

Prenatal Residential Proximity to Agricultural Pesticide Applications and IQ in Children

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**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.

Salinas Valley - the “Salad Bowl” of the Nation

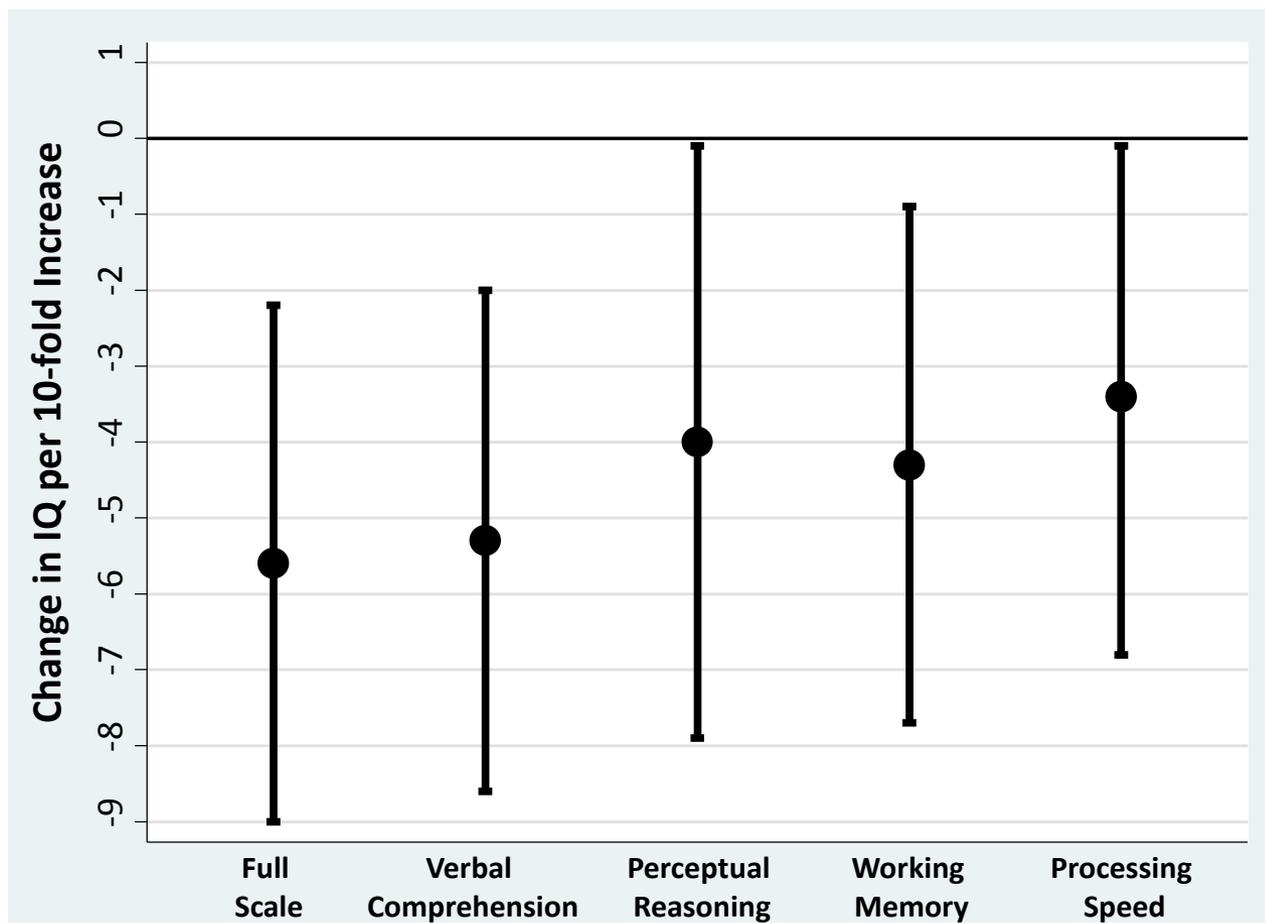


- Ranked #1 in the country for lettuce and all vegetables
- Almost \$3 billion in agricultural revenues in 2012
- Over 4.2 million kg of agricultural pesticide use in 2012

Previous Study in CHAMACOS Cohort: Prenatal Biomarker of Pesticide Exposure

- Urine samples from pregnant mother's at ~ 13 and 26 weeks gestation
- Measured dialkylphosphate metabolites (**DAPs**) as a biomarker of exposure to organophosphate pesticides

Previous Study in CHAMACOS Cohort: Prenatal 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

