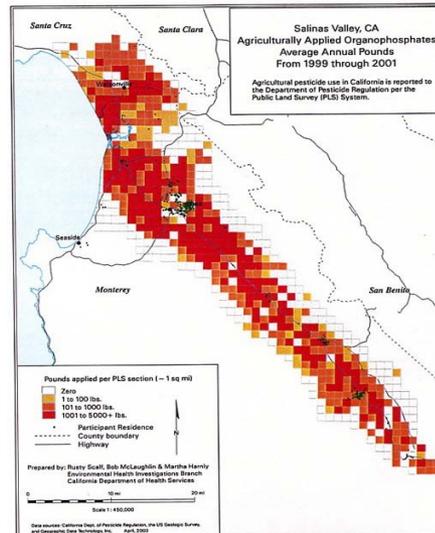
- Pesticides:
 - Organophosphates (OPs)
 - Pyrethroids
 - Methyl bromide
 - Fungicides containing manganese
 - Organochlorines, e.g. DDT
- Flame retardants (PBDEs)
- Chemicals in plastics e.g. Bisphenol-A (BPA), Phthalates
- Air pollution

Exposure



Photo taken by Brenda Eskenazi

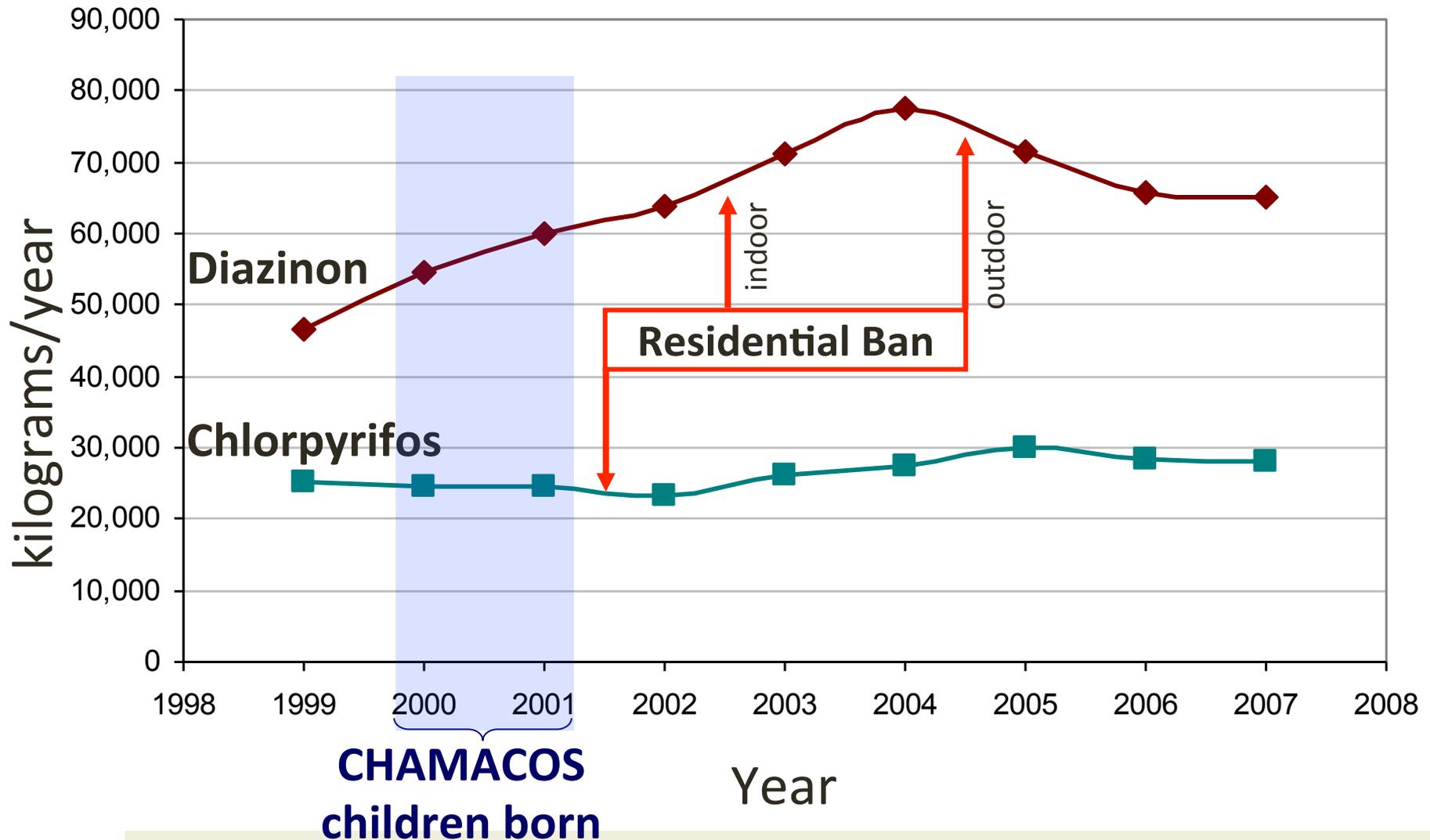
We determine pesticide exposure in 5 ways:



Organophosphate Pesticide Use in the Salinas Valley, 2001

OP Pesticide	Pounds	Excreted in urine as
Malathion	96,520	Dimethyl (DM) phosphates ~220,000 lbs. (42%)
Oxydemeton-methyl	57,859	
Dimethoate	34,224	
Naled	17,045	
Methidathion	14,220	Diethyl (DE) phosphates ~199,000 lbs. (38%)
Diazinon	133,537	
Chlorpyrifos	54,945	
Disulfoton	10,216	Other ~104,000 lbs. (20%)
Acephate	71,725	
Bensulide	32,669	
Total	~520,000	

Little change in OP pesticide use in the Salinas Valley before and after US residential ban





In Salinas, children live,
play and go to school right
near the fields.

We found OP pesticides in:

