Pesticides & Child Health

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PEHSU
Pediatric Environmental
Health Specialty Units

Outline

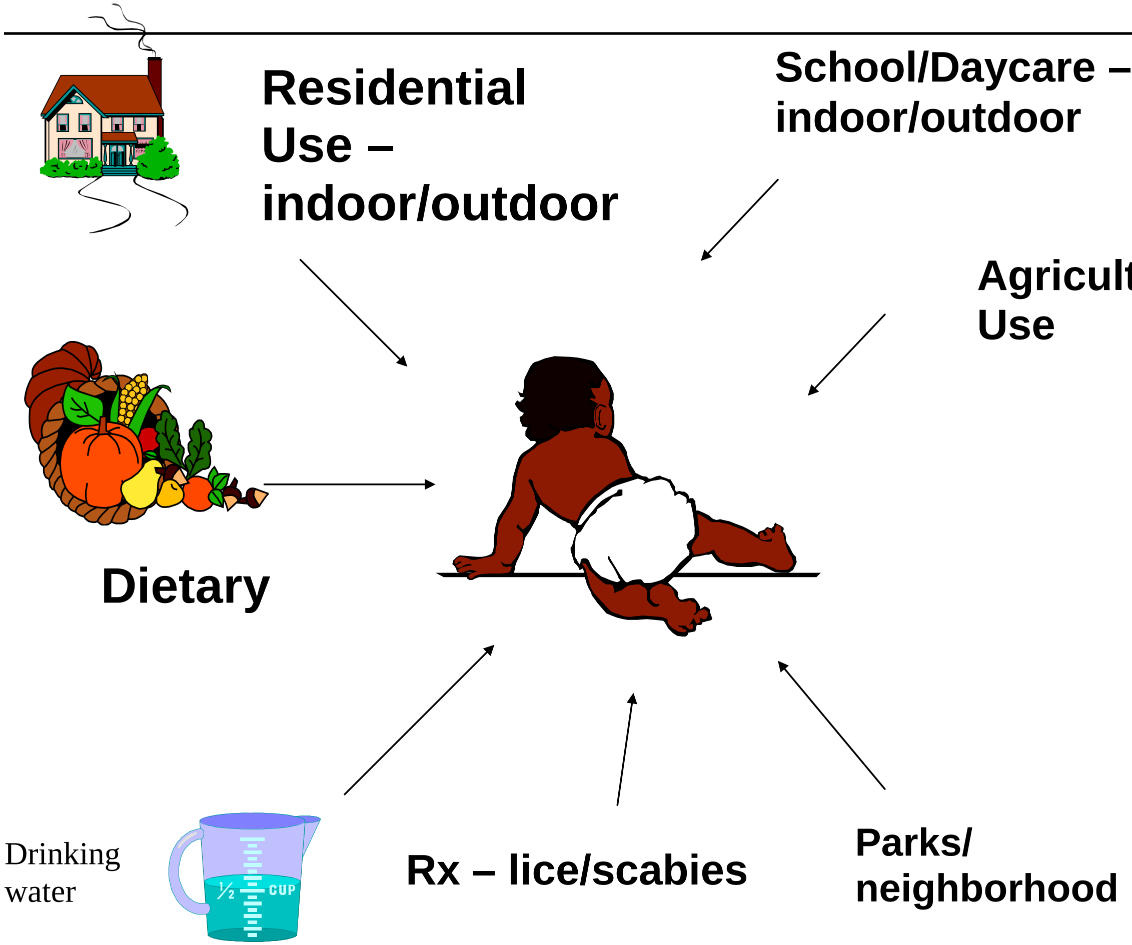
Pesticides and Child Health: What do we know? What do we wish we knew?

- Sources and pathways of exposure for children
- Vulnerability of children
- An abbreviated review of the evidence base: Health endpoints
- Strengths/Limitations of available data