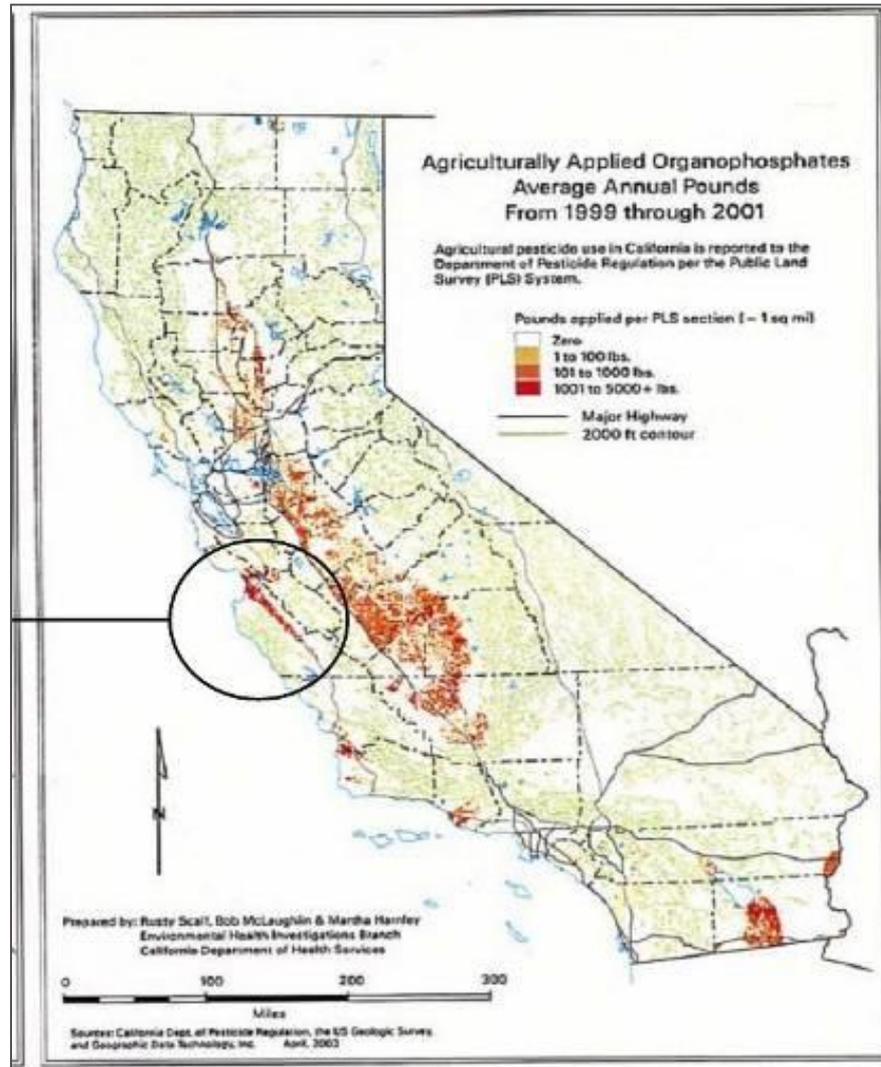
Limitations of DAPs as a Measure of Exposure

- Short-term (daily) and long-term (seasonal) variability
- Not pesticide specific
- Not toxicity weighted
- Does not identify source of exposure

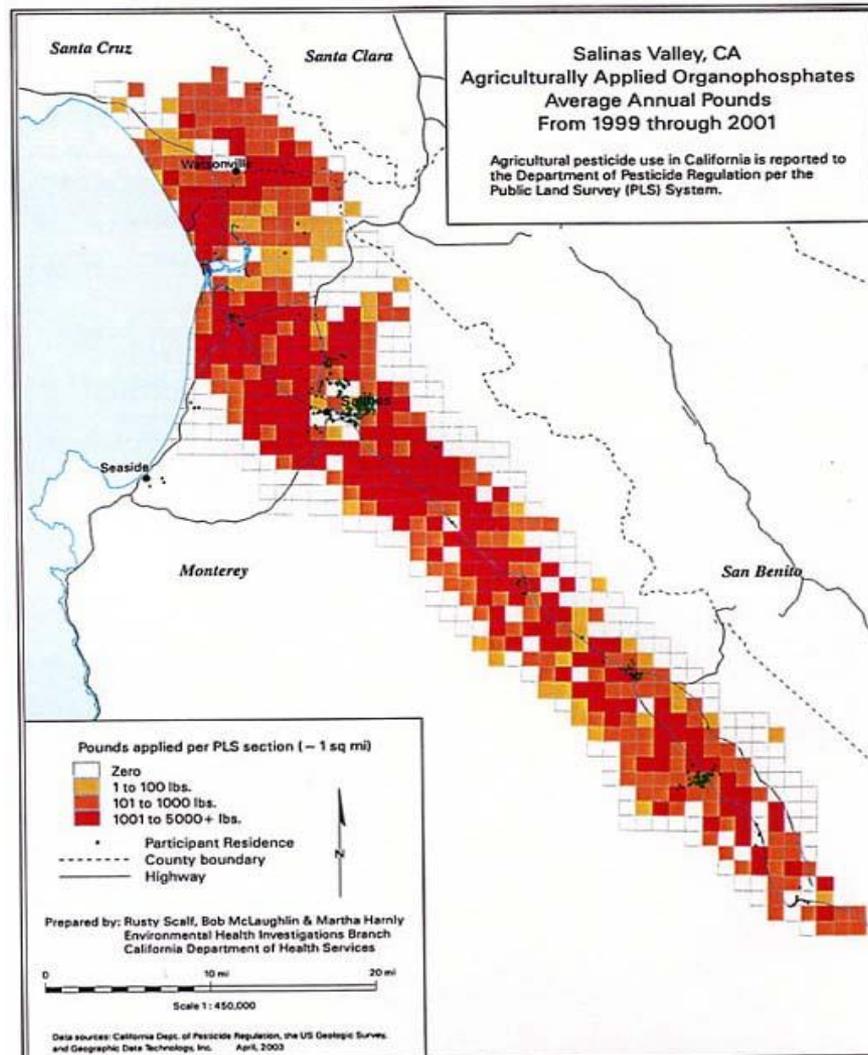
Pesticide Use Report (PUR) Data

- Unique database
 - Mandatory since 1990
 - Comprehensive reporting of all pesticides
 - Largest agricultural state in the country
 - Other states are implementing
- Provides the following information:
 - Pesticide active ingredients
 - Pounds applied
 - Application date
 - Location to a square-mile section
 - Crop treated

Agricultural Use of Organophosphates in California



Agricultural Use of Organophosphates in the Salinas Valley



Research Question

Is nearby agricultural pesticide use related to neurodevelopment of children?