House dust

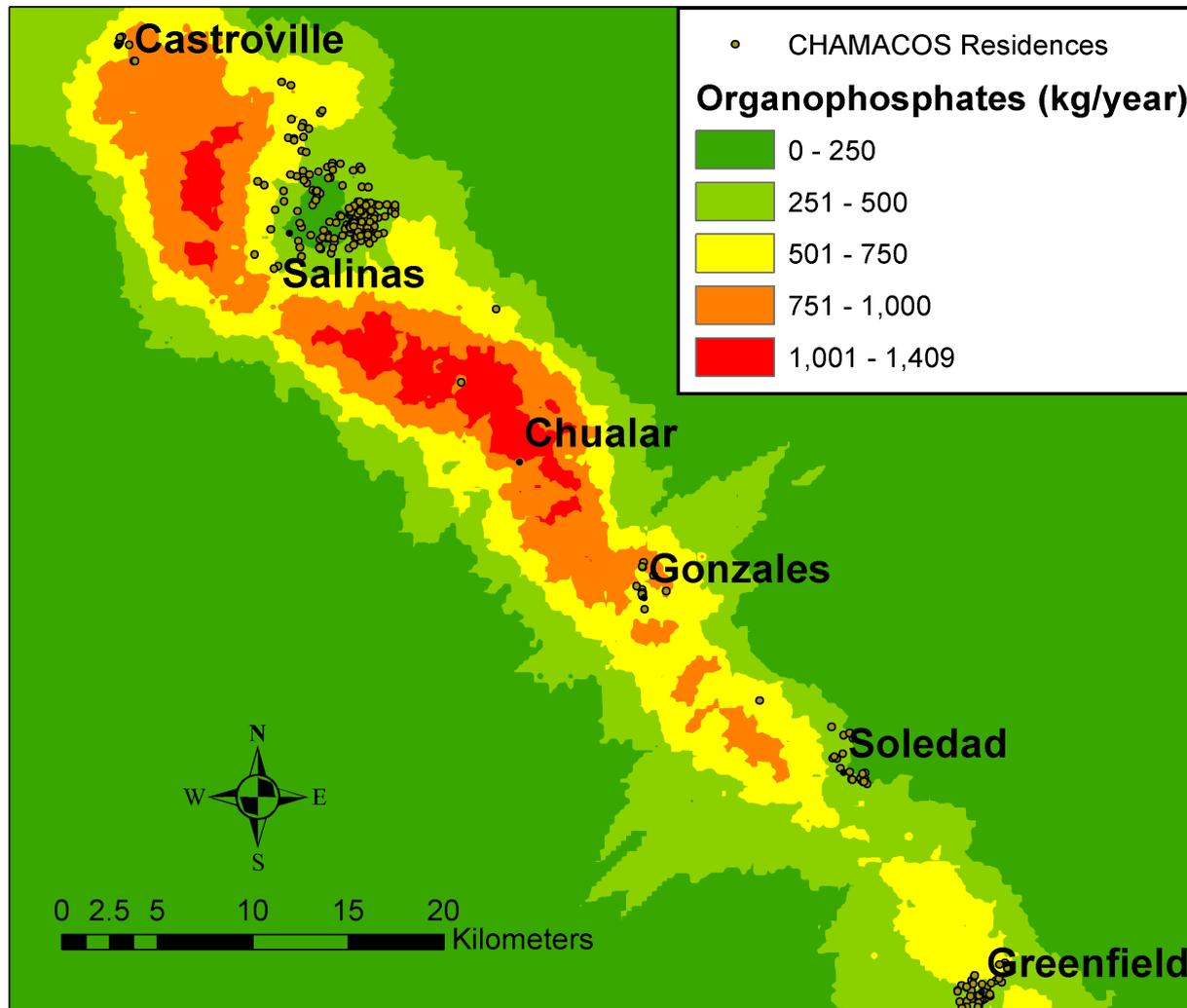


and
biological
samples

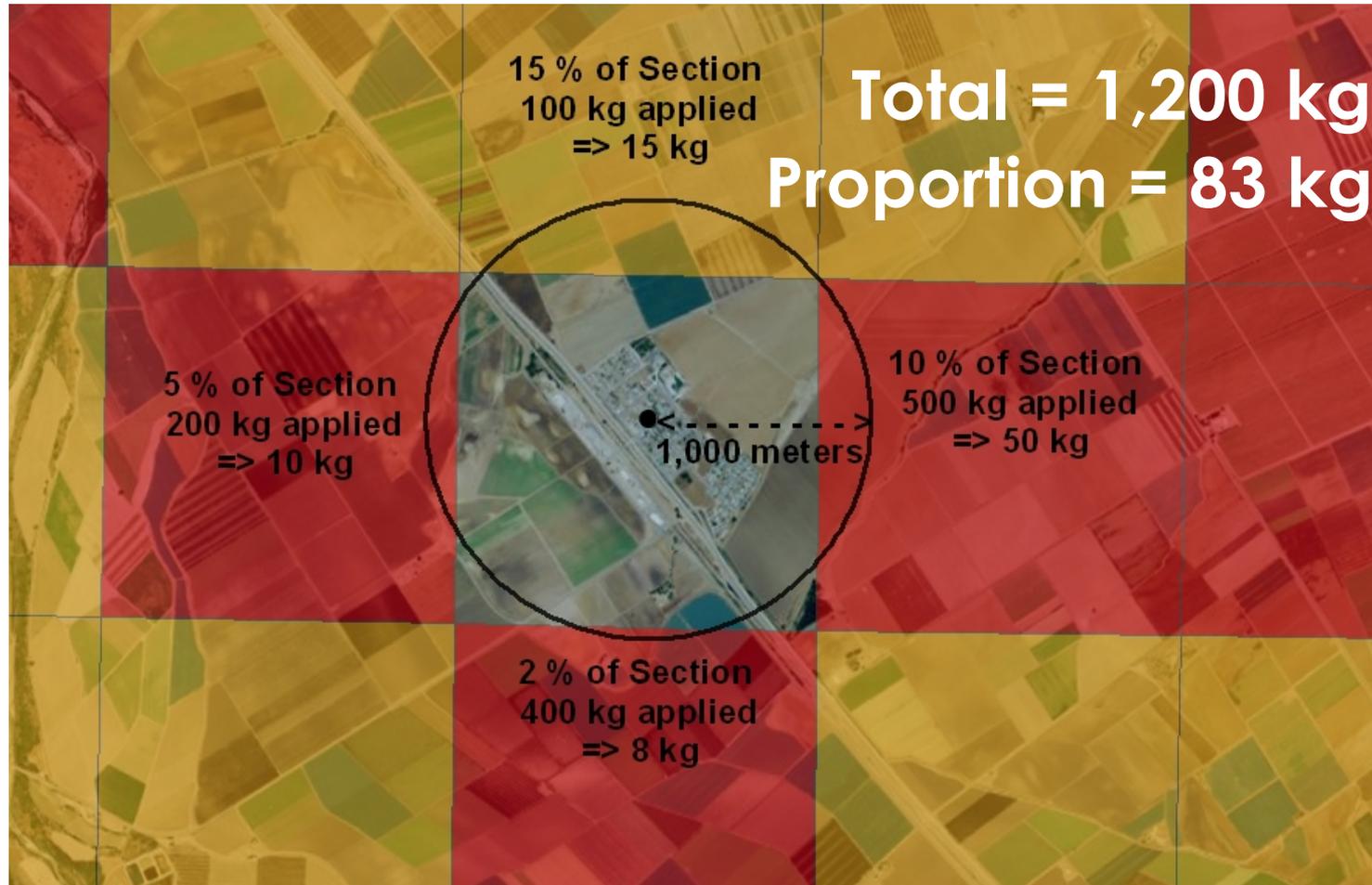


Harnly et al., ES&T, 2009

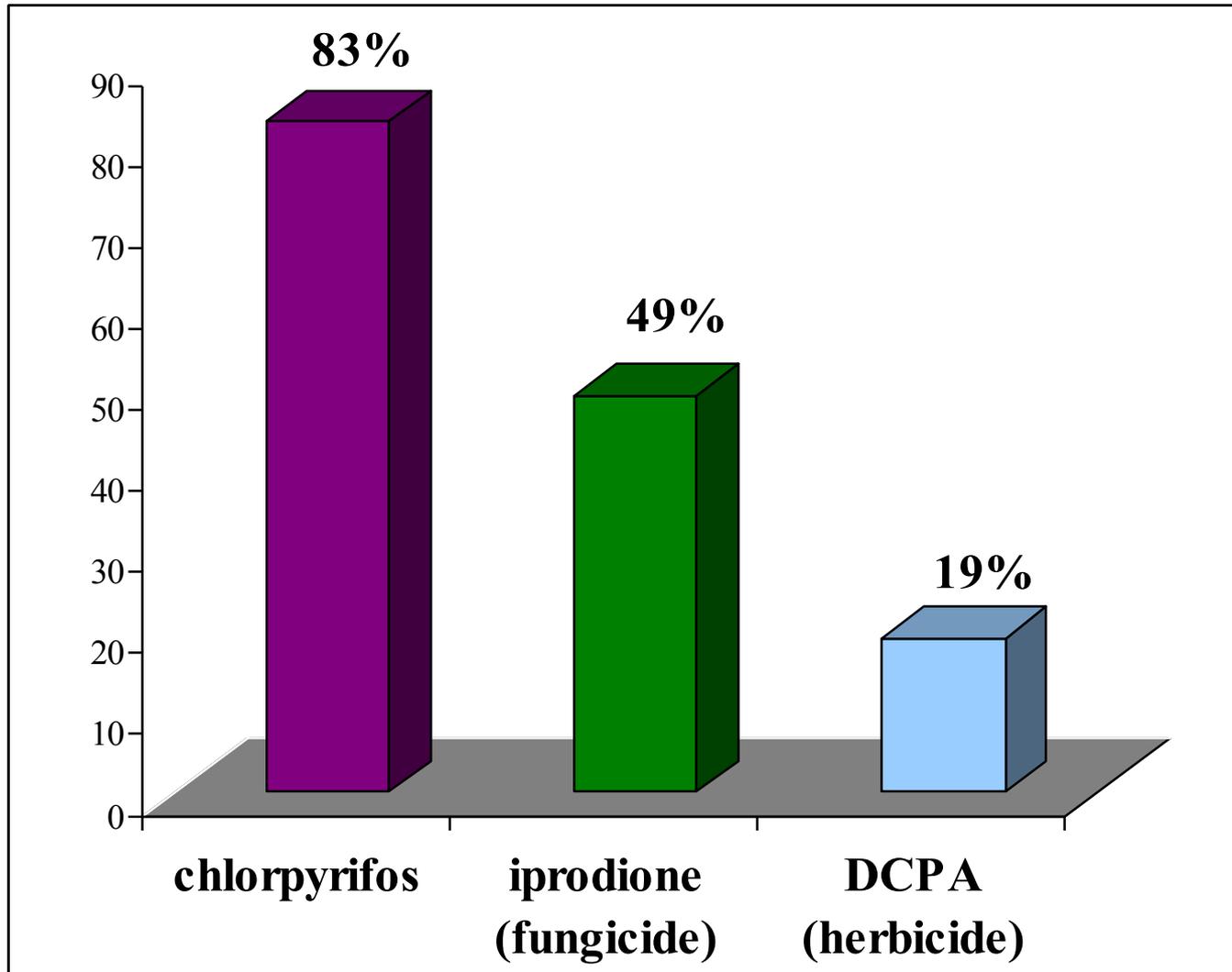
Agricultural Use of Organophosphates (PUR) During Prenatal Period 1999 – 2000



Methods: Pesticide Use Estimates



Nearby agricultural use associated with home dust levels (n=197)



% increase in house dust for each kg applied per day

Harnly et al., ES&T, 2009

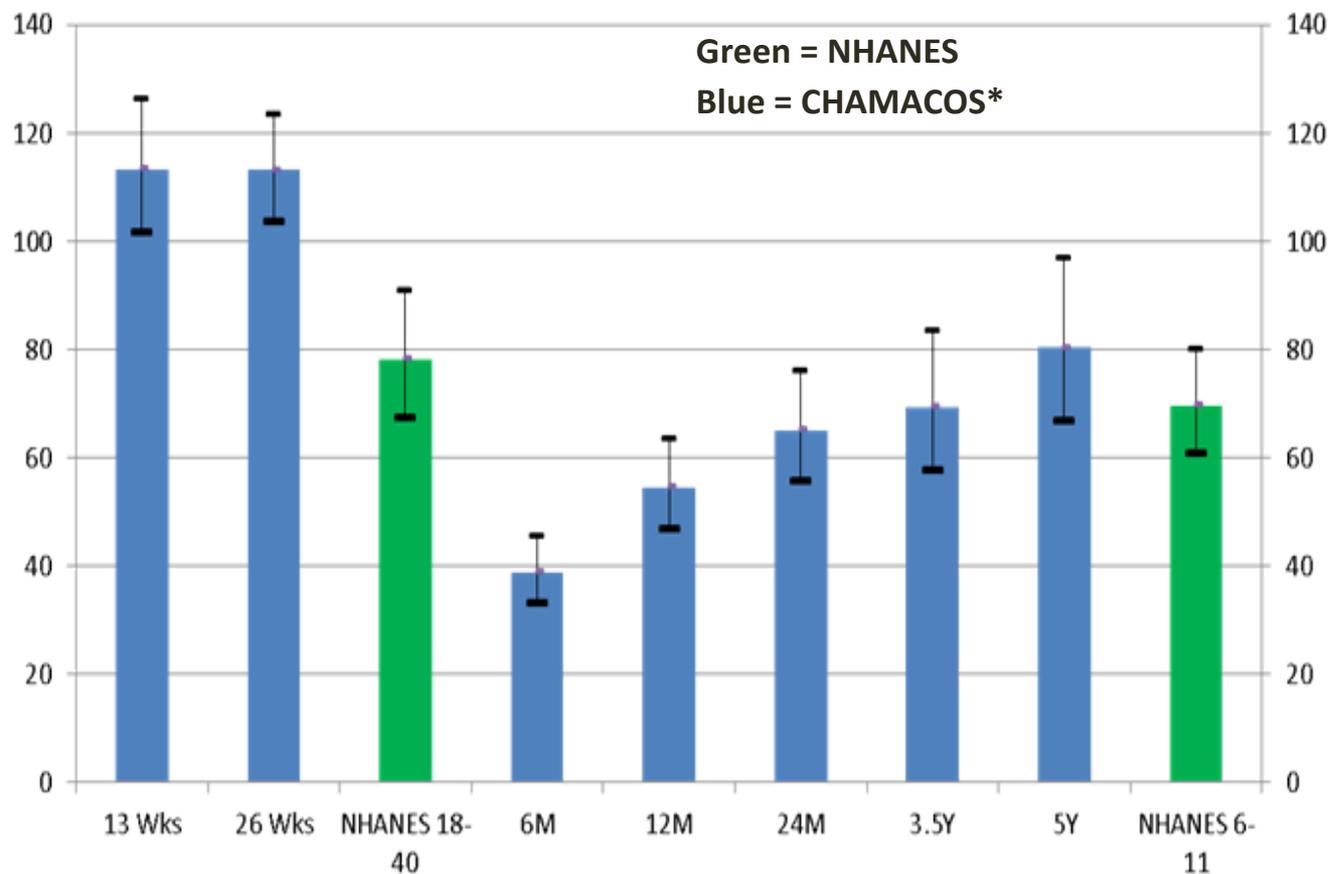
Pesticides in breast milk



Overall (N=93)	DF
Organophosphates	
Chlorpyrifos*	97%
Chlorpyrifos-methyl	56%
Fonofos	12%
Phosmet	10%
Disulfoton	9%
Diazinon	1%
Pyrethroids	
cis-Permethrin	100%
trans-Permethrin	100%
Cyfluthrin	22%
Cypermethrin	12%
Deltamethrin	6%
Other	
Propoxur	26%
Bendiocarb	4%
Atrazine	23%

Weldon et al., JEM, 2011

CHAMACOS participants' OP metabolite levels are higher than US averages (NHANES)

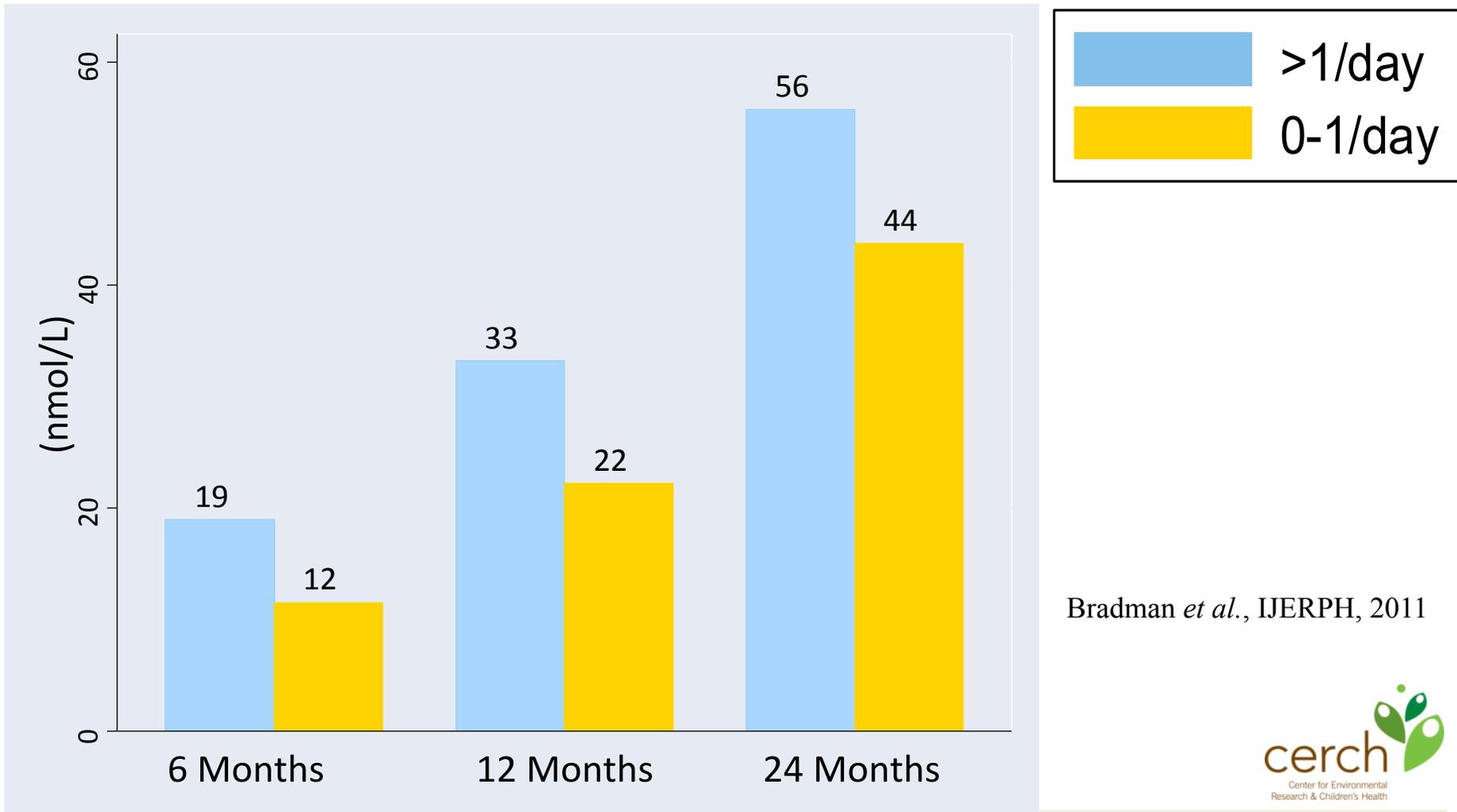


*13 and 26 week levels from mothers; all others from children

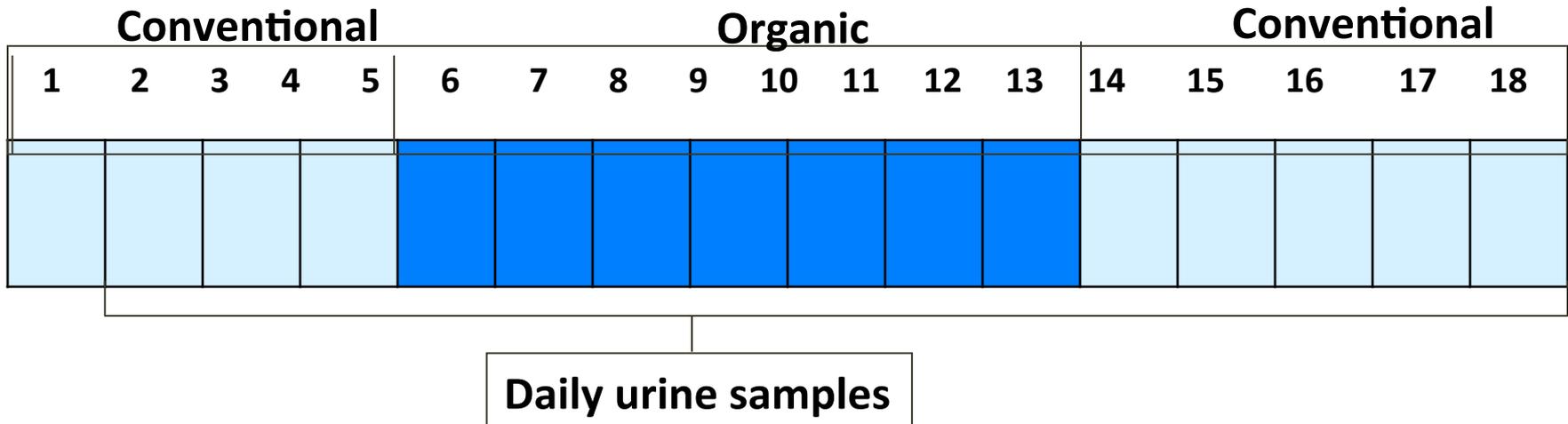
Bradman et al. EHP, 2005, 2011



Median DM metabolite levels by fruit and vegetable consumption



Design of organic diet study



- 20 children in two locations:
 - Ag (Salinas)
 - Urban (Oakland)
- 3-6 year old boys and girls
- Mexican-American low-income families
- Farmworker parent (Salinas)