Reduce risk of pesticide use

- Policy/practice approaches

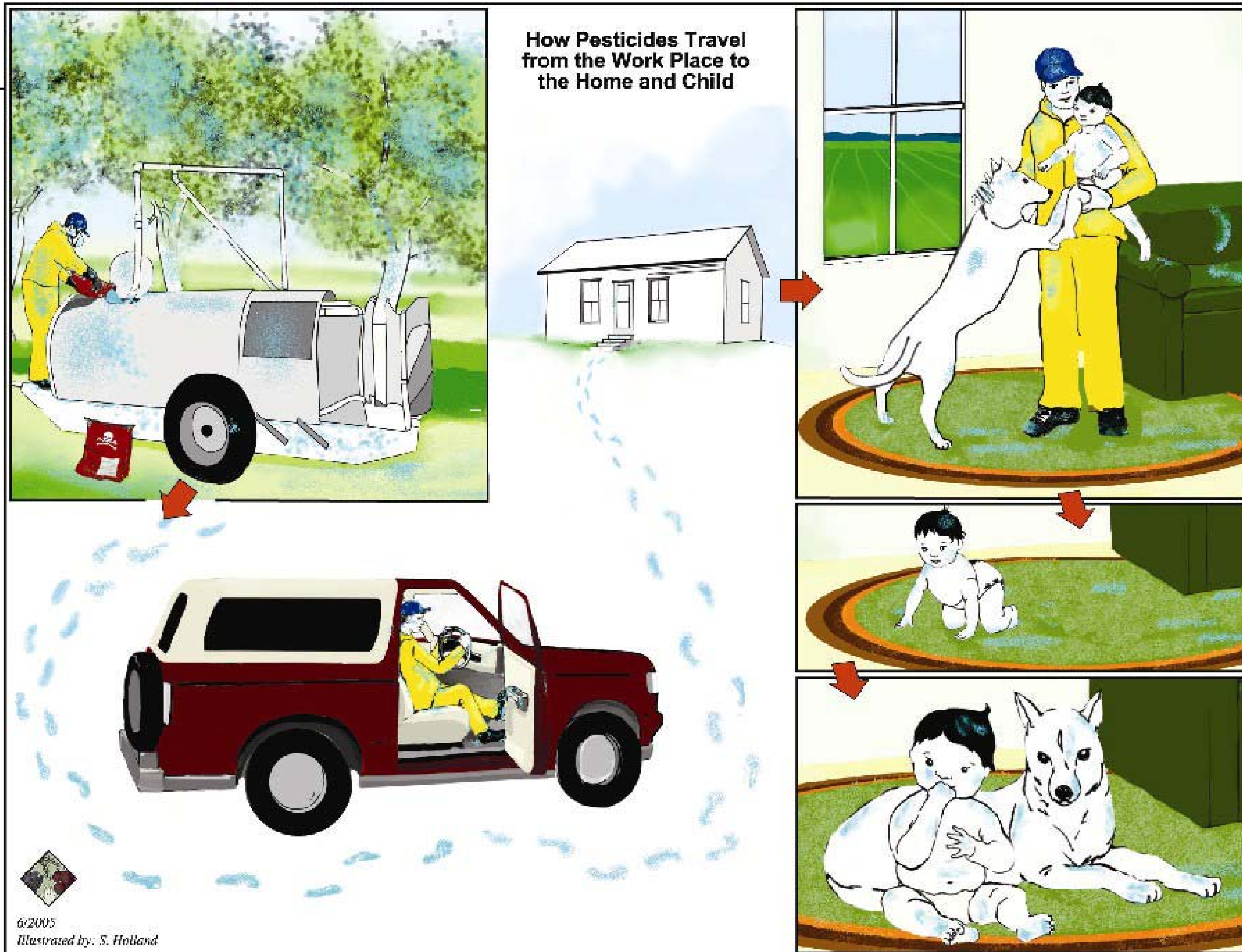
Sources – Child/Pesticide Encounters



Variability based on geography, cultural/social factors, policies

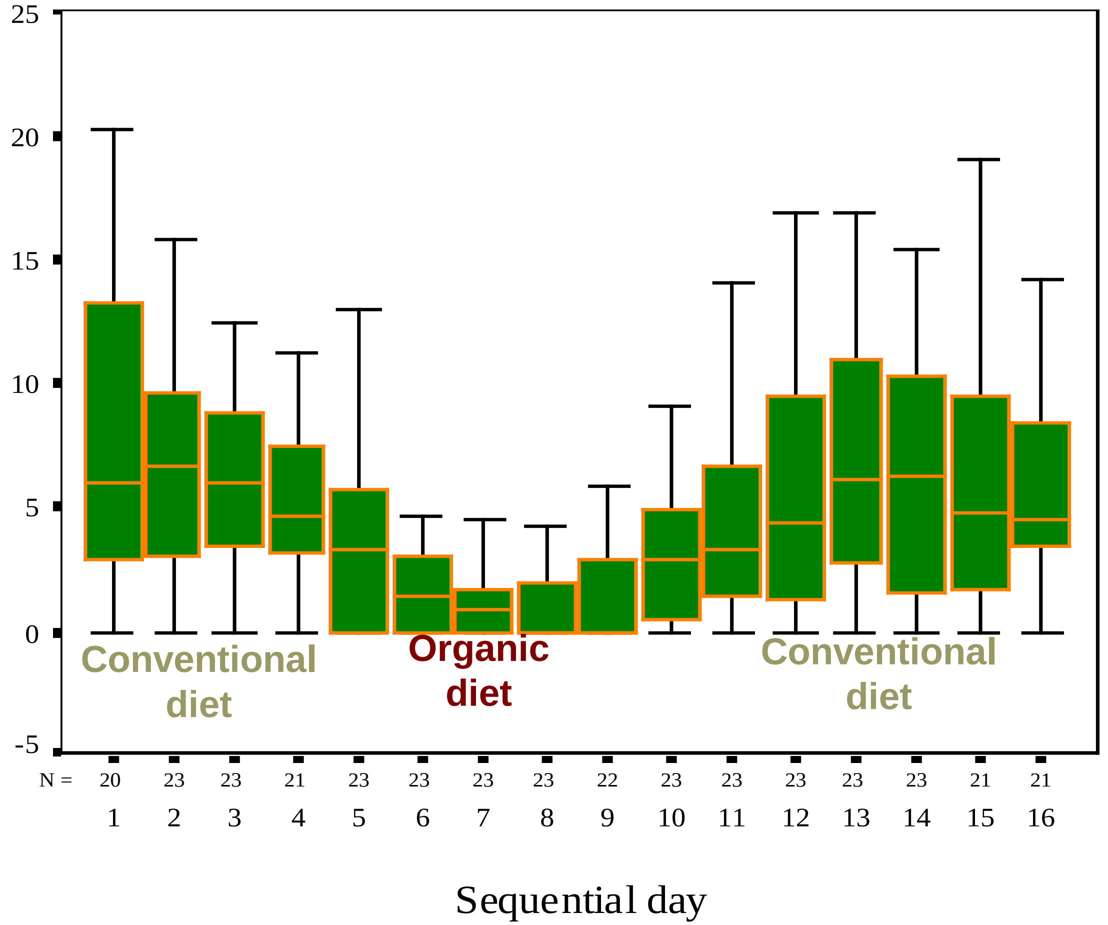
How much/what types from each source?