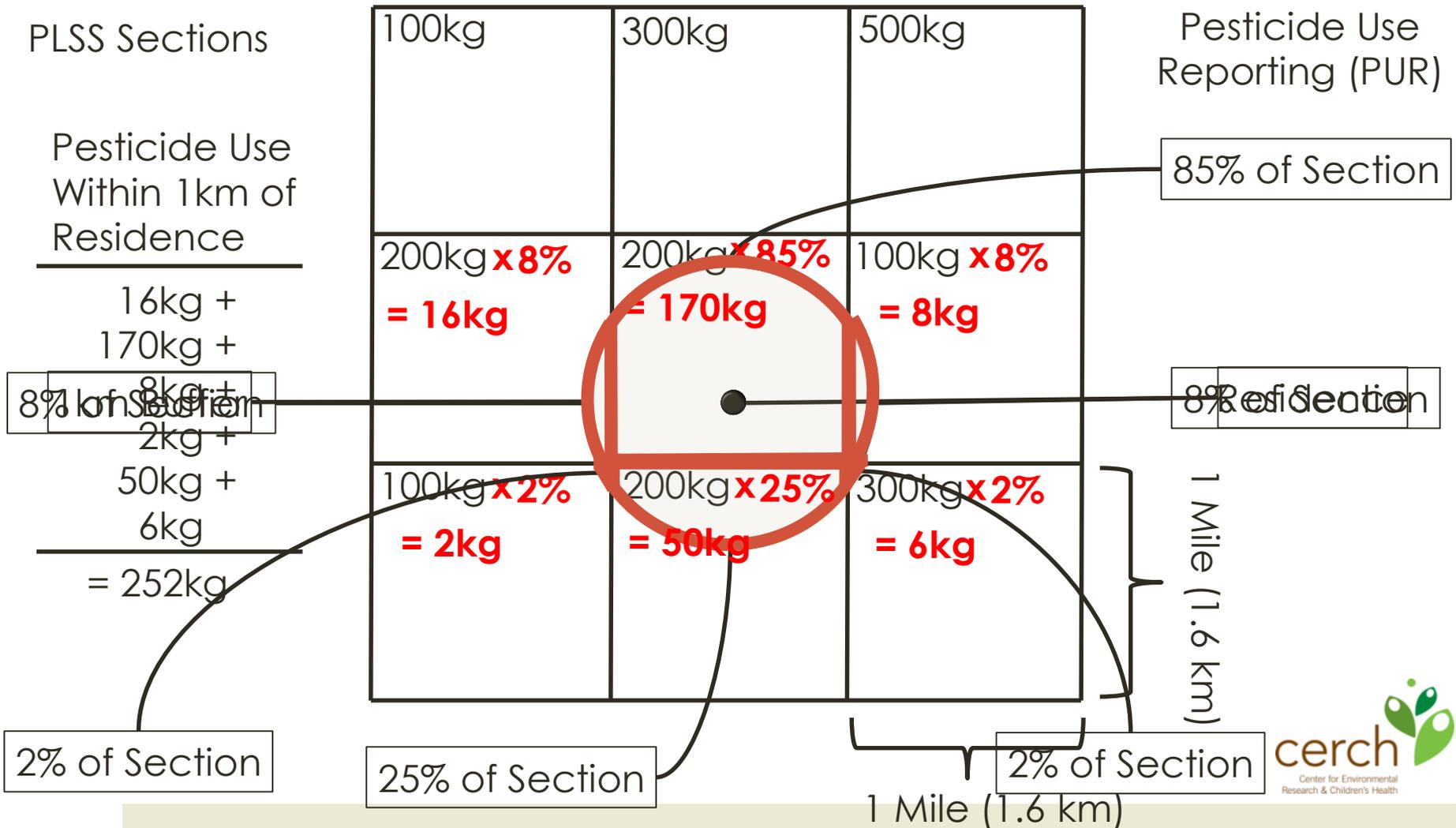




In 1999-2000, we enrolled 601 pregnant women from clinics

- 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

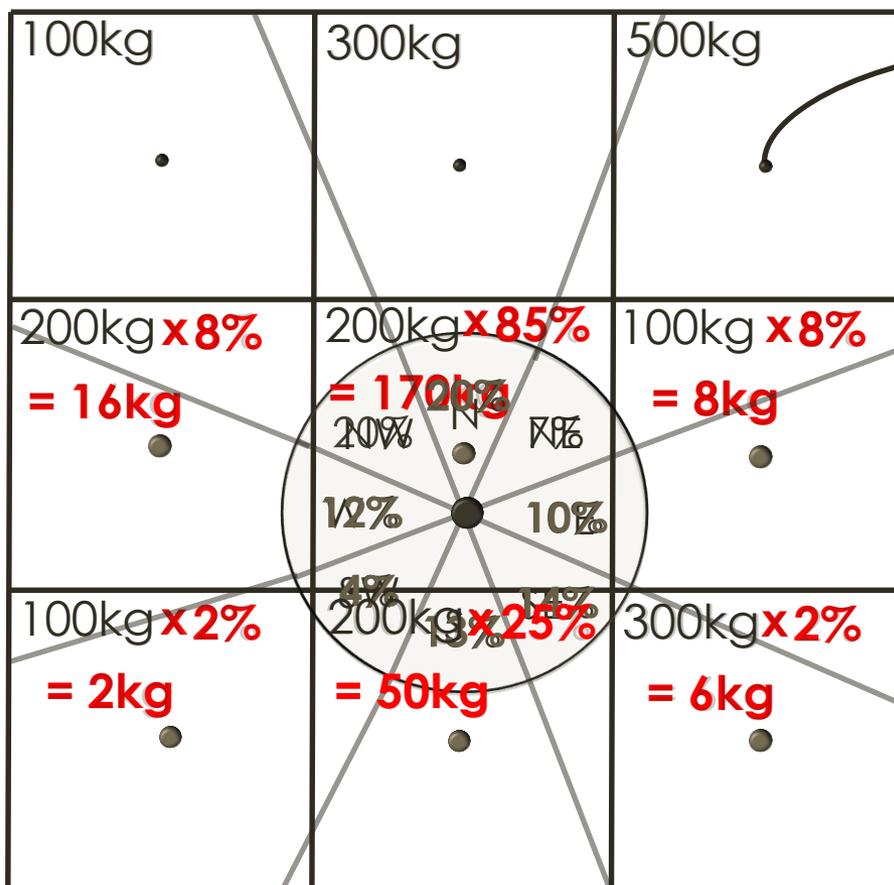
Methods – Pesticide Use Residential Proximity