Fungicides containing Manganese (Mn) widely used in agriculture



Manganese (Mn)

- *Low doses: Essential nutrient*
- *High doses: Neurotoxicant*

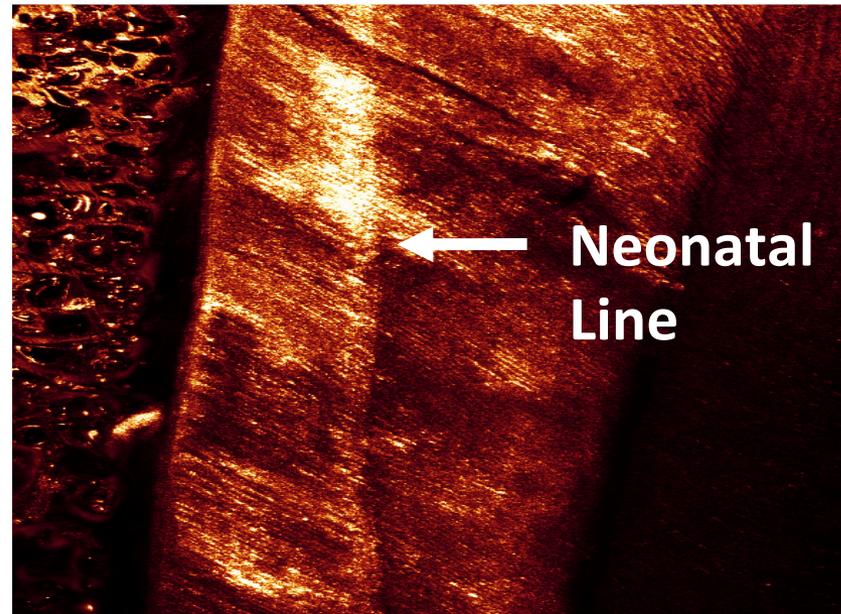
Maneb/Mancozeb

- *~20% Mn*

Mn in shed teeth as a biomarker

Growth rings in teeth

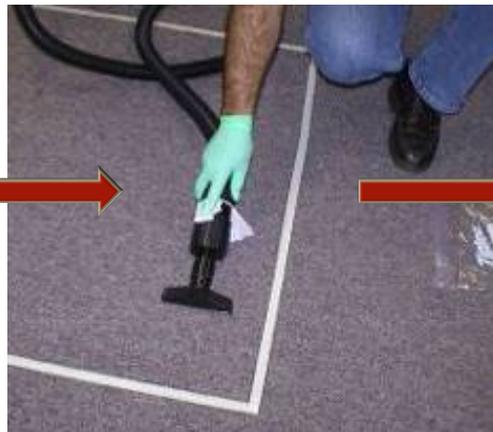
Growth rings in a tree



Arora et al., Environ Sci Tech, 2012;
Austin et al., Nature, 2013

Mn prenatal tooth concentration was associated with:

- Agricultural work
- Agricultural use of Mn fungicides nearby
- Soil type at residence
- Mn dust loading



Gunier et al. JESEE, 2013



By ground
California
CHAMACOS



We also measured blood levels of Mn in pregnant women living near fields with fungicide use in California and Costa Rica

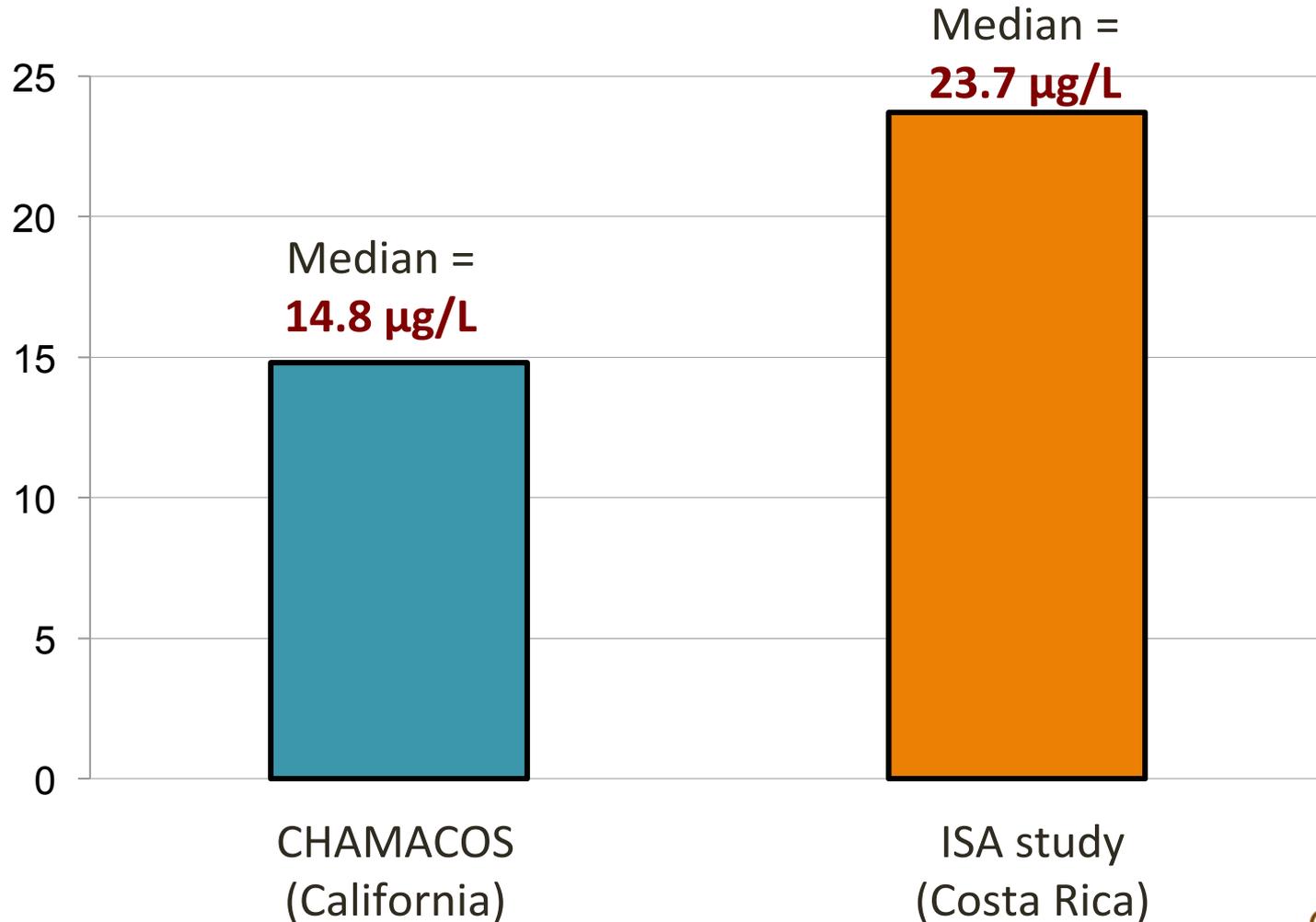


By air
Costa Rica
Proyecto ISA*

*PI: Berna Van Wendel de Joode

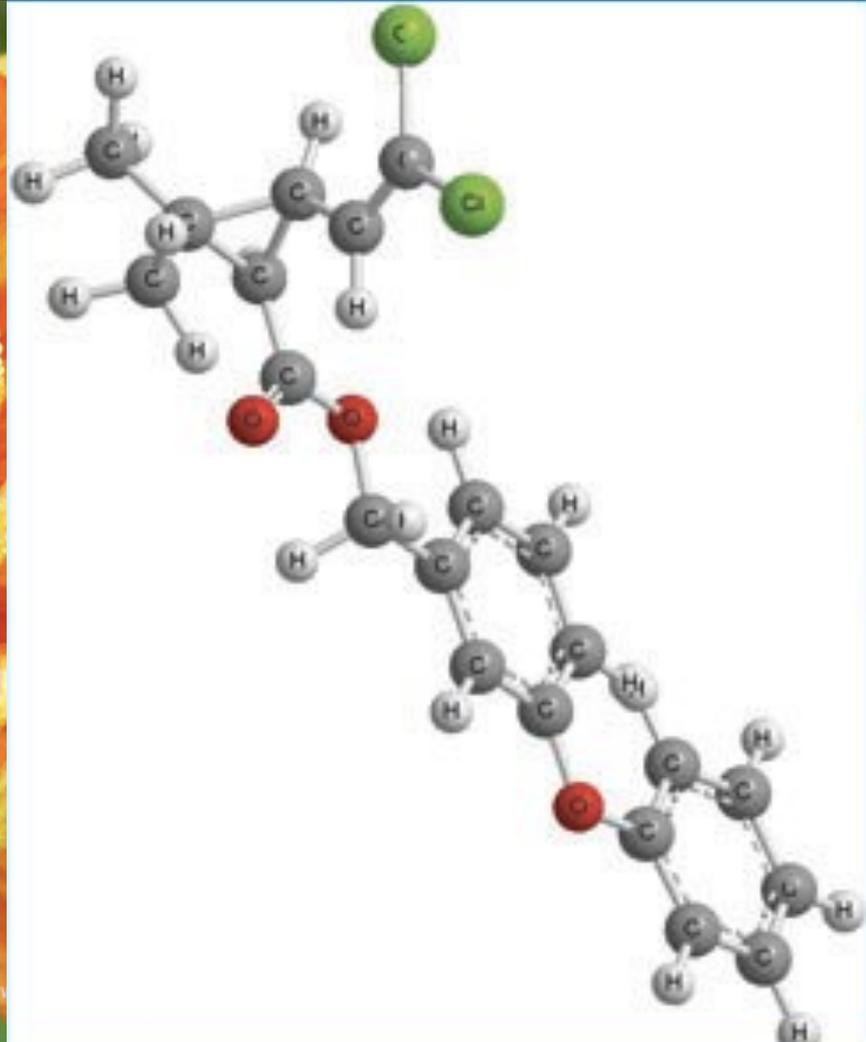
Photo by Karin Hallén,

Blood Mn levels in pregnant women exposed to ground-level vs. aerial fungicide spraying



Mora et al. ES&T, 2014

Pyrethroids

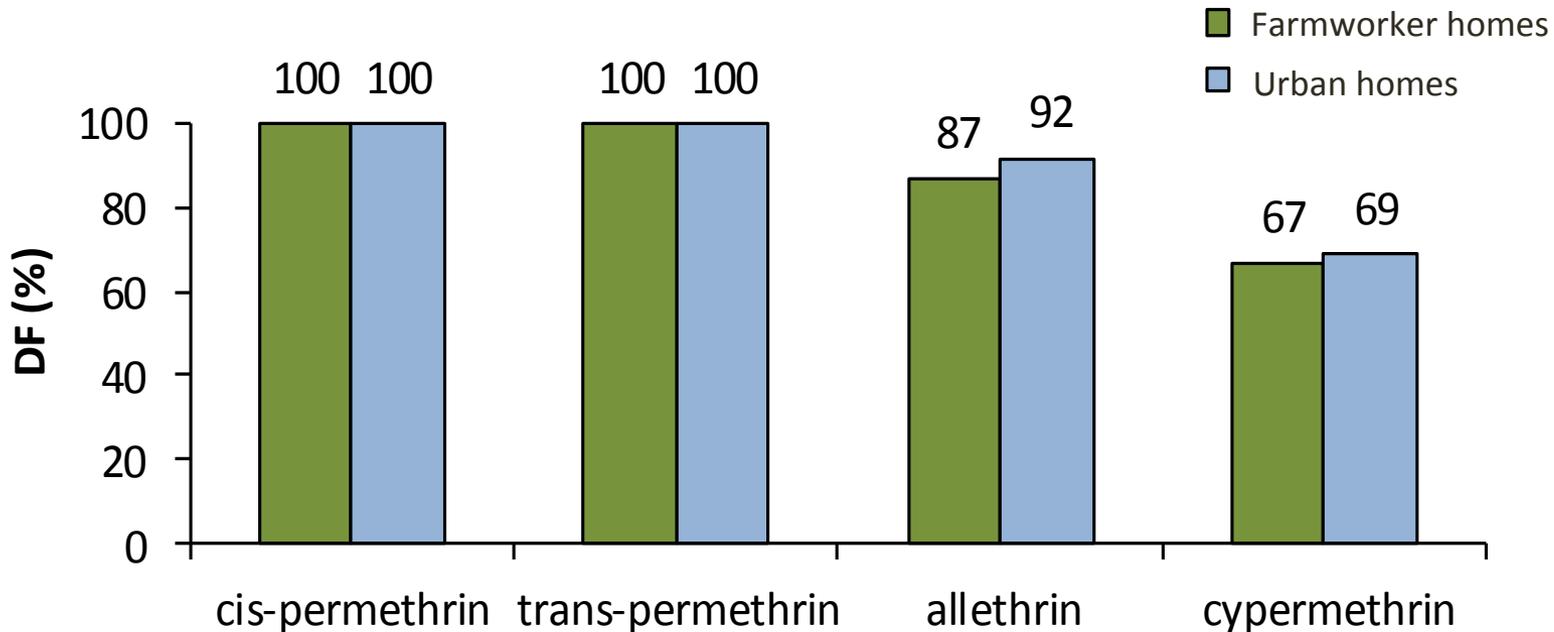


Pyrethroid pesticides detected in almost every dust and breast milk in CHAMACOS.