Parental Take-Home Pathway



Importance of diet as exposure source:

Urinary pesticides concentrations of 22 Children Before, During, and After Organic Diet Intervention



Lu et al. 2005

Child vulnerability to pesticide toxicity

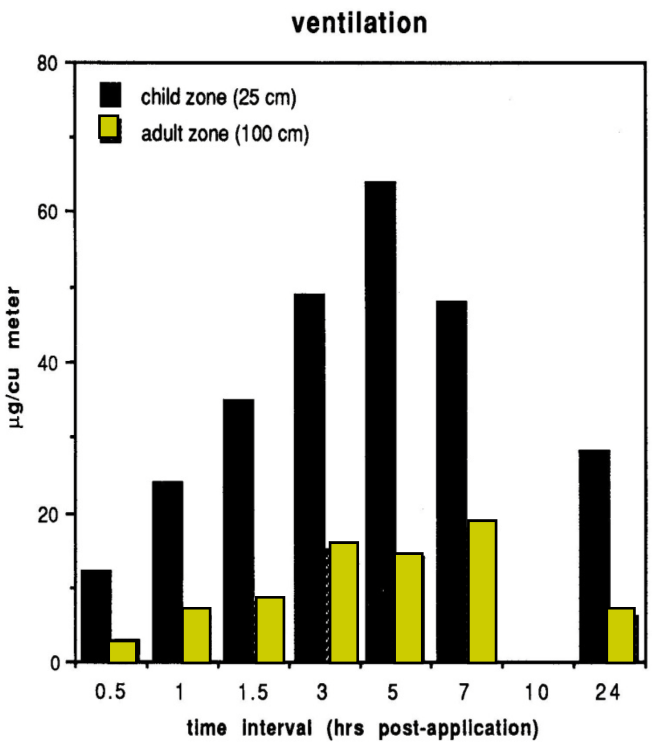
“Kids are not small adults”

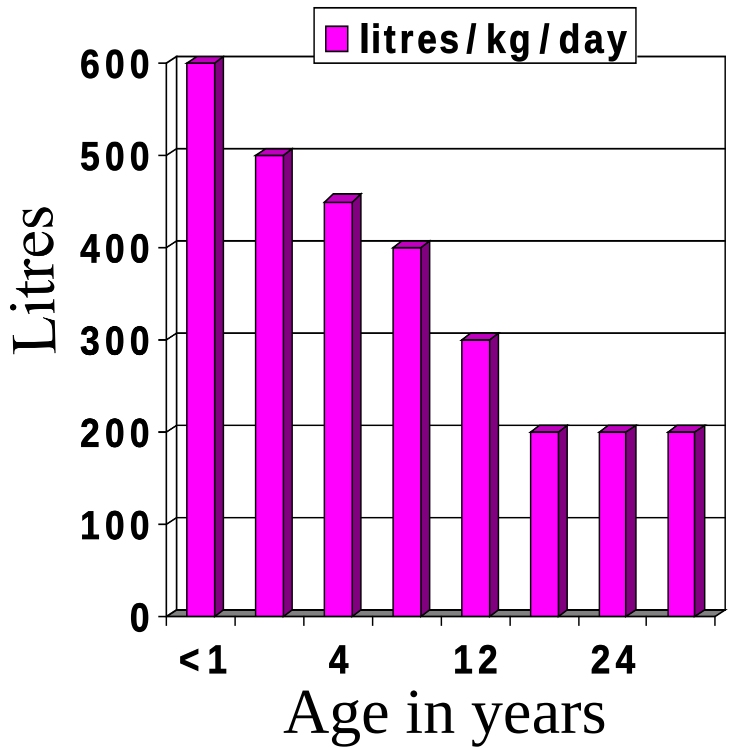
- ✓ Enhanced exposure opportunities
  - Differences in behavior and metabolism

Perturbations of developmental processes

- Form & function of organs and organ systems: birth defects, low birth weight, susceptibility to infections, learning disabilities