Methods – Pesticide Use Wind Weighting

Pesticide Use
Within 1km of
Residence

$$\begin{aligned}
 &16\text{kg} + \\
 &170\text{kg} + \\
 &8\text{kg} + \\
 &2\text{kg} + \\
 &50\text{kg} + \\
 &6\text{kg} \\
 \hline
 &= 252\text{kg}
 \end{aligned}$$



Centroid

Wind Adjusted
Pesticide Use
Within 1km of
Residence

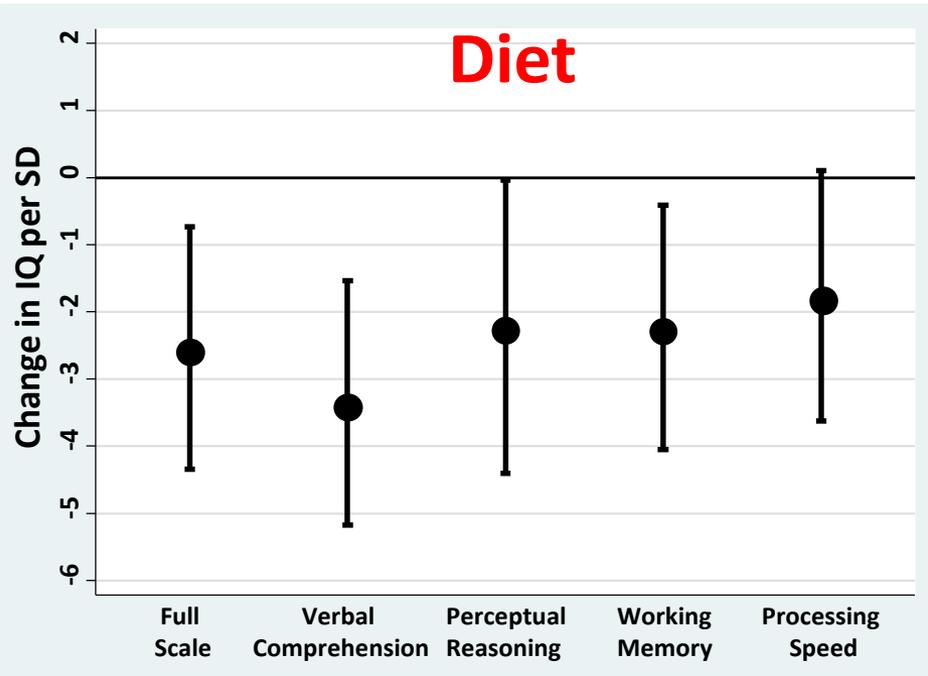
$$\begin{aligned}
 &(16\text{kg} \times 12\%) + \\
 &(170\text{kg} \times 20\%) + \\
 &(8\text{kg} \times 10\%) + \\
 &(2\text{kg} \times 4\%) + \\
 &(50\text{kg} \times 13\%) + \\
 &(6\text{kg} \times 14\%) \\
 \hline
 &= 44.14\text{kg}
 \end{aligned}$$

Cognitive Assessment at 7-years of Age

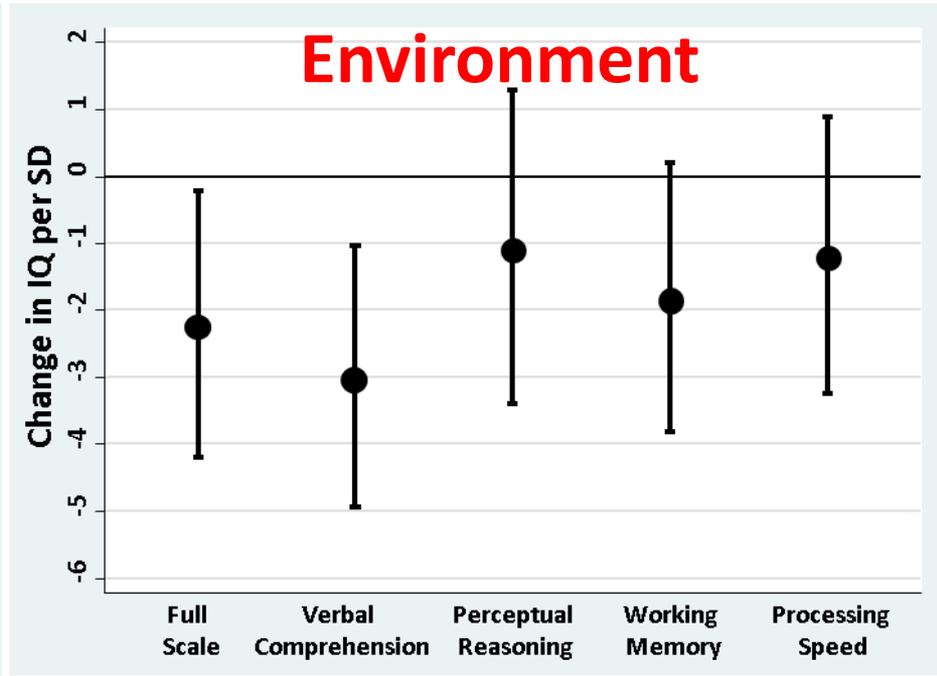
- Wechsler Intelligence Scale for Children, 4th Edition
- Four domains:
 - verbal comprehension
 - perceptual reasoning
 - working memory
 - processing speed
- All assessments by a single bilingual psychometrician
- Conducted in Spanish (67%) and English (33%)