Harnly et al., 2009 ES&T; Weldon et al., JEM, 2011

Pyrethroids widely detected in dust from farmworker and urban homes



- Higher DF compared to OP pesticides
- High pesticide use reported
- Most reported applying a pyrethroid

Are pesticide exposures related to the health and development of children?



Length of gestation is shorter for infants of women with higher OP metabolites.

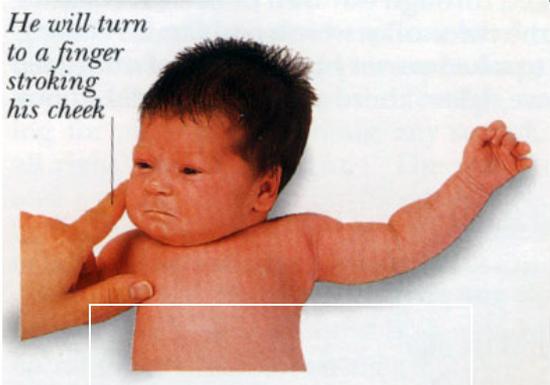


For every 10 fold increase in DAPs in the later half of pregnancy, there was a ½ week decrease in gestation

Eskenazi et al., EHP, 2004

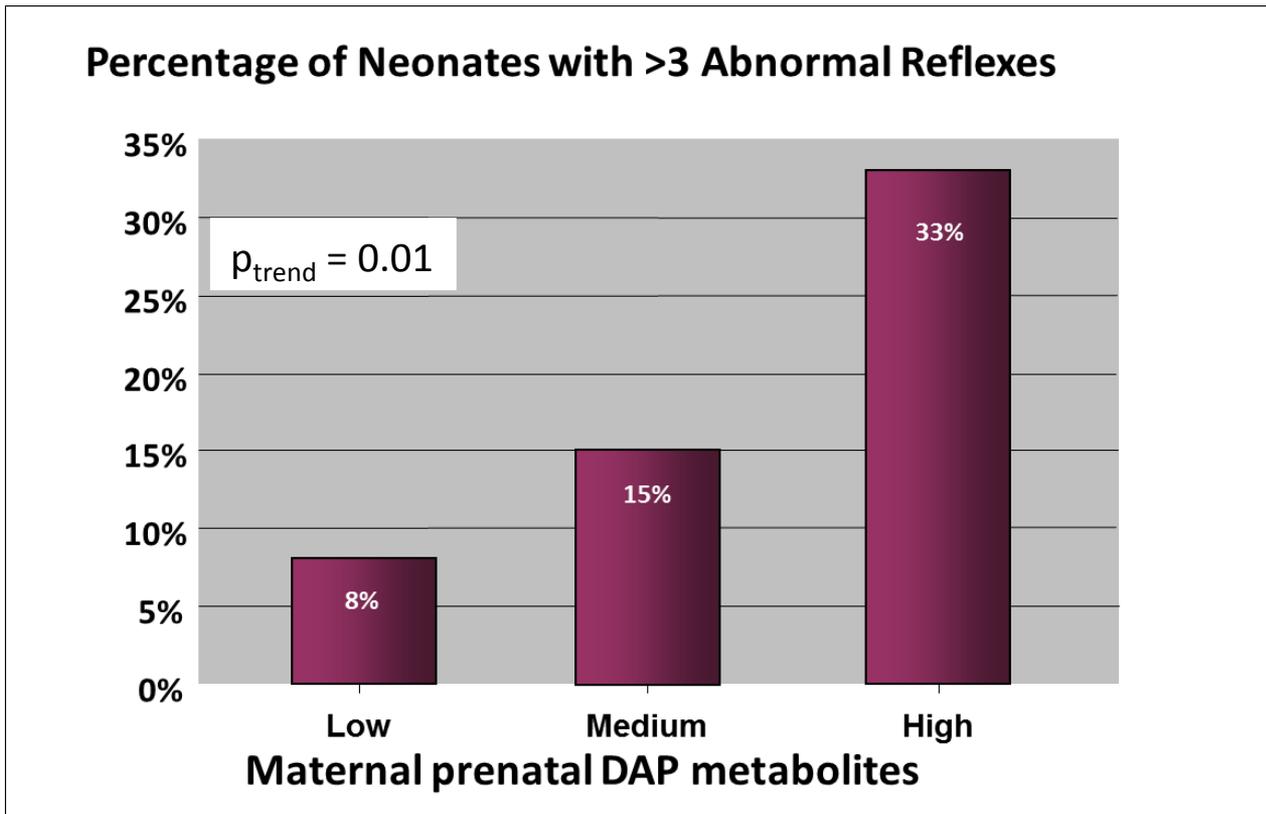
Prenatal OP metabolites related to abnormal reflexes in neonates (n=184)

Brazelton Neonatal Behavioral Assessment Scale



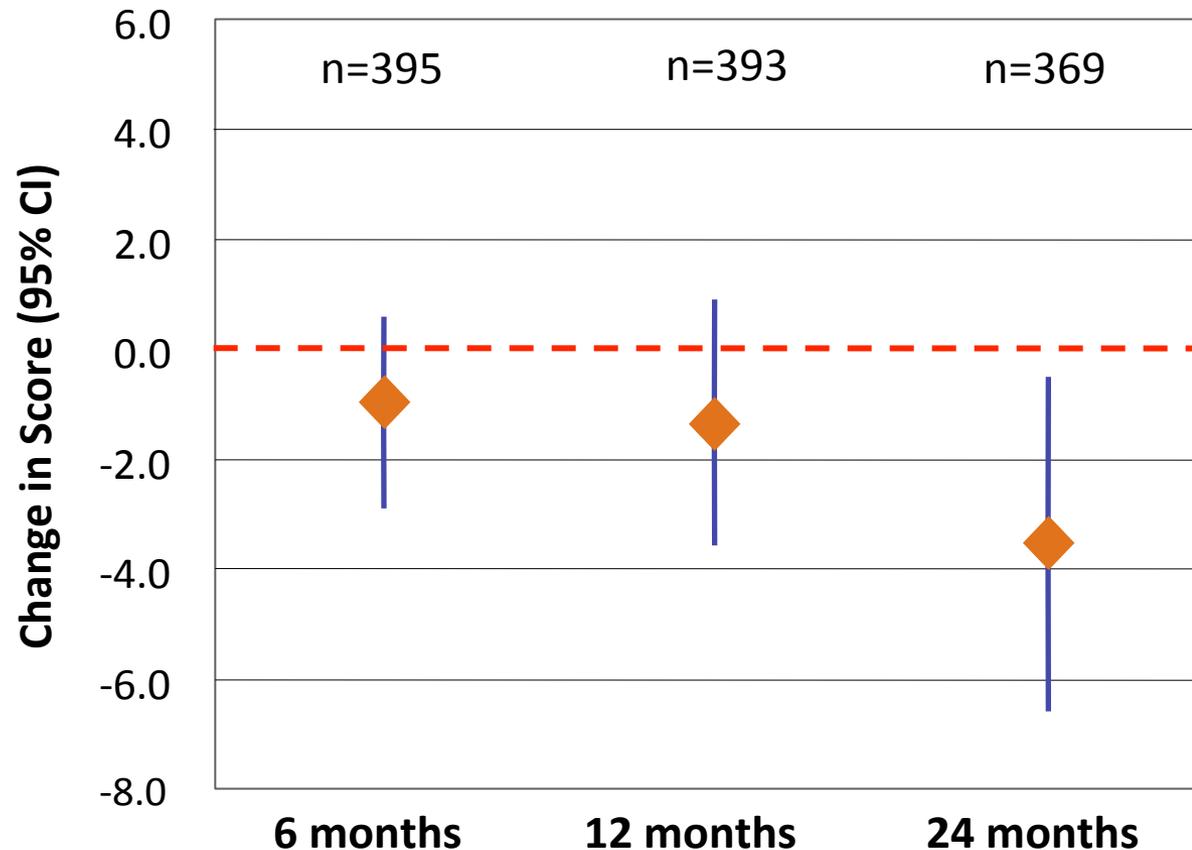
www.ababycare.com

Only cluster in 7



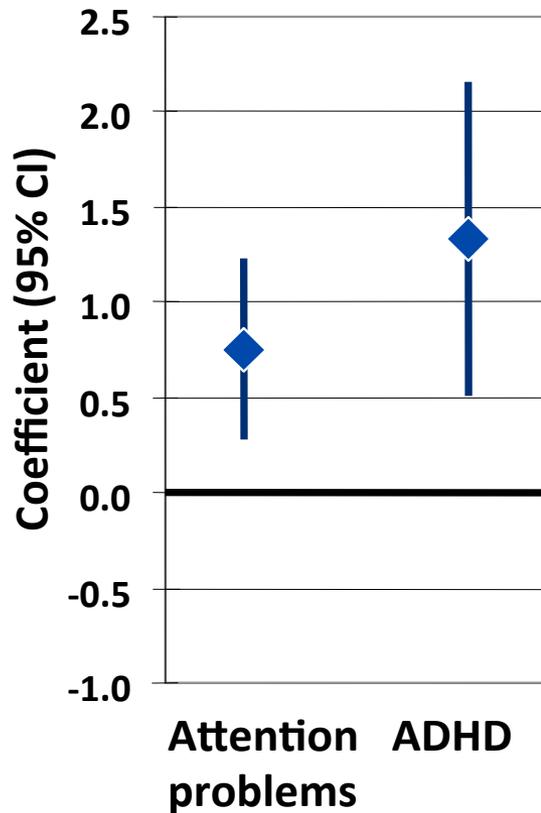
Prenatal OP metabolites and Bayley Mental Development at 6, 12, and 24 months

Eskenazi *et al.*, EHP 2007



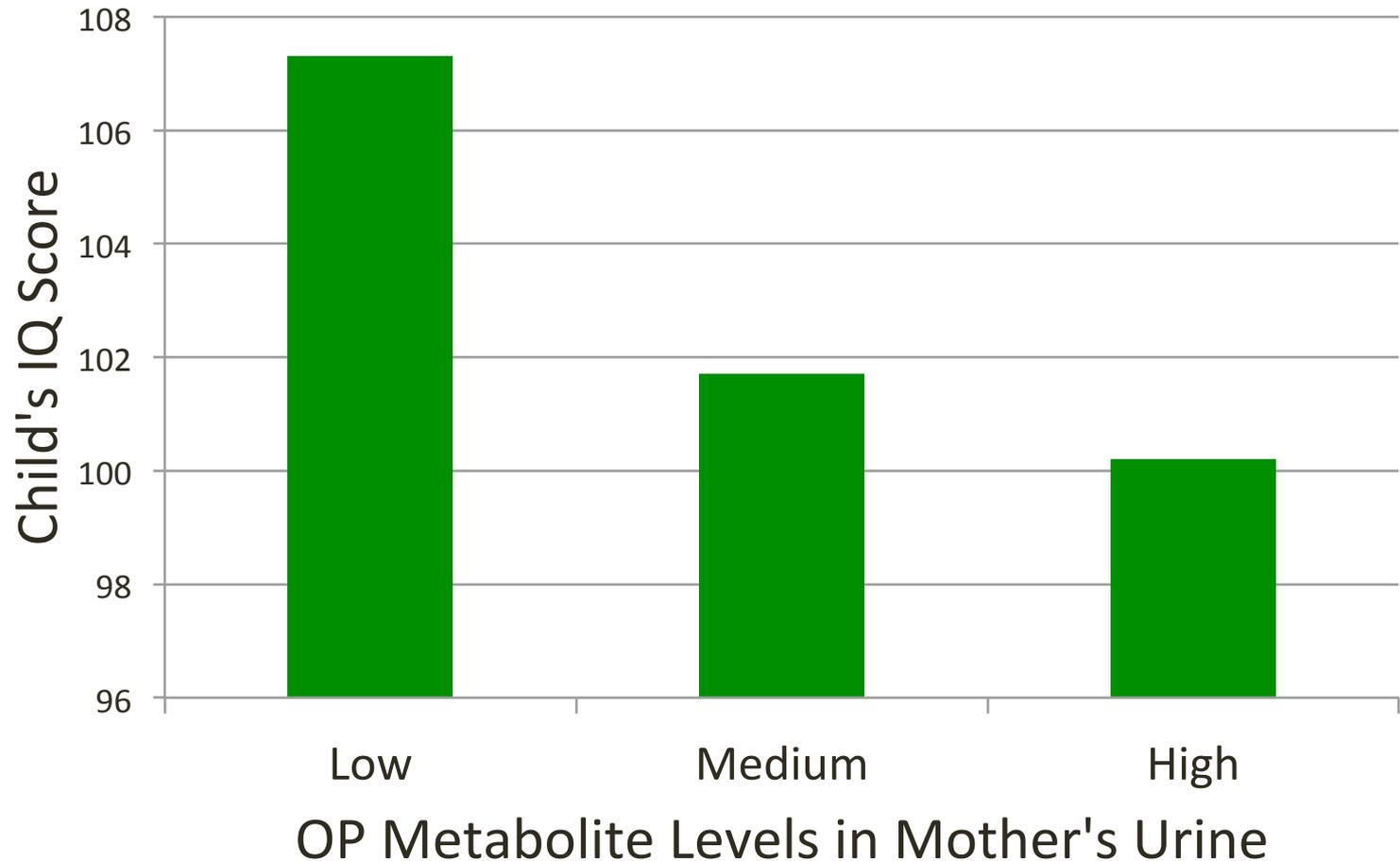
Adjusted for psychometrician, gender, age, parity, assessment location, breastfeeding duration, maternal PPVT, poverty status, and HOME score