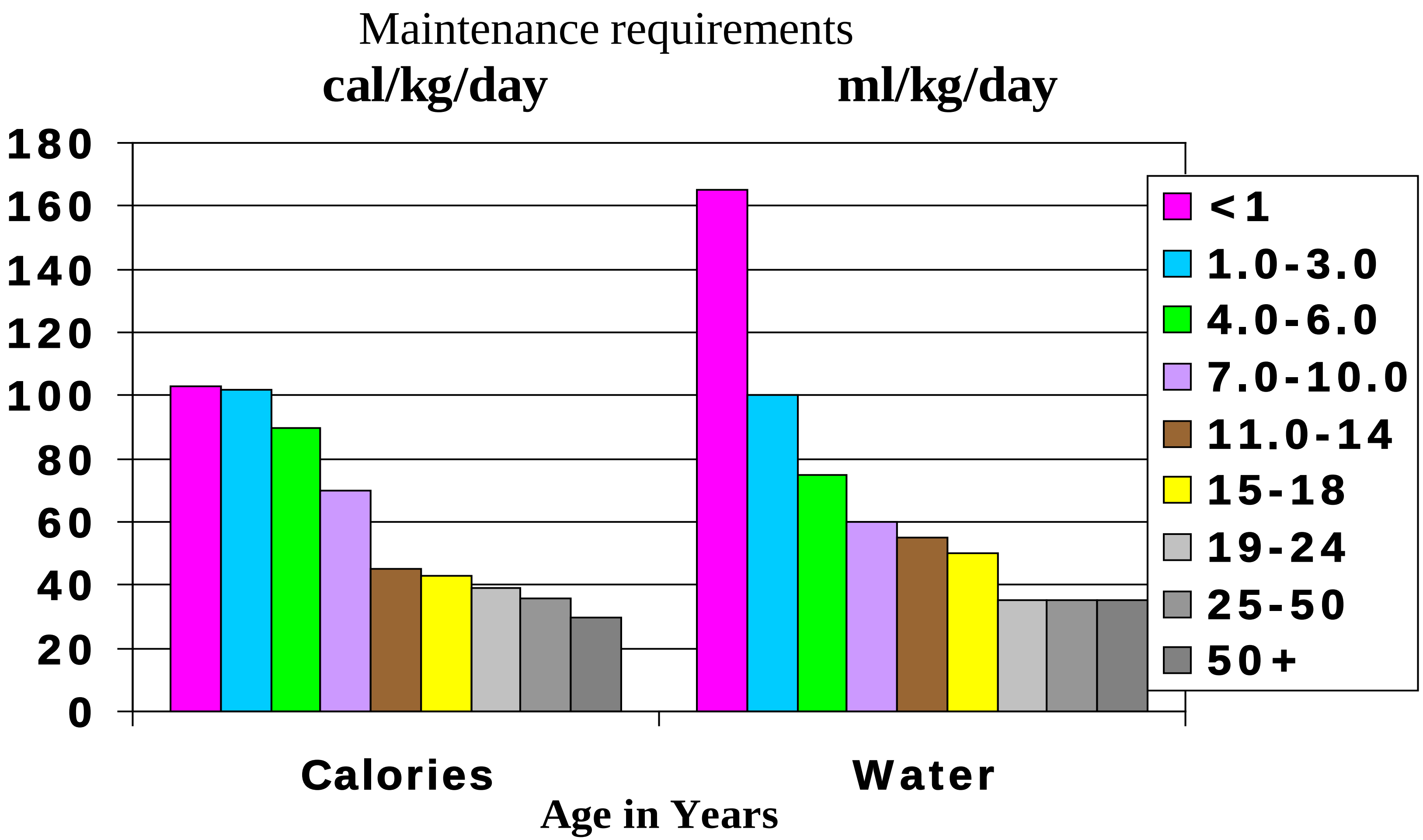
Indoor pesticide application: Kid vs. Adult