Agricultural OP pesticide use (PUR) is independently associated with IQ at 7 years

Urinary DAPs



Agricultural OPs from PUR



Adjusted for child's age, sex, language of assessment, maternal education, maternal intelligence, household poverty level, maternal depression, maternal country of birth and HOME score. **Adjusted for prenatal DAPs**

Bouchard et al., EHP, 2011

Unpublished data

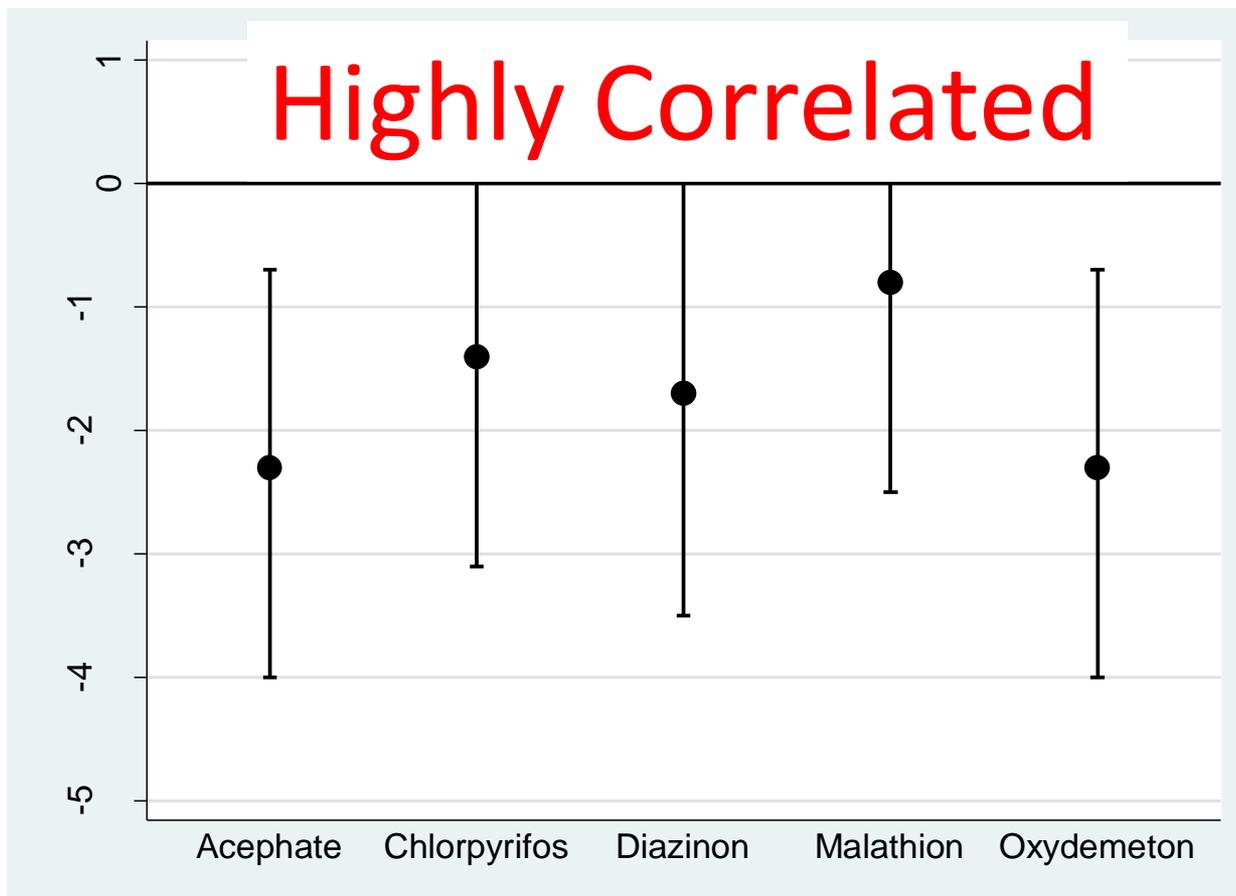


Organophosphate Pesticide Use in the Salinas Valley, 2000

OP Pesticide	Kg Applied
Diazinon	56,434
Malathion	37,161
Acephate	34,792
Oxydemeton	28,767
Chlorpyrifos	25,357
Total	~250,000

Source: California Department of Pesticide Regulation

Prenatal agricultural use of individual OPs and Full-scale IQ at 7-years (Single pesticide models)



Adjusted for sex, child's age, language of assessment, maternal education, maternal IQ, household poverty level, maternal depression, maternal country of birth, HOME score and prenatal DAPs.