Prenatal OP metabolites related to CBCL attention at 5 Years

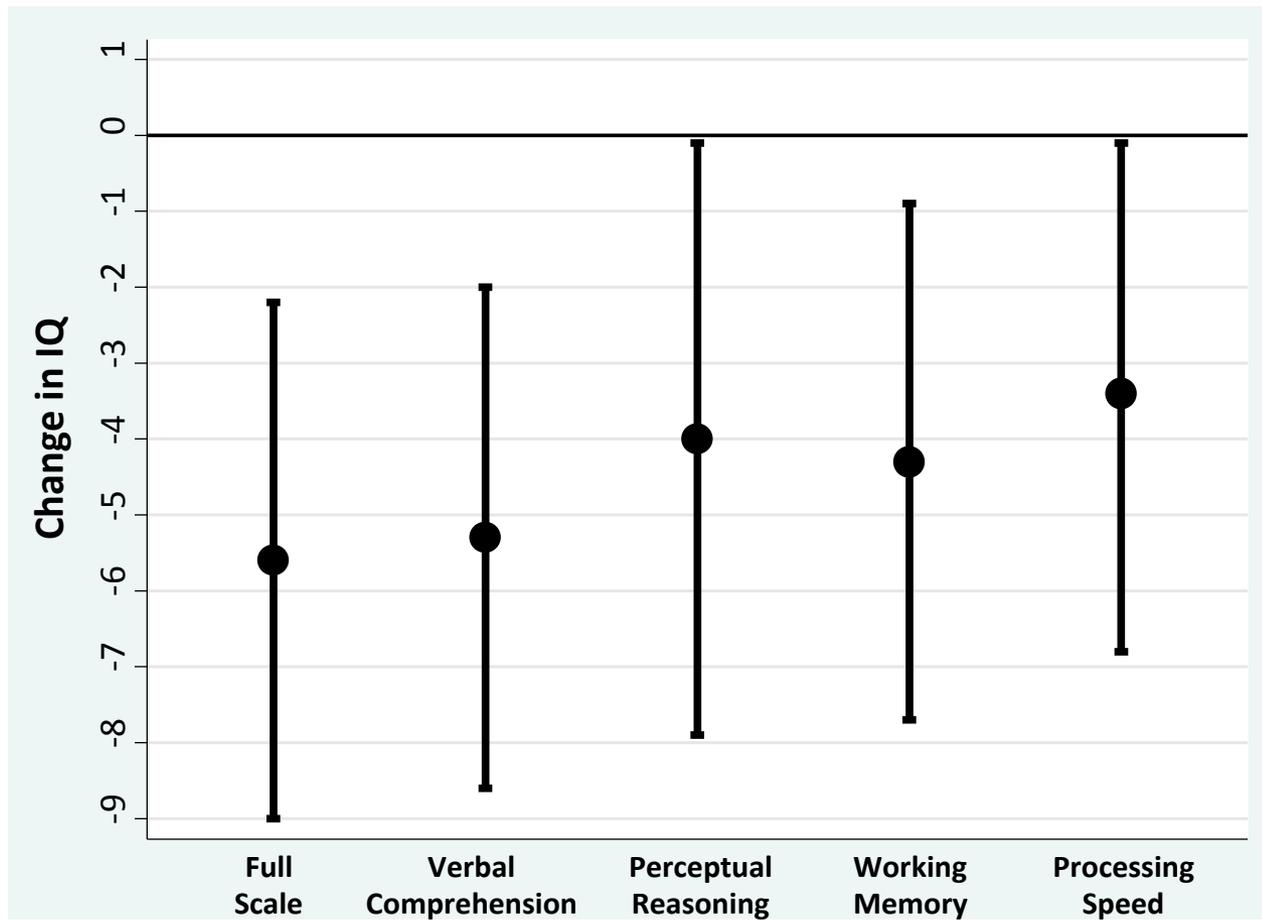


Adjusted for sex, age, maternal education, depression, IQ, breastfeeding duration, and childcare
Marks et al., EHP, 2010

And mothers' OP metabolite levels were also related to child's IQ at age 7



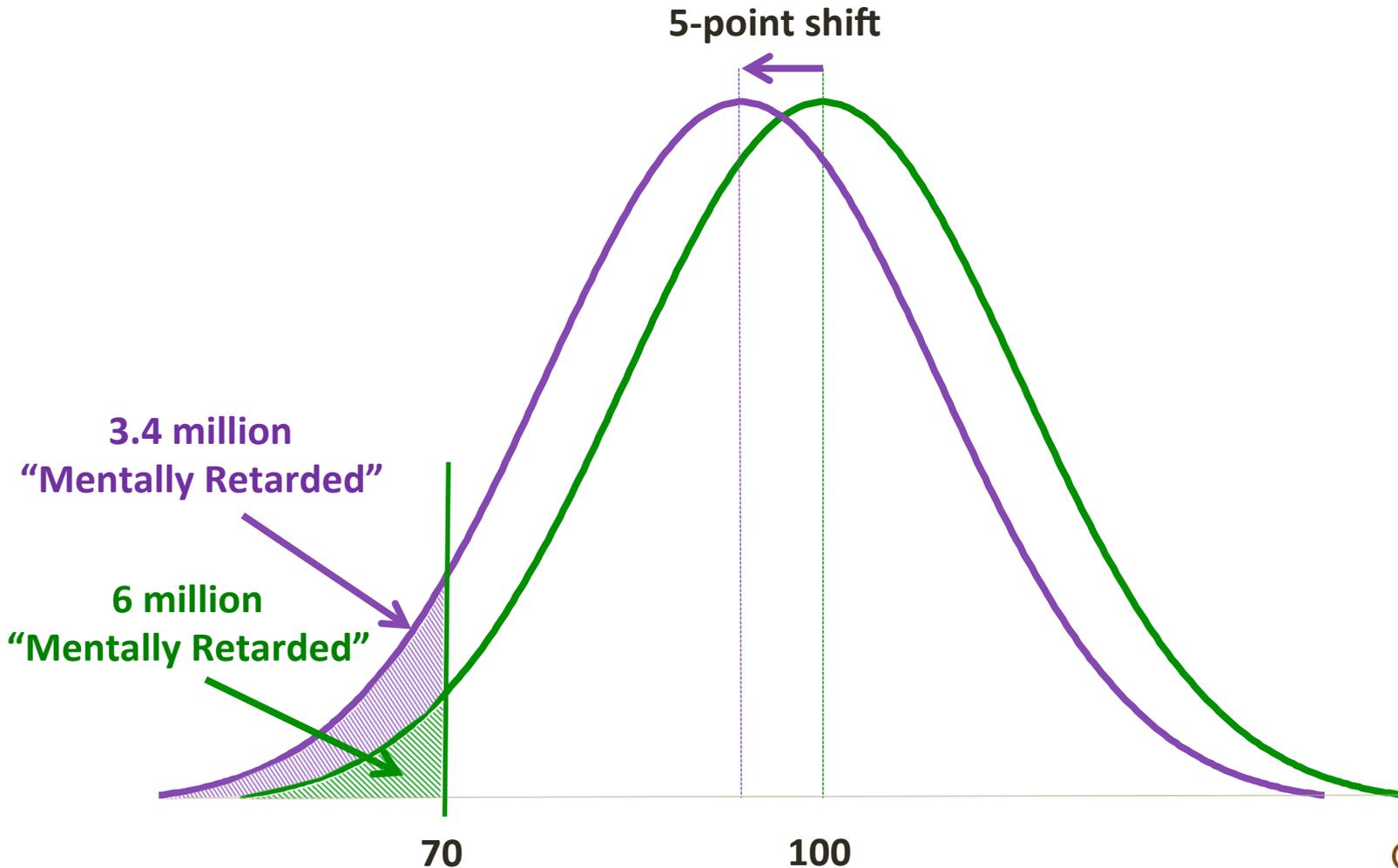
Prenatal exposure to OPs by urinary DAPs and IQ at 7-years



Adjusted for sex, child's age, language of assessment, maternal education, household income per person and HOME score.

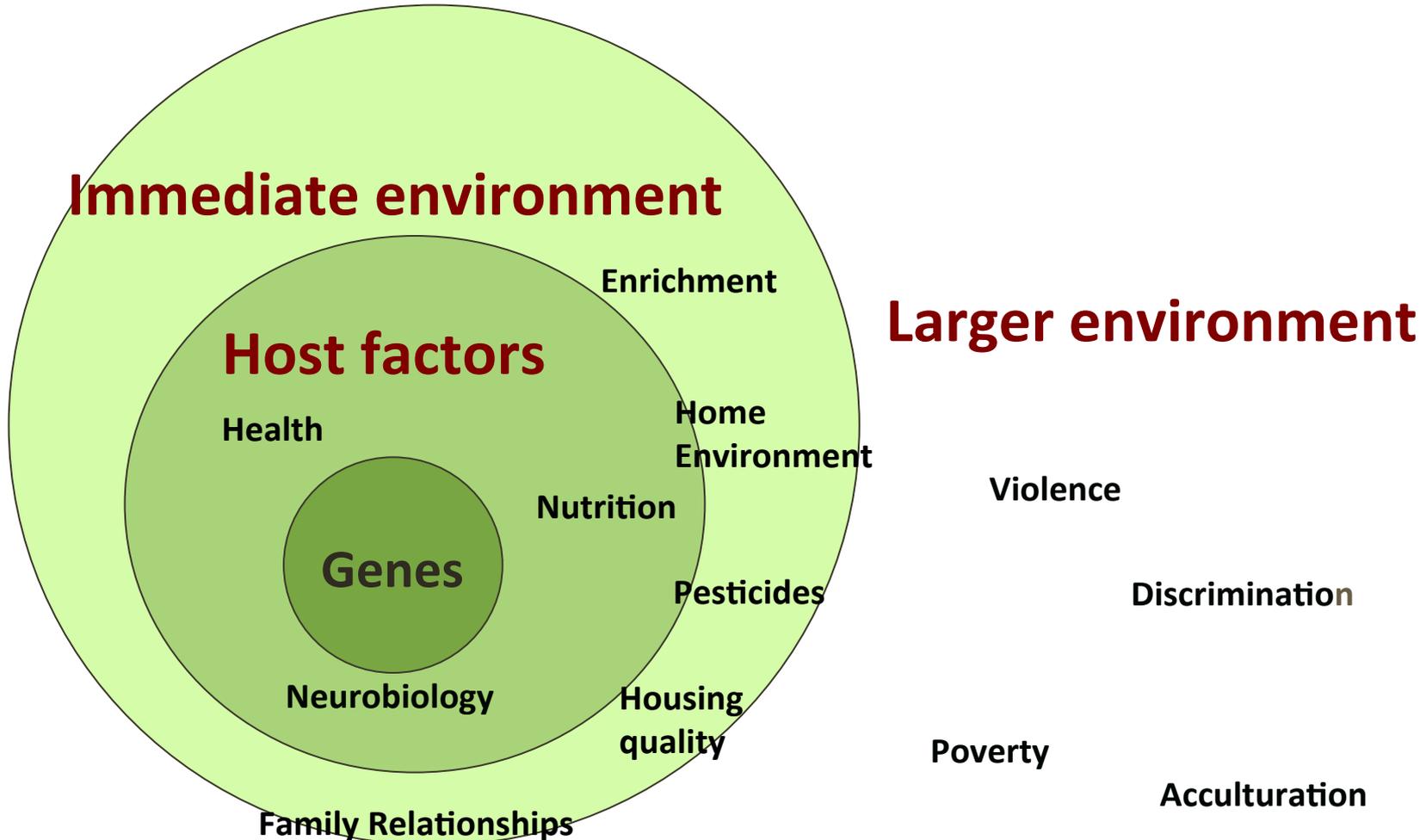
Bouchard et al. EHP, 2011

Population shift in IQ



Weiss, B. Trends Pharmacol Sci (1988)