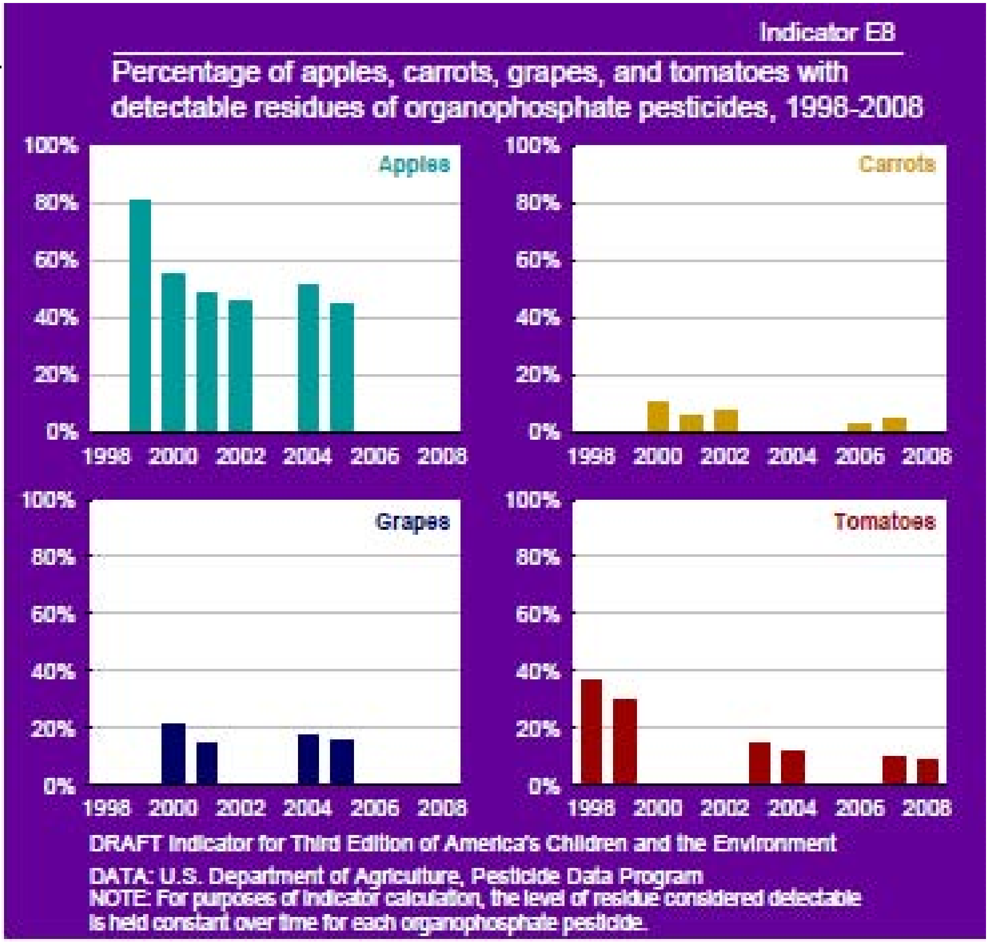
Guzelian, ILSI, 1992

Dietary intake: Kids vs. Adults



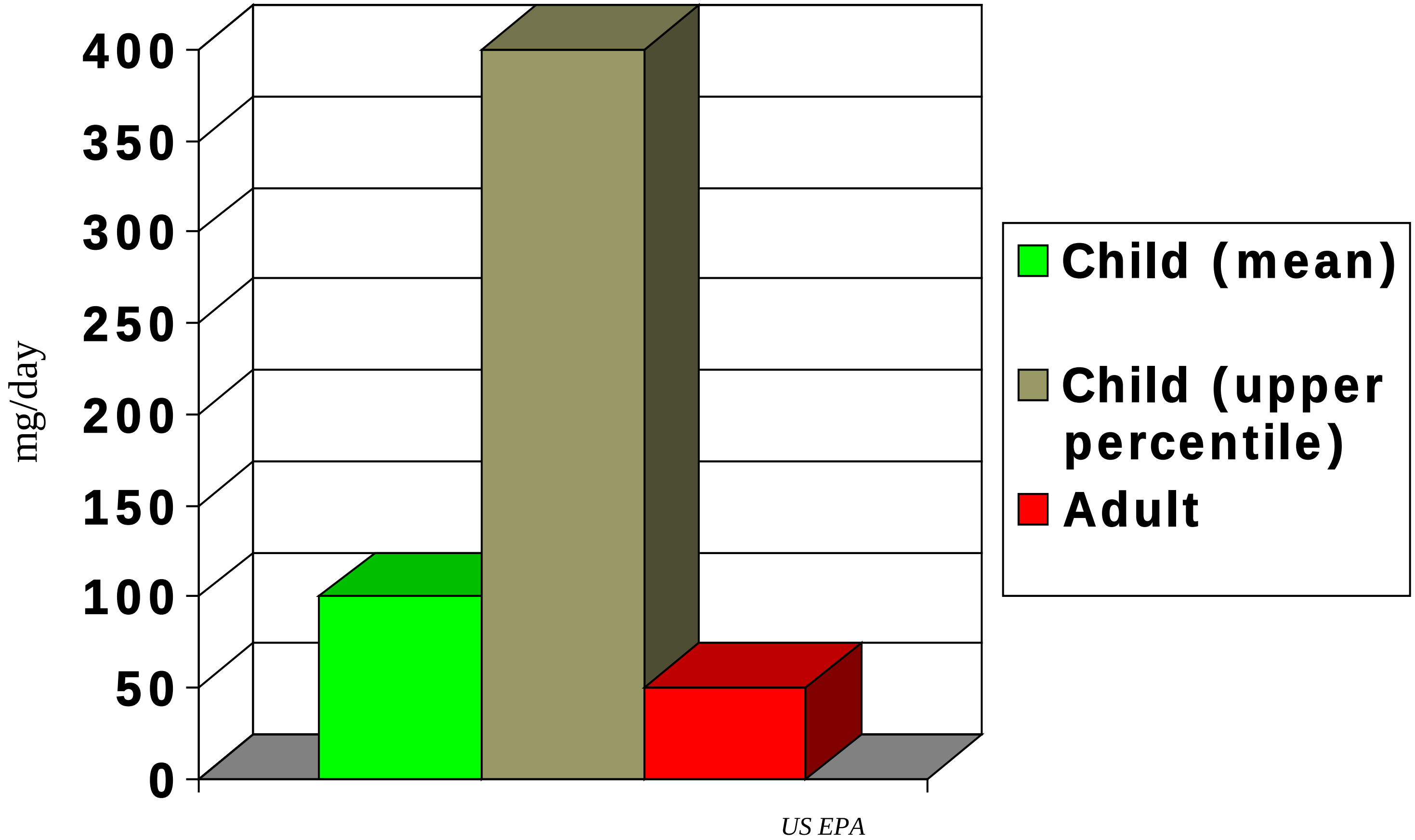
Dietary differences

Age (years)	Apple (g/kg/day)
<1	5.0
3-5	3.8
Adolescent/ Adult	0.4

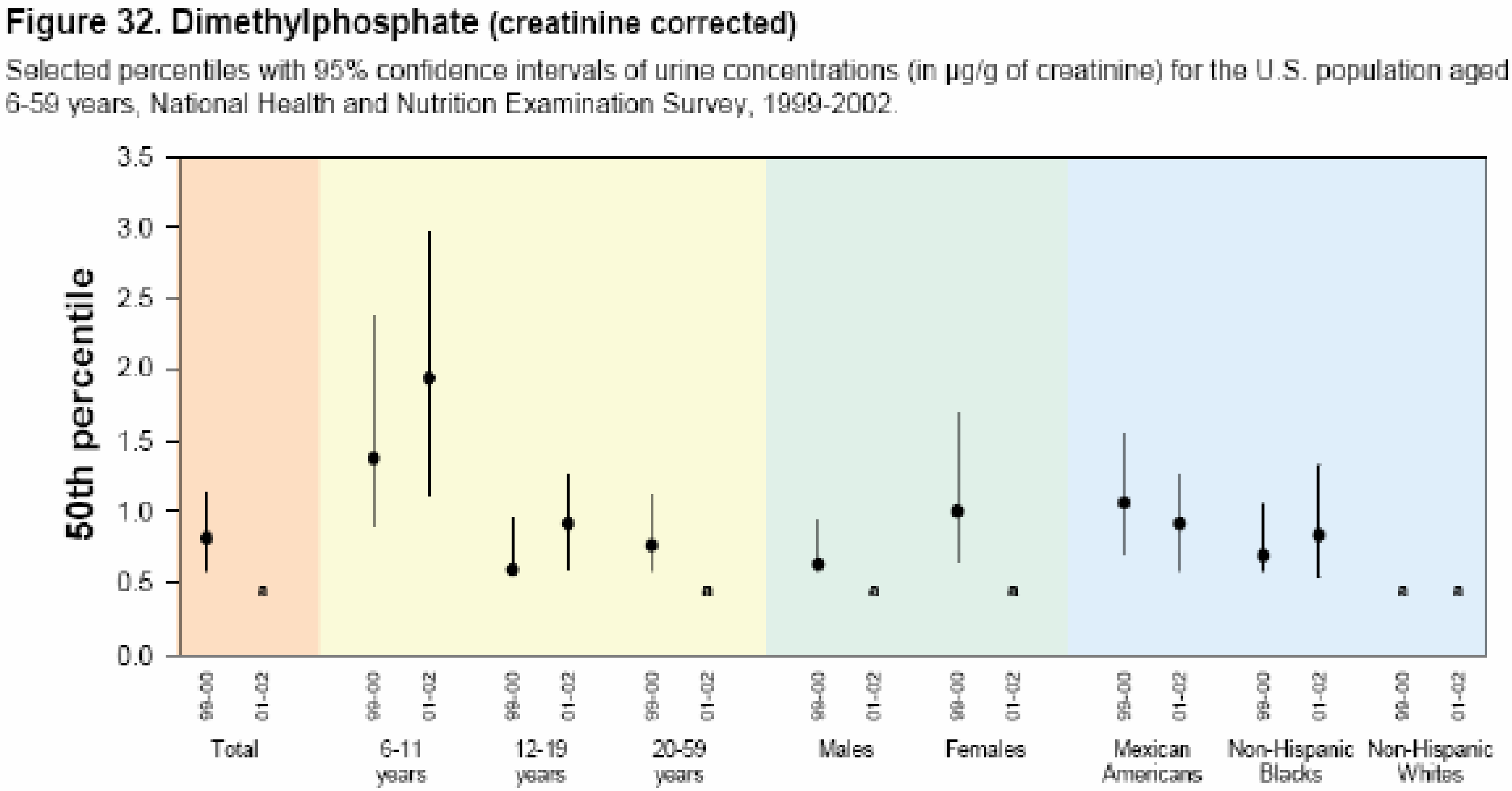


Adapted from Selevan 2000, US EPA 2011

Incidental soil ingestion: Kids Vs Adults



Body Burden of Organophosphate Metabolite



Source: Third *National Report on Human Exposure to Environmental Chemicals*, Centers for Disease Control, http://www.cdc.gov/exposurereport/.

Child vulnerability to pesticide toxicity

"Kids are not small adults"