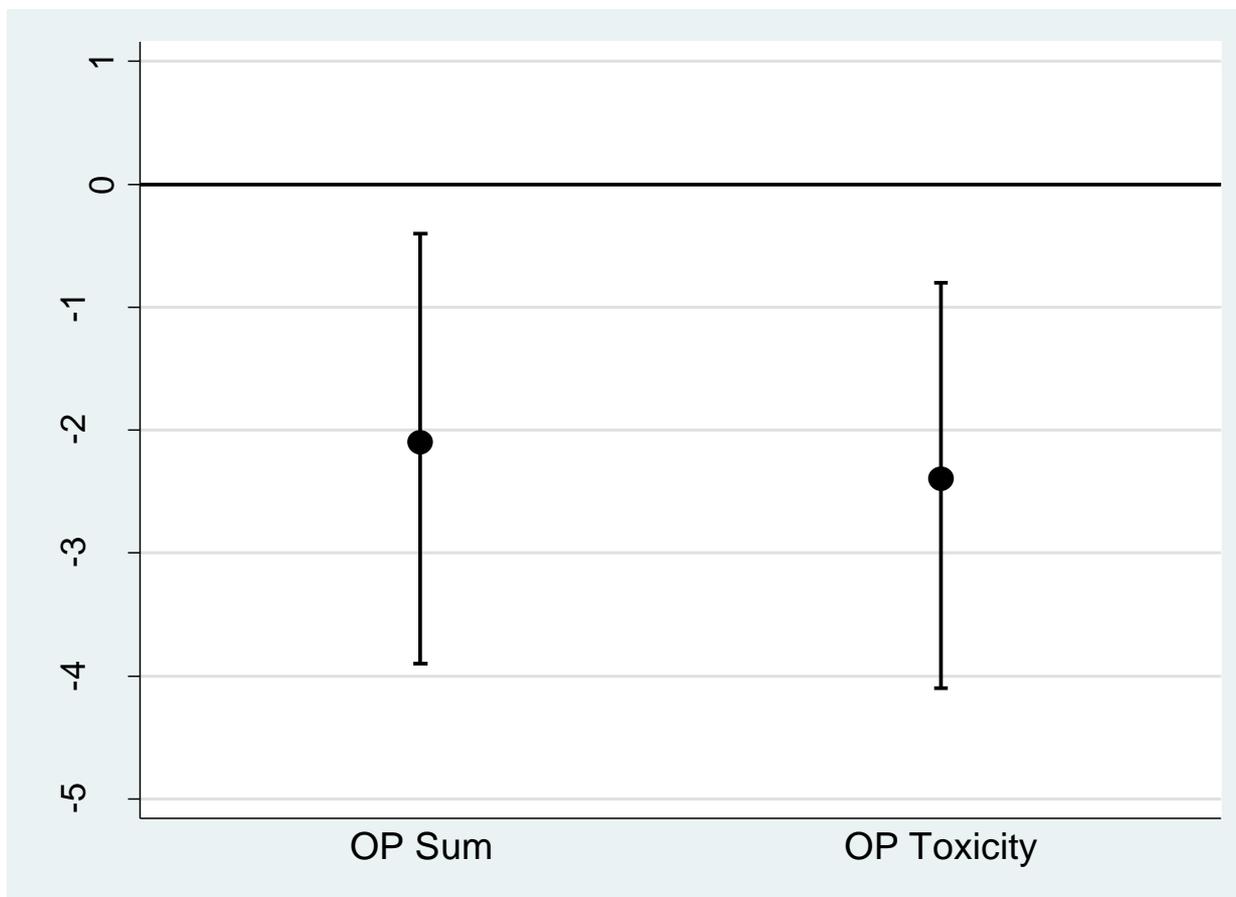
Toxicity Weighted OP Pesticide Use in the Salinas Valley, 2000

OP Pesticide	Kg Applied	Relative Potency*	Toxicity Weighted
Oxydemeton	28,767	0.86	24,739
Acephate	34,792	0.08	2,783
Chlorpyrifos	25,357	0.06	1,521
Diazinon	56,434	0.01	564
Malathion	37,161	0.0003	11

*Relative potency based on AChE inhibition, methamidiphos is reference.

Sources: California Department of Pesticide Regulation and US EPA

Prenatal agricultural use of total OPs and FSIQ at 7-years



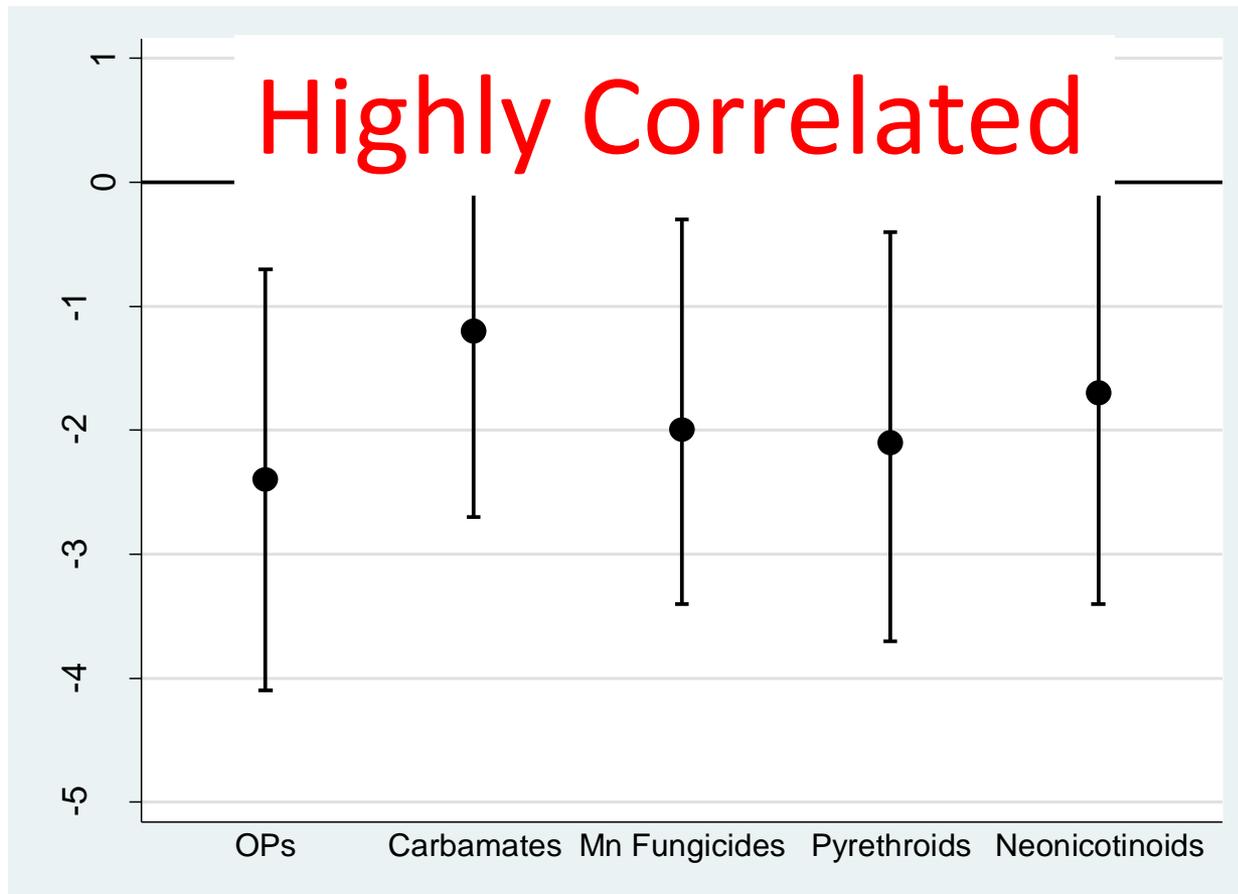
Adjusted for sex, child's age, language of assessment, maternal education, maternal IQ, household poverty level, maternal depression, maternal country of birth, HOME score and prenatal DAPs.