Neurobehavioral development is determined by many factors



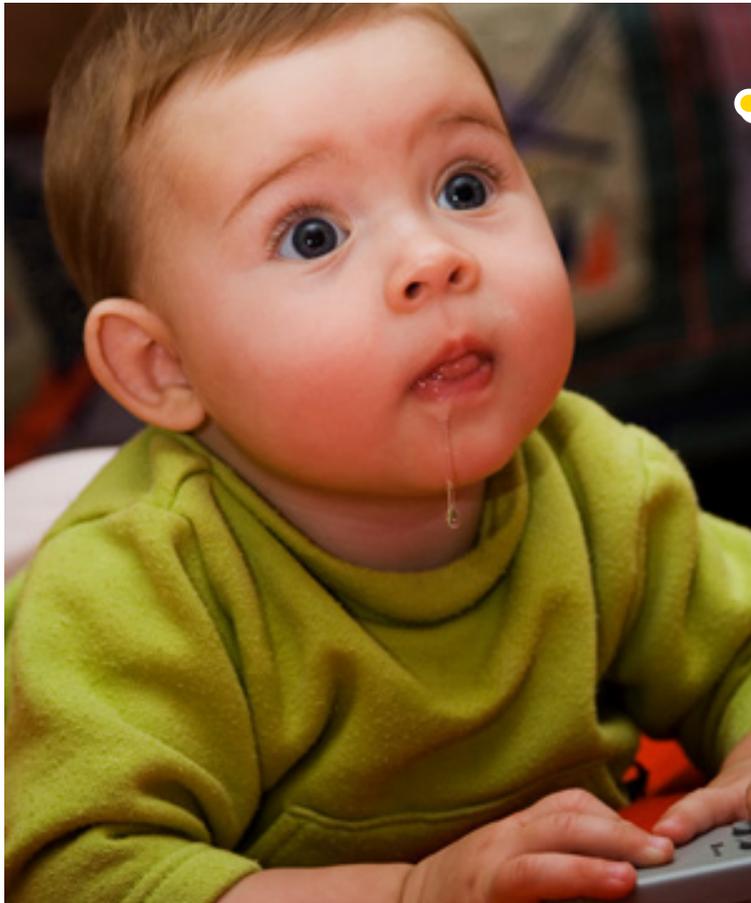
Poor home environment



Photo by Seth Holmes

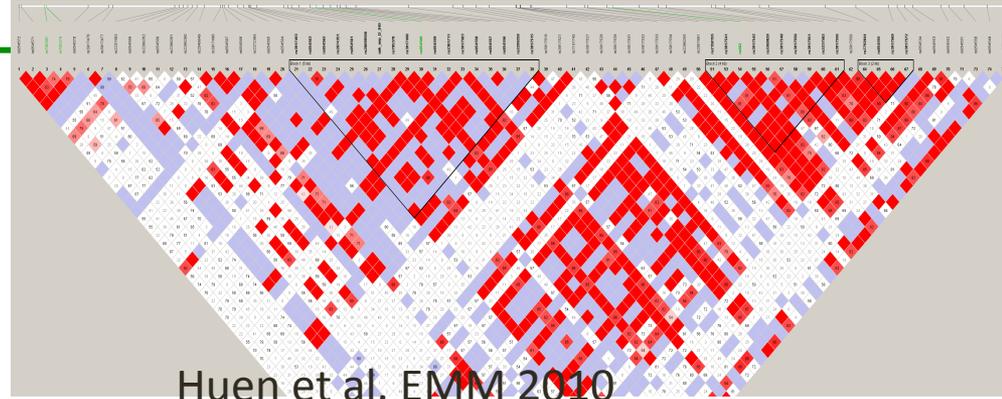
Maternal depression (12 m) (CES-D)	50%
Housing Density >1.5 per room	49%
Rodents	32%
Food Insecurity	50%
No blocks or stacking toys (12m)	51%

Are there some who are more susceptible to OPs?



- Paraoxonase enzyme detoxifies OPs in the body
- Amount and efficiency of the enzymes depend on genes called PON1

Measurements



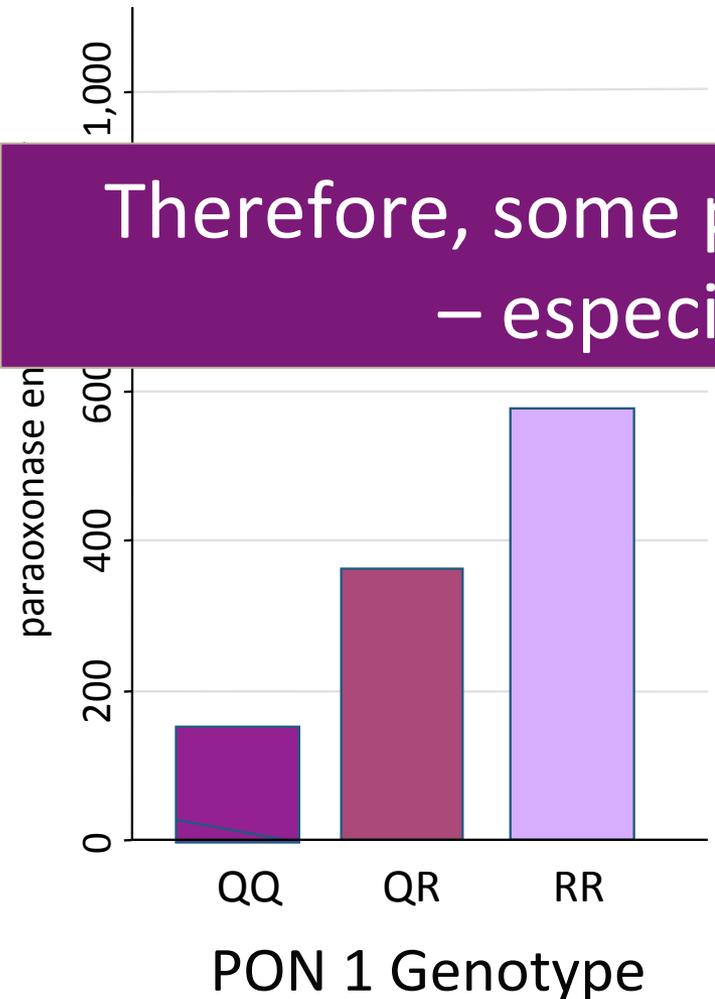
PON1 Genotype (Mother and Child)

- *PON1*₋₁₀₈
- *PON1*₁₉₂

PON1 Enzyme Activity

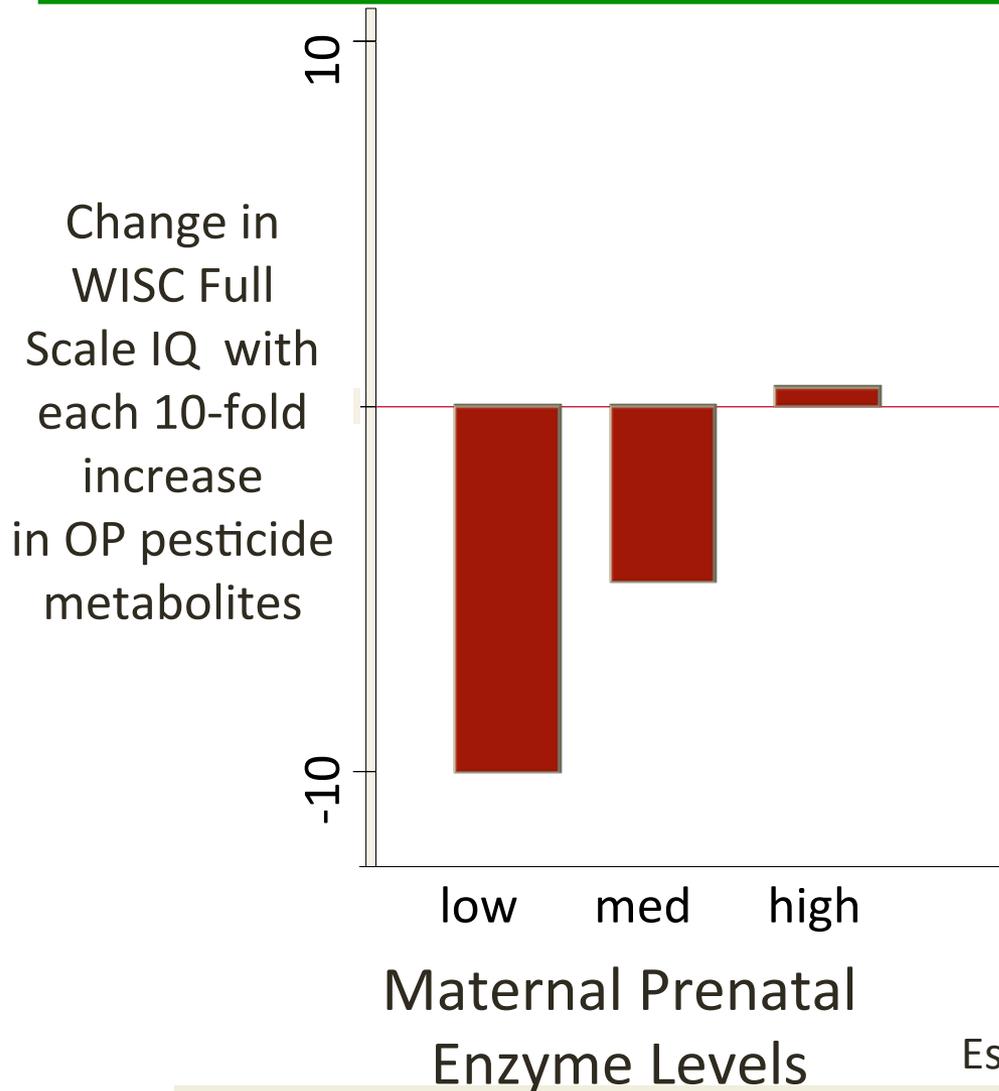
- Arylesterase
- POase
- CPOase
- Maternal at 26 wks & delivery
- Fetal (cord)
- Child at age 5

The levels and efficiency of enzymes depends on your genetics ...and your age



Therefore, some people are more susceptible – especially young children

Mom's OP metabolites related to poorer children's IQ especially in moms with lower PON enzyme



Collegeforlatinos.com

*Adjusted for maternal education, maternal IQ, HOME score at 6 months, and maternal PON192 genotype plus language of assessment.

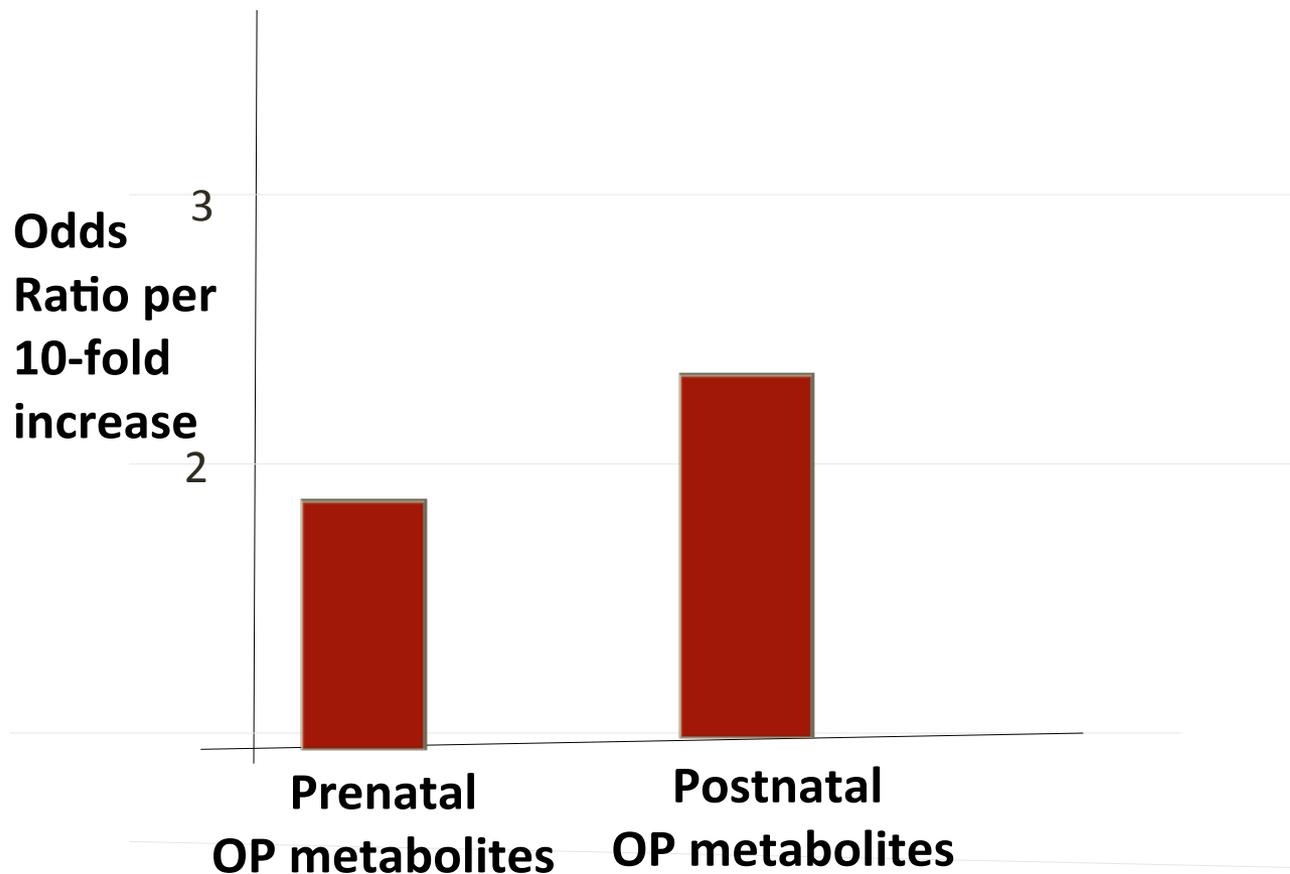
Eskenazi et al. , Environ Res, 2014

OP pesticide exposure and asthma



- Acute OP pesticide exposure associated with respiratory distress
- Some occupational studies show association of OP exposure and poorer respiratory outcomes
- Parasympathetic nervous system controls of lung tissue
- Autonomic sympathetic pathways also associated with respiratory function

Late prenatal and postnatal OP metabolites related to respiratory symptoms at school-age



momscleanairforce.org

Models adjusted for:

Child's gender, age, Maternal smoking, ETS, Season of birth, PM2.5, Breastfeeding, Mold, Traffic, Roaches

Raanan et al., EHP, 2015.