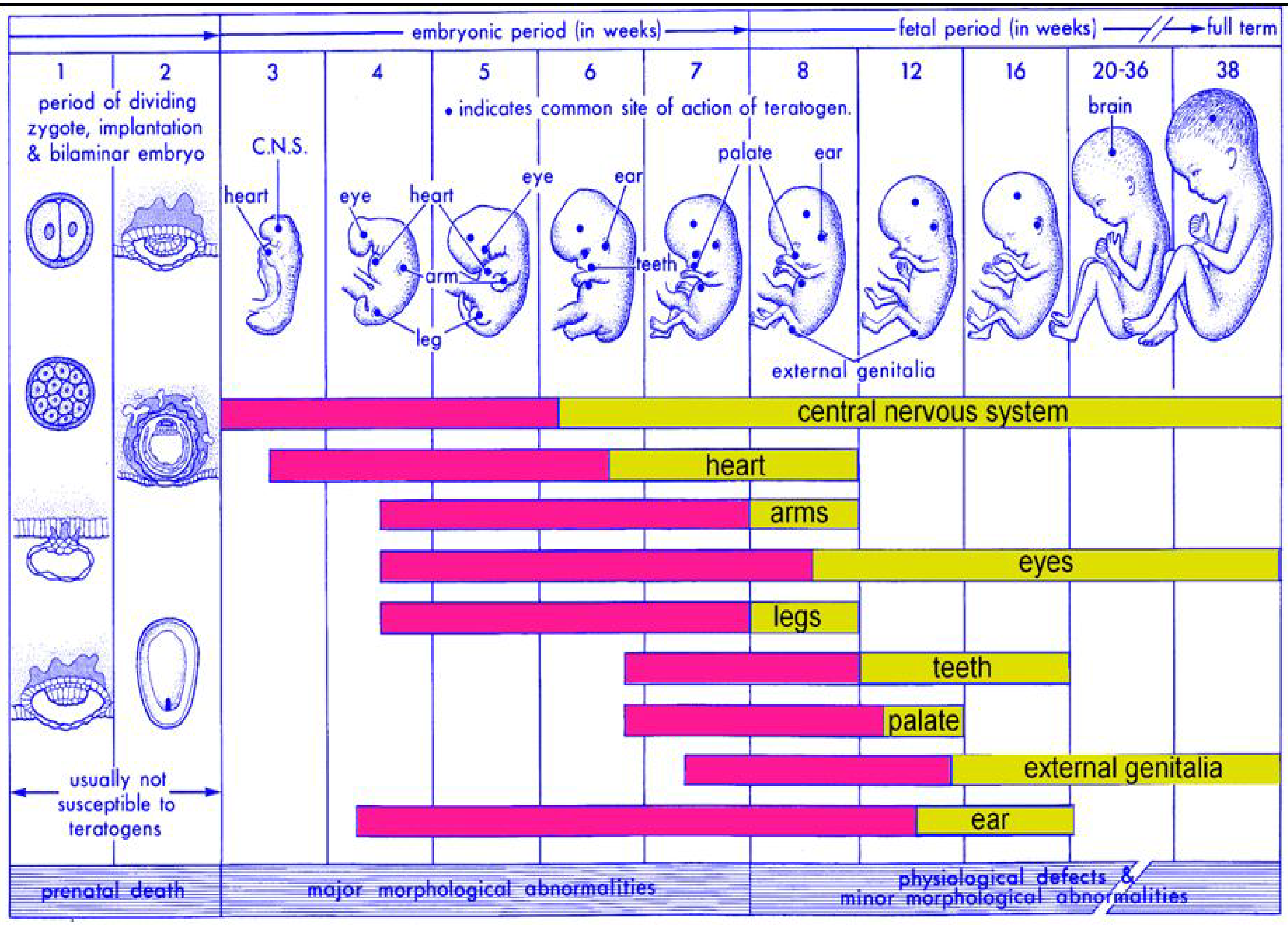
Enhanced exposure opportunities

Differences in behavior and metabolism

✓ Perturbations of developmental processes

Form & function of organs and organ systems: birth defects, low birth weight, susceptibility to infection, learning disabilities

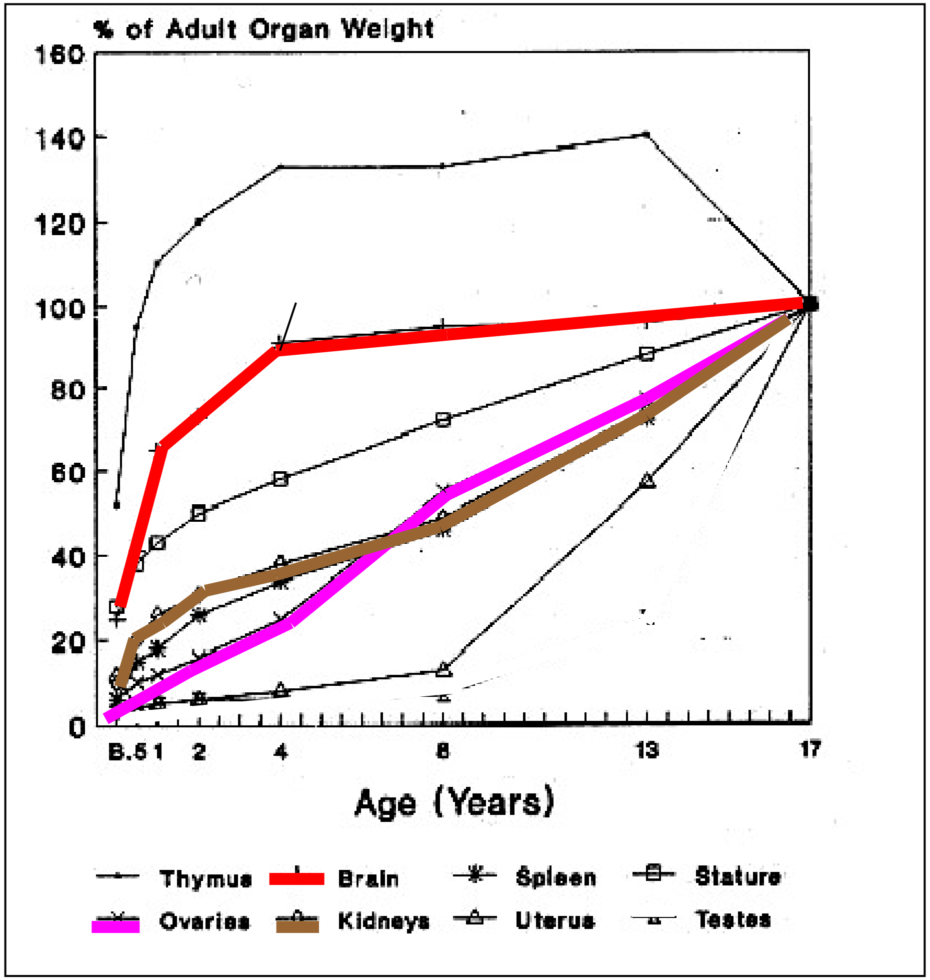
Fetal period: Major organ development



Schematic illustration of the sensitive or critical periods in human development. Red denotes highly sensitive periods; yellow indicates stages that are less sensitive to teratogens.
Moore KL. The Developing Human: Clinically Oriented Embryology. Philadelphia: W. B. Saunders Company, 1973.

Moore, Elsevier Inc, 1973

Organ and organ system development: birth to adolescence



Altman eds, FASEB, 1962

- **Vital organ growth**
  - Brain
  - Lungs
  - Kidneys
  - Reproductive organs
- **Physiological function**
  - Central nervous system
  - Immune system
  - Endocrine system

Pesticides & Child Health Impacts

- Acute Toxicity (poisoning)
  - Toxicological/Experimental data
  - Case reports
- Chronic (long lasting) effects after acute poisoning
  - Animal models
  - Observation epidemiology

Pesticides and child health impacts

Influence on disease or disability from low level, chronic exposure

Do pesticide exposures contribute to increases in the major chronic diseases of childhood?