Agricultural use of neurotoxic pesticides in the Salinas Valley, 2000

Pesticide Group	Kg Applied
Organophosphates	245,105
Carbamates	66,717
Mn-fungicides	154,783
Pyrethroids	16,386
Neonicotinoids	7,111

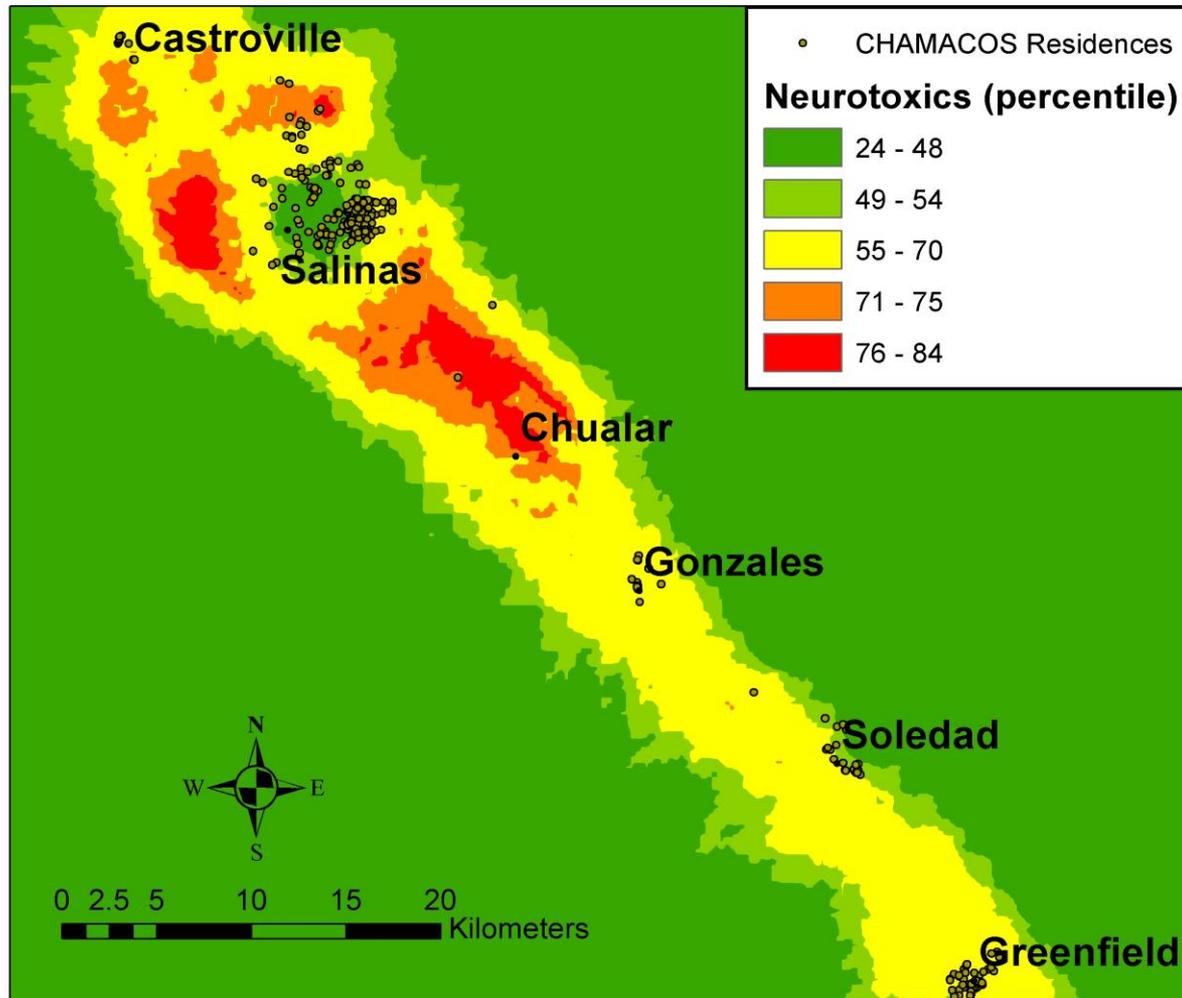
Source: California Department of Pesticide Regulation