In summary, prenatal OPs (DAPs) related to:

- Shortened gestational duration
- Abnormal neonatal reflexes
- Decreased mental development at 2 years
- Decreased IQ at age 7 years
- Increase in pervasive development disorder at 2 years
- Attention problems in school-age
- Potential susceptible sub-populations to OPs (PON1)
- Respiratory symptoms in children

With farmworkers and growers, we developed a worksite intervention

THE INTERVENTION:

- Warm water in the fields
- Lightweight coveralls
- Gloves
- 5 field-based education sessions

THE EVALUATION:

- KAB Questionnaires
- Sampling of:
 - Worker urine
 - Hands
 - Clothing
 - Dislodgeable foliar residue



We also acted to reduce take-home exposure

With a home-based educational intervention for farmworker families



CHAMACOS Study Photos

We “intervene” with the entire community

>> Youth Community Council
Photovoice Project, Community 5k Run/Walk, Recycling Program, Walkability Survey

community

>> Prenatal Environmental Health Kiosk
 >> Kiosk brochures

>> Curriculum on Integrated Pest Management
 >> Environmental Quality in Child Care Center Trainings

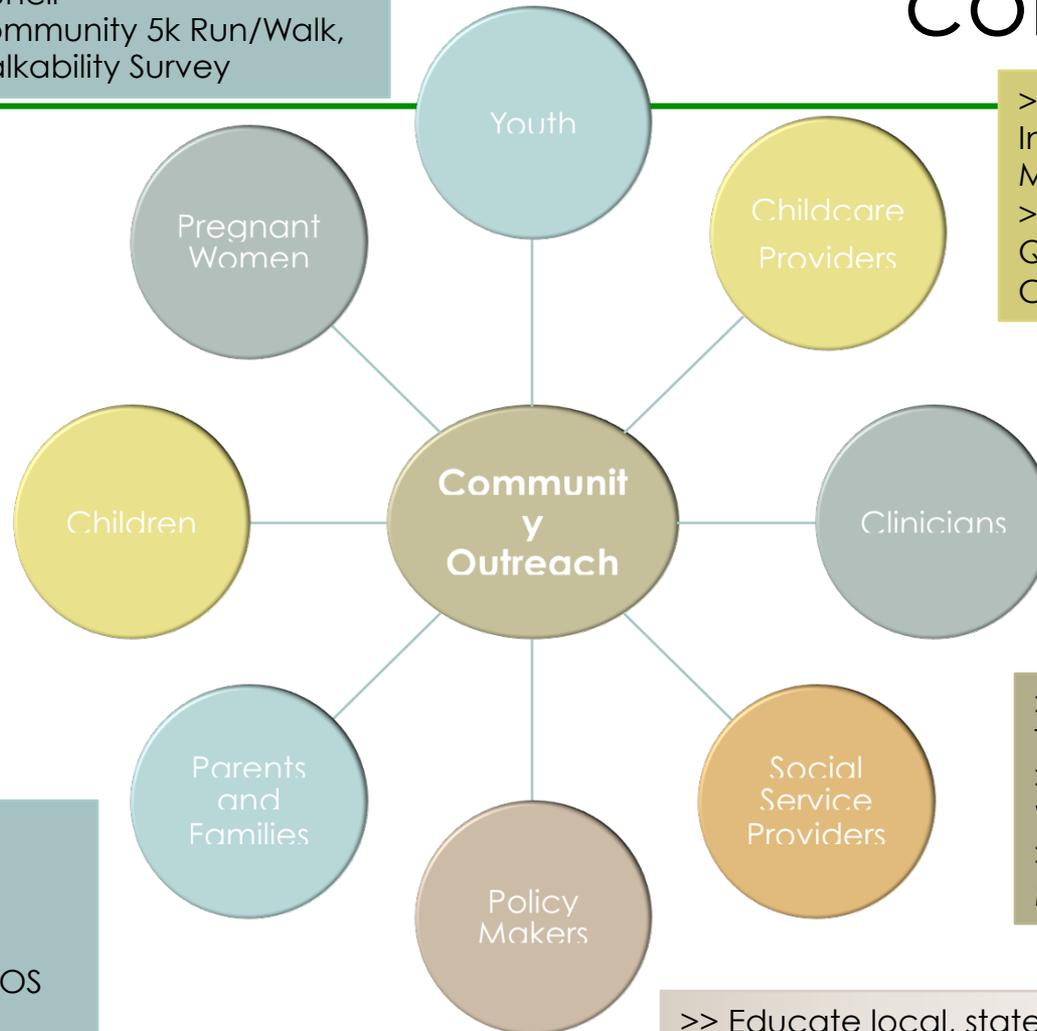
>> Puppet Show on Pesticide Exposure Prevention
 >> Youth Participant Community Forums

>> Grand Rounds
 >> Trainings on environmental hazards with CME credits

>> Healthy Homes Presentation
 >> Pesticide Exposure Prevention Trainings
 >> Overview of CHAMACOS Study Presentations
 >> Participant Community Forums
 >> La Semilla Newsletter

>> Healthy Homes Training
 >> Train-the-Trainer Workshop
 >> Resources and Materials Available

>> Educate local, state, and federal policymakers
 >> Help inform resolutions



Puppet show to teach children about pesticides



CHAMACOS Study Photo

And as a community-based participatory research project...



...we have educated more than 30,000 farmworkers and their families on how to protect themselves from pesticide exposure



We teach children with puppet shows.

And youth in our Youth Community Council by engaging in research



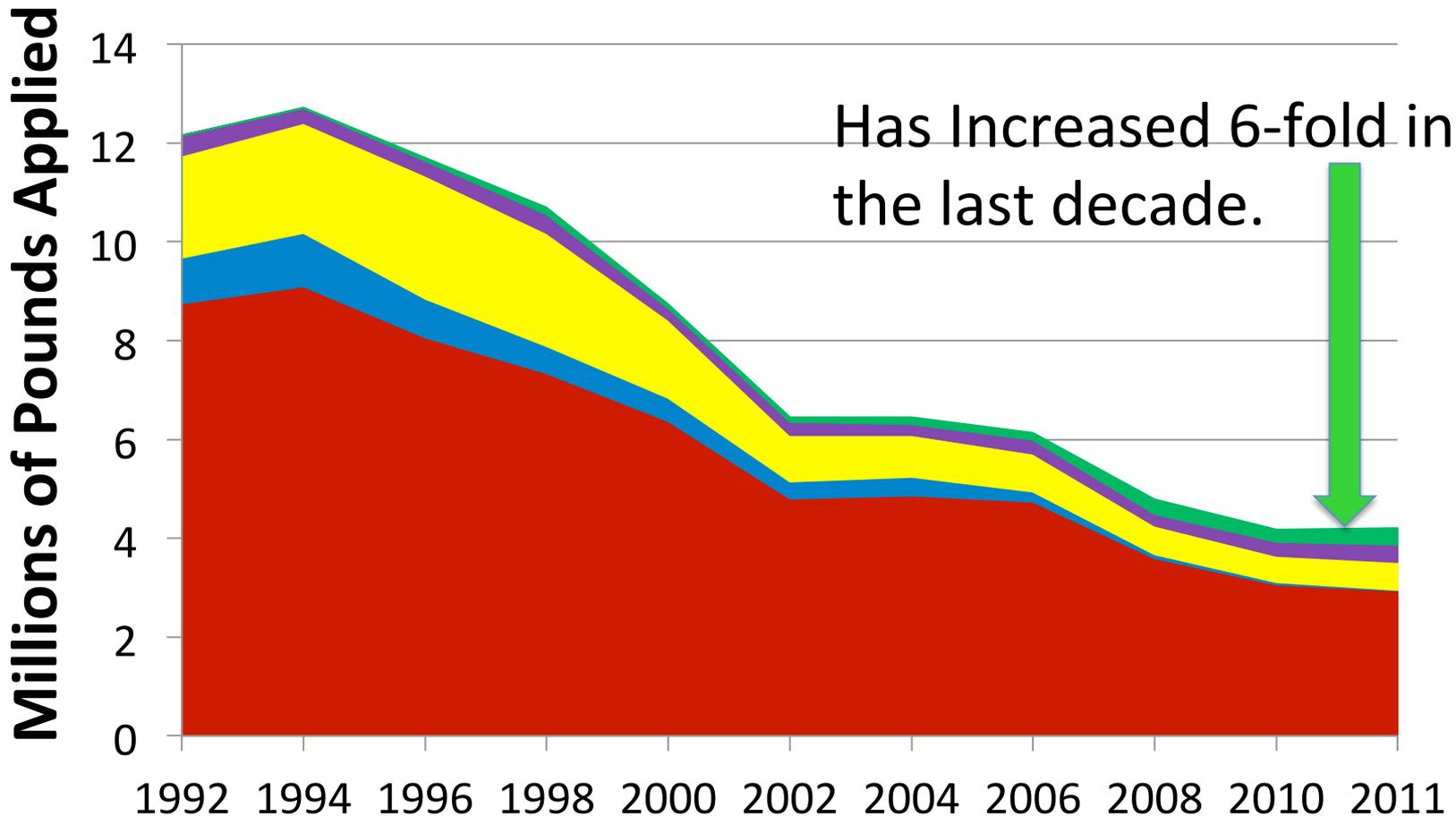
CHANGE

AHEAD



Agricultural Insecticide Use in California

Organophosphates Organochlorines Carbamates Pyrethroids **Neonicotinoids**



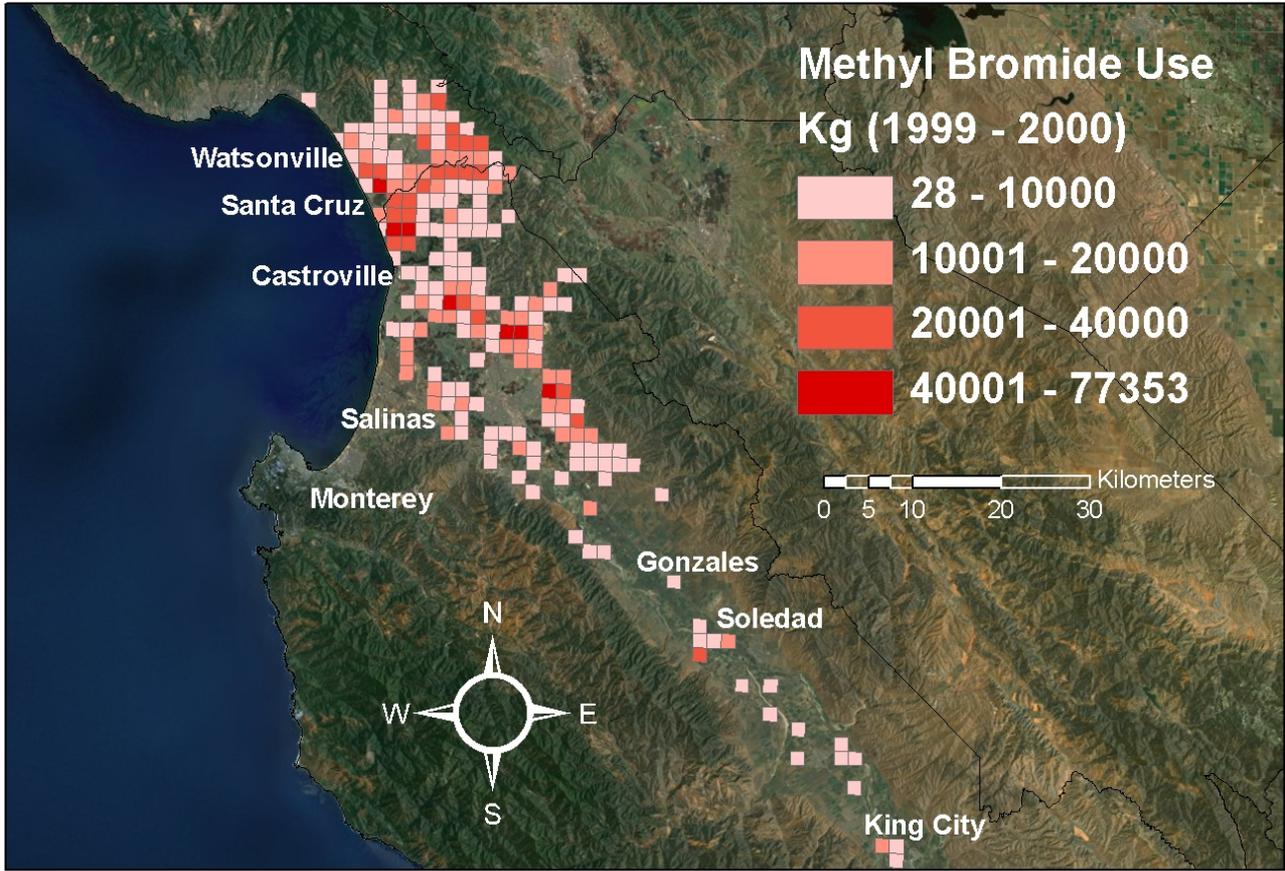
Source: California Department of Pesticide Regulation, 2013

Agricultural use of neurotoxic pesticides in the Salinas Valley

Pesticide Group	In 2000 (lbs)	In 2012 (lbs)
Organophosphates	539,232	236,776
Carbamates	146,777	75,503
Mn-fungicides	340,522	232,042
Glyphosate	133,432	110,620
Fumigants	3,479,511	4,461,434
Pyrethroids	36,050	45,370
Neonicotinoids	15,645	30,232