Prenatal agricultural use of neurotoxic pesticides and Full-scale IQ at 7-years (Single group models)

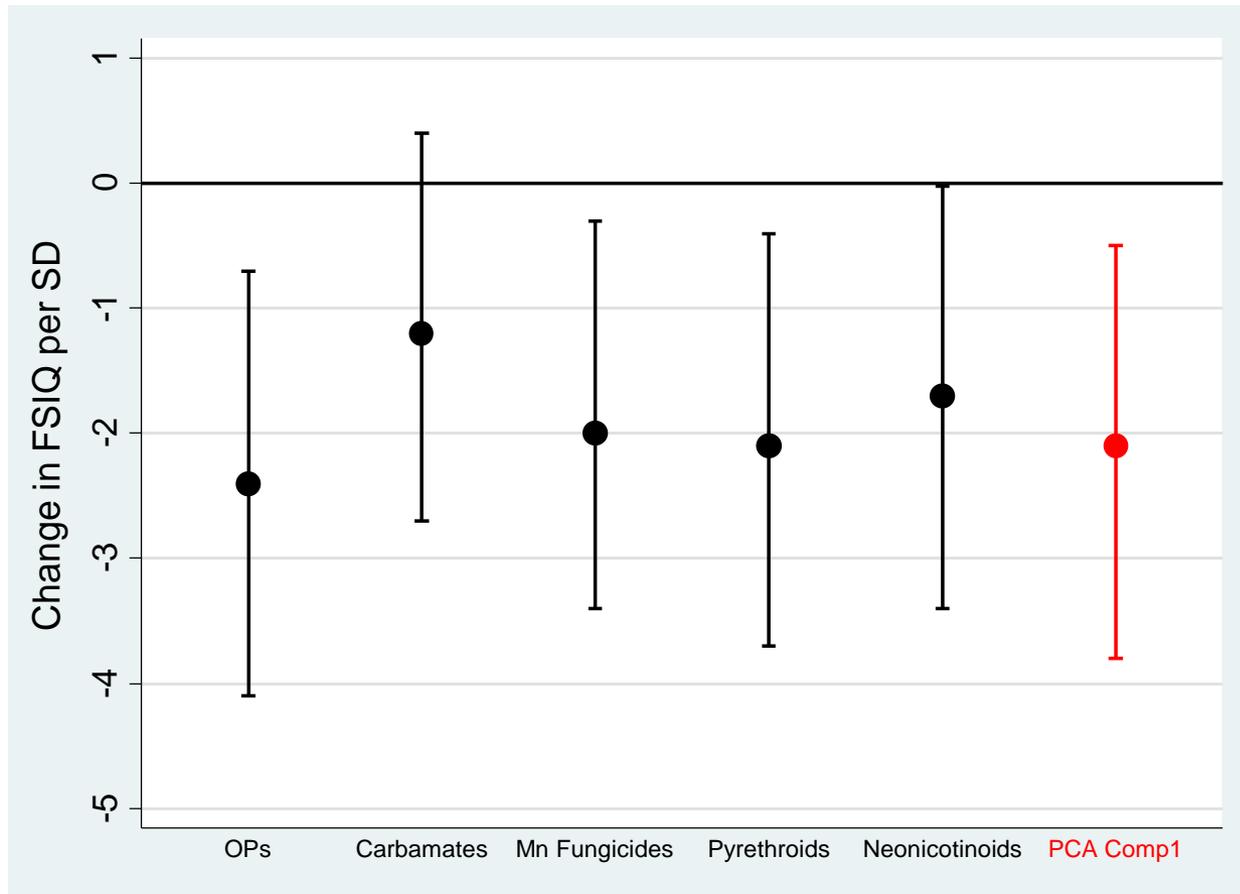


Adjusted for sex, child's age, language of assessment, maternal education, maternal IQ, household poverty level, maternal depression, maternal country of birth, HOME score and prenatal DAPs.

Can we combine agricultural use of neurotoxic pesticides?



Prenatal agricultural use of neurotoxic pesticides and Full-scale IQ at 7-years (PCA)



Adjusted for sex, child's age, language of assessment, maternal education, maternal IQ, household poverty level, maternal depression, maternal country of birth, HOME score and prenatal DAPs.

Not just CHAMACOS: PUR and neurodevelopment/degeneration

- Neural Tube Defects
 - Rull et al. 2006 – methomyl and benomyl
 - Yang et al. 2014 – 2,4 D, methomyl and imidacloprid
- Autism
 - Roberts et al. 2007 – dicofol and endosulfan
 - Shelton et al. 2014 – organophosphates and pyrethroids
- Parkinson's Disease
 - Costello et al. 2009 – maneb and paraquat
 - Wang et al. 2014 - organophosphates
- Previous studies have not incorporated wind or toxicity

Future Directions: Improved Exposure Estimates

- Optimize PUR exposure estimates using measured pesticide concentrations in air and house dust
 - Refine use of wind data
 - Buffer distance from residence
 - Time period of applications
 - Physical properties of pesticides
 - Precipitation and temperature
- Collaboration with Department of Pesticide Regulation

Summary

- Prenatal residential proximity to agricultural pesticide use associated with decreased IQ in children at 7-years of age
 - Organophosphates – acephate and oxydemeton-methyl
 - Manganese containing fungicides – maneb
 - Pyrethroids
 - Neonicotinoids
- Agricultural pesticide use is highly correlated
 - Both individual pesticides and pesticide groups
 - Statistical and toxicological methods to evaluate cumulative effects
 - Statistical methods to evaluate components of correlated mixtures
- Need to improve PUR estimates of exposure based on measured levels in environmental samples

Thank you to collaborators



Thank you to our funders



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