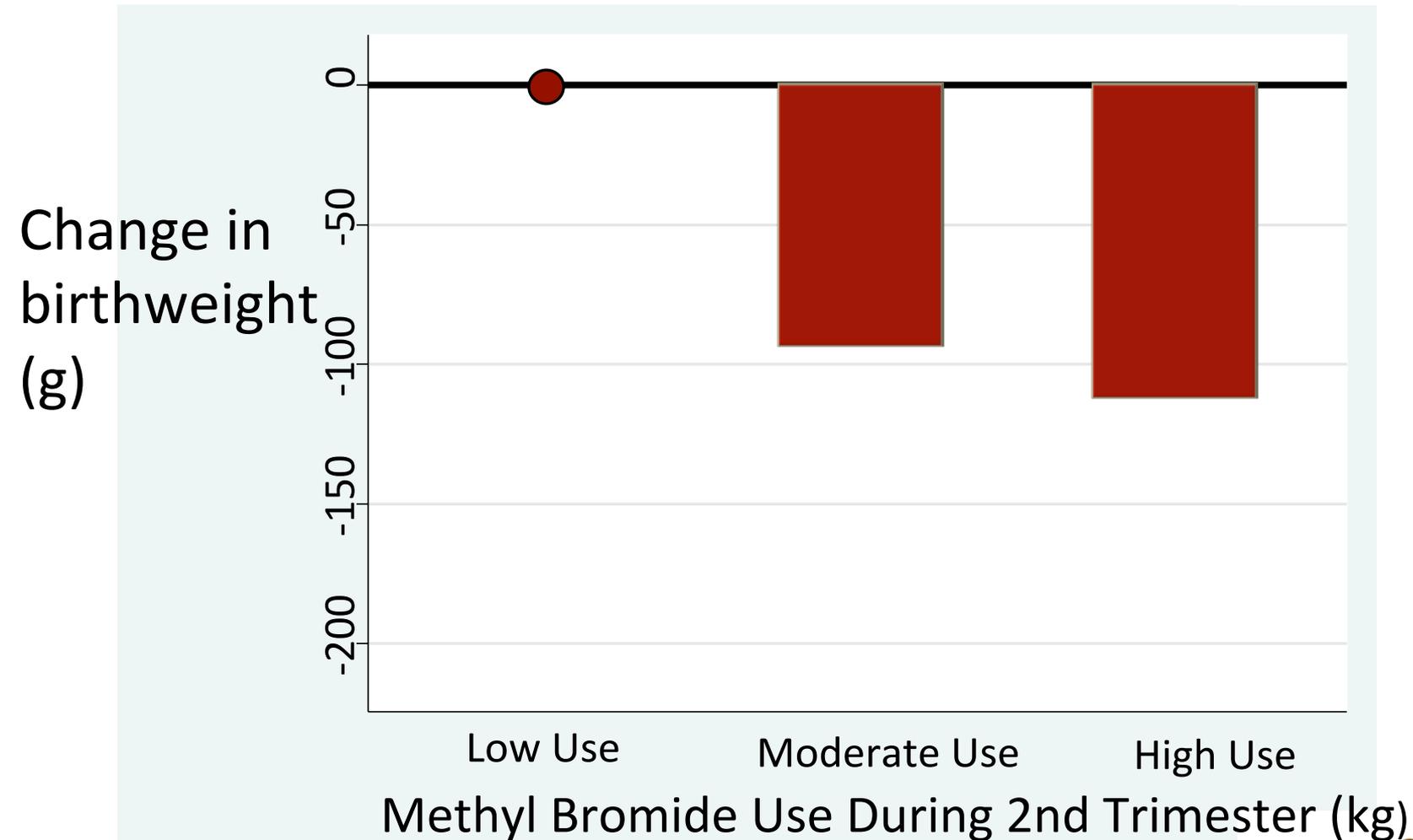


Methyl Bromide:
A fumigant fungicide widely used in strawberry fields



Source: California Department of Pesticide Regulation

Living close to methyl bromide use in 2nd trimester related to lower birthweight



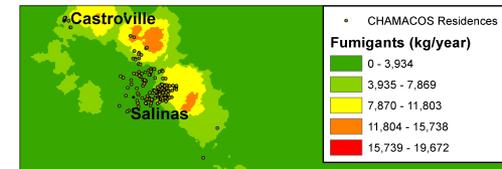
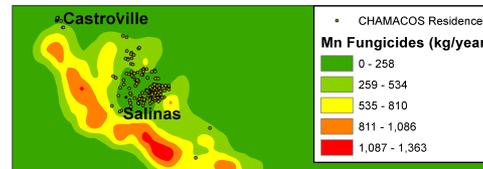
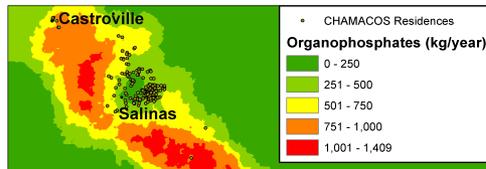
Gemmill et al., EHP, 2013

Future Directions

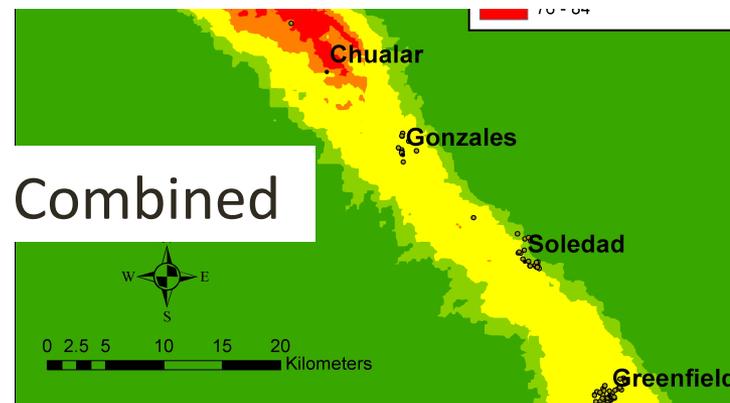
- Assessing exposures to complex neurotoxic pesticide mixtures
- Interaction of social adversity and neurotoxic pesticide exposure on early adult success



Agricultural use of neurotoxic pesticides during prenatal period 1999 – 2000



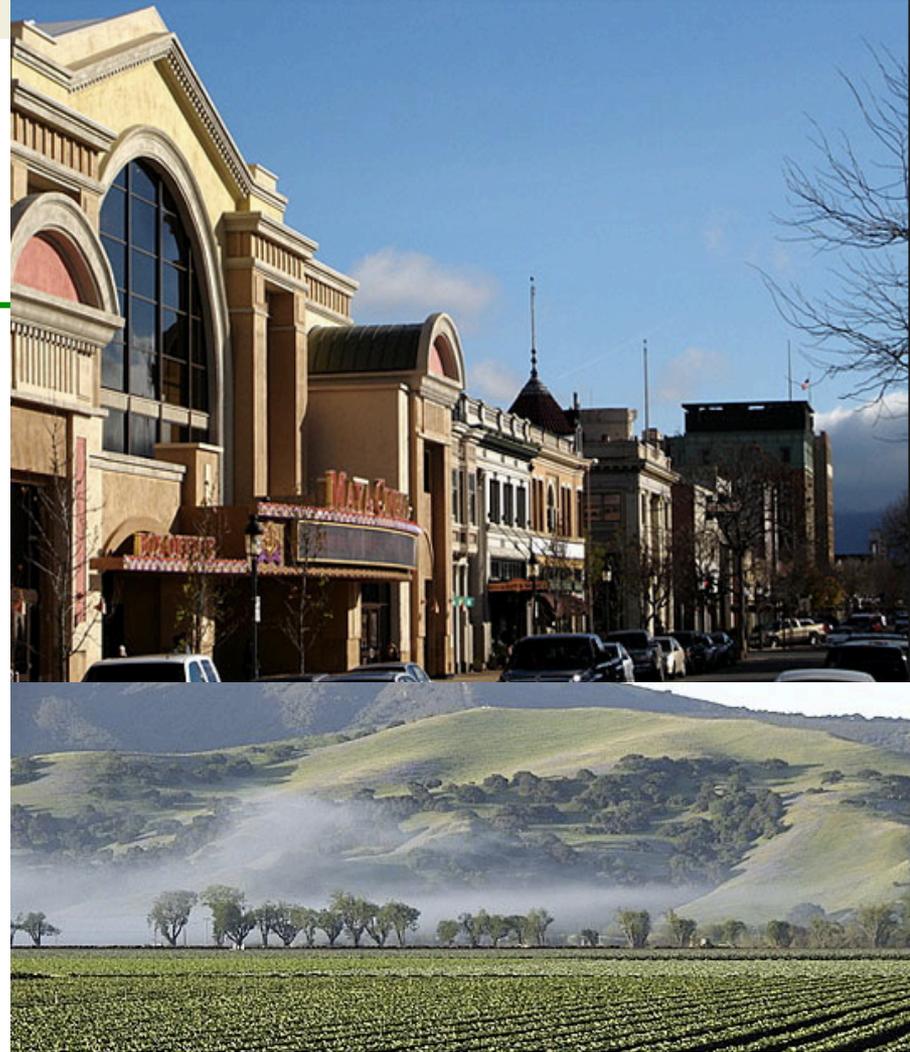
How can we combine exposure to multiple neurotoxic pesticides and classes with different toxicities and modes of action and with potentially different brain targets?



Salinas (pop 150K)

Salinas Valley, Monterey

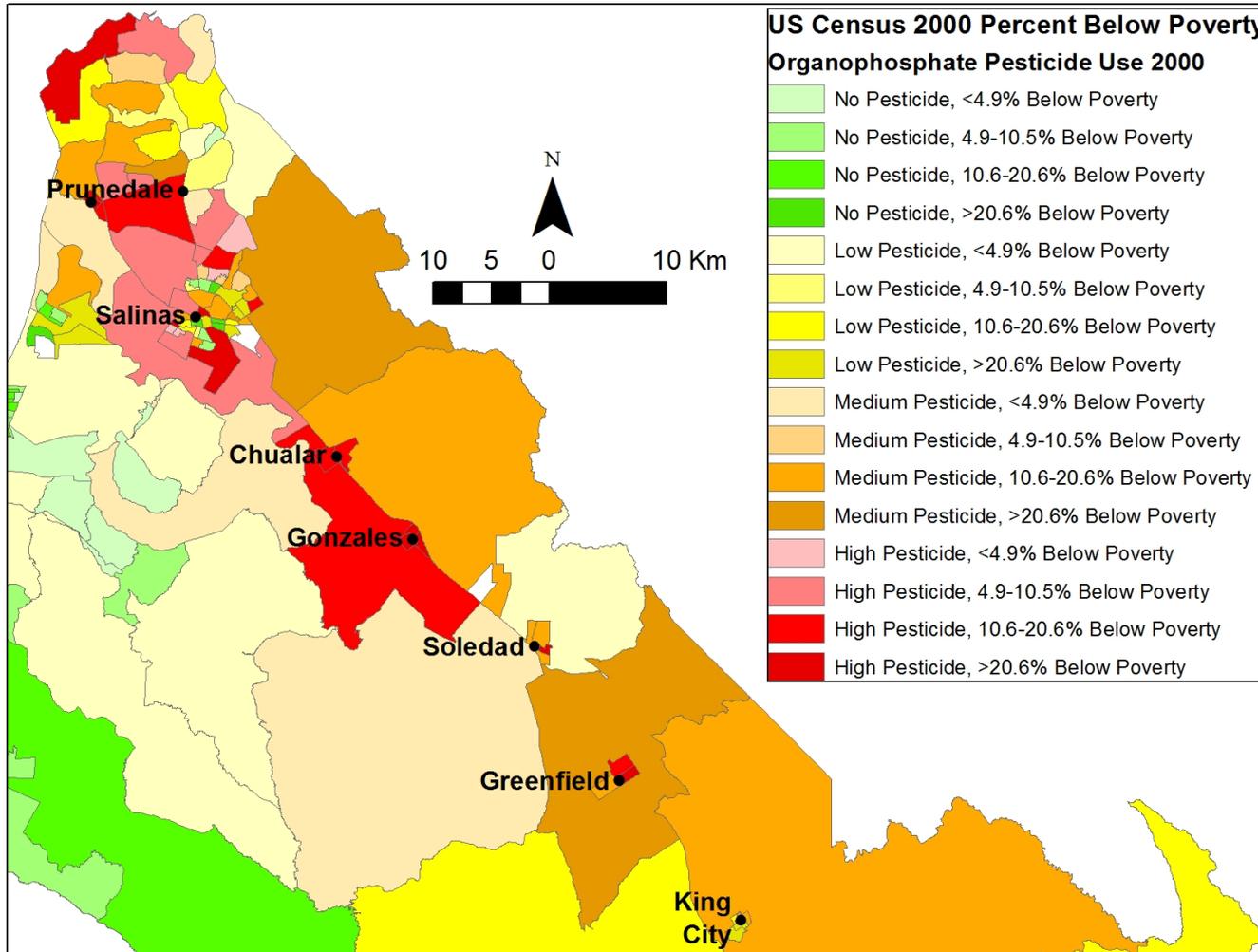
- 75% Latino, mostly Mexican
- 31% below the poverty level
- 50% HS students subsidized lunch
- 33% do not graduate HS
- Very high teen pregnancy rate
- 2.5 X homicides than US average
- 3 X robberies than US average
- 10% HS students report being in gang

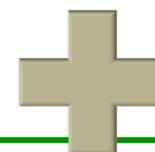


Salinas is one of six high-risk communities nationally for youth gang violence and, alongside cities such as Detroit and Inglewood in Los Angeles, as having one of the highest gang-related homicide rates in the U.S.

- U.S. Dept of Justice-led National Forum on Youth Violence Prevention

OP Pesticide Use and Percent Below Poverty Monterey County 2000





Neurotoxic exposome

Neurobiology/genes





CERCH Photos

Thanks to our funders



With additional support from:



Passport Foundation



*And a very special
thanks to the families
who have
participated all these
years!*



Thank YOU!!!



www.cerch.org