- Asthma
- **Cancer**
- Birth outcomes (Birth defects, Low birthweight/prematurity
- **Neurodevelopment (e.g. learning disabilities, ADHD, Autism)**

Acute poisoning

Overall – acute poisoning in U.S. children is rare

Mild, reversible short term symptoms to fatalities

- Improper application*
- Drift*
- Improper storage
- Unintentional ingestion

*UW PEHSU cases

Local Case

- Family (11 & 12 yo sons) commercial residential application early in morning
  - Casoron 4G (Chemtura, 4% dichlorbenil)
  - Ronstar G (2% oxadiazon) (Bayer)

- Dust entered townhouse via open below ground window & two fresh air intakes
- Kids enter home after school, one went to basement and immediately felt dizzy and started coughing. Dust & granules noted on desk and other surfaces.
- Mom arrives after work noted strong chemical odor
- All occupants described feeling dizzy, developing sore and burning throats, cough, and a chemical taste in the mouth on arrival and continued for few days
- Moved out – symptoms resolved
- Complaint filed with WSDA
  - Investigation and environmental sampling
  - Citations issued: improper application method, lack of appropriate posting, used in manner that harmed humans
- 3 months later, 1 child recurrent hives and nasal/eye allergy symptoms

Prevention

- IPM approach?

- In this case:
  - Proper application techniques

  - Label external furnace/air intakes and prohibit application near intakes

Acute poisoning

No national surveillance/no rates available

Poison center data summaries:

Approximately 45% of all pesticide incident reports occurred in children

8th most common substance encountered in children < 5 years (43,526 = 3.4% of young child NPDS reports)

Bronstein 2008

Poison Control Center Data 2007

Pesticide	<6 Years	6–19 Years
Anticoagulant rodenticides	11,592	360
Pyrethroids	5468	1801
Insect repellents	6,738	1,625
Organophosphates	1,096	429
Borates/boric acid	3,447	131
Glyphosate	1,133	321
Carbamates	1,062	235
Naphthalene	1,042	106

Bronstein 2008

Poison Center data

- Rates of reported pesticide poisonings described as moderate/ major / and fatal have declined from 1995-2004 by approximately 42%.

- Sharpest declines in poisonings were from organophosphate and carbamate insecticides (reflective of policy change)

Blondell 2008

Chronic Health Implications

Most focus in recent years, most robust evidence:

- ✓ **neurodevelopmental effects**
- ✓ **childhood cancer**

Fewer informative data but concern for:

birth outcomes including growth and gestational deficits

birth defects, **immunological function effects**, respiratory disease including **asthma,** and **endocrine/reproductive effects**

Neurodevelopment & Pesticides

- Organochlorines, organophosphates – accumulating and consistent support for adverse impacts

  Biological plausibility and toxicological mechanisms

  Multiple epidemiological studies

- Functional deficits (mental, motor) -- symptoms and behaviors (inattention, hyperactivity, autism-related) -- diagnosed conditions (ADHD)

Rosas 2008

OP Pesticides and ADHD

- Cross section study using U.S. NHANES – Are children with higher concentrations of OP metabolites in urine more likely to meet diagnosis of ADHD based on structured interview?
- Kids with 10 x's higher metabolites – (1 ½ - double likelihood of ADHD diagnosis))
- Strengths – Large sample size, valid case definition, biomarker of exposure, representative sample of US kids 8-15 y, some covariates (ses, lead, prem/lbw)
- Limitations – Cross-sectional, potential confounders not addressed (parental neurobehavioral status, stress, etc)

Bouchard 2010

Pediatric cancer and pesticides

- Some pesticides have undergone cancer classification by EPA

  Malathion (possible), Dichlorvos (probable), permethrin (likely human)

- Substantial observational epidemiological data demonstrating a link between pesticide exposure and childhood cancers

- Challenges/limitations: Exposure assessment is generally crude, recall bias, specificity of cancer type

Pediatric leukemia and pesticides

- Most consistently associated tumor type = Acute Lymphocytic Leukemia (ALL)
- Associations with household insecticide use (lawn/garden herbicides, insecticides)
- Maternal pre-conceptional and prenatal exposures

Infante-Rivard 2007

Pediatric brain tumors and pesticides

- 2^{nd} most commonly associated cancer - Brain tumors
- Prenatal exposure to insecticides, particularly in the household, as well as both maternal and paternal occupational exposure before conception though birth

Schuz 2001, Wijngaarden 2003, Cordier 2001, Flower 2004, McKinney 2003, Feychting 2001, Heacock 2000, Rodvall 2003, and Schreinemarchers 2000

Fetal growth/pre-term birth

- Several studies associate maternal DDT/DDE preterm birth, IUGR, LBW

- OPs - NYC follow up cohorts

- Ecological studies link triazine herbicide exposure and fetal growth

Longnecker 2001, Ribas-Fito 2002, Weisskopf MG 2005, Wolff 2007, Siddiqui 2003, Villanueva 2005

Birth defects and pesticides

- Available studies are heterogeneous in design, conflicting in results, and they often have an insufficient exposure assessment/ecological designs. Recognizing these limitations they do suggest role of:

- ✓ paternal or maternal *occupational* exposures
- ✓ OC and OP insecticides, phenoxy and triazine herbicides
- ✓ cryptorchidism, orofacial clefts, limb reduction defects, and heart defects

Bottom line, a small risk is noted but the findings are not robust and data specific to pesticide subtypes are not adequate

Bell 2001, Arbuckle 1999, Weselek 2007, Nurminen 1995, Garry 1996/2002, Romitti 2007

Asthma & pesticides: emerging hypothesis

- – Iowa rural kids - any pesticide use indoors or any outdoor use in the previous year $\neq$ asthma symptoms and prevalence (Merchant 2005)

- + California Children's Health Study (So.CA) – herbicides and pesticides/insecticides strong association with asthma diagnosis before age 5 years (5 x's more likely, 2.4 times more likely, respectively) (Salam 2004)

Pesticide Child Health Studies: Key Points Summary

- Most evidence for adverse effects associated with insecticides (organochlorines/organophosphates)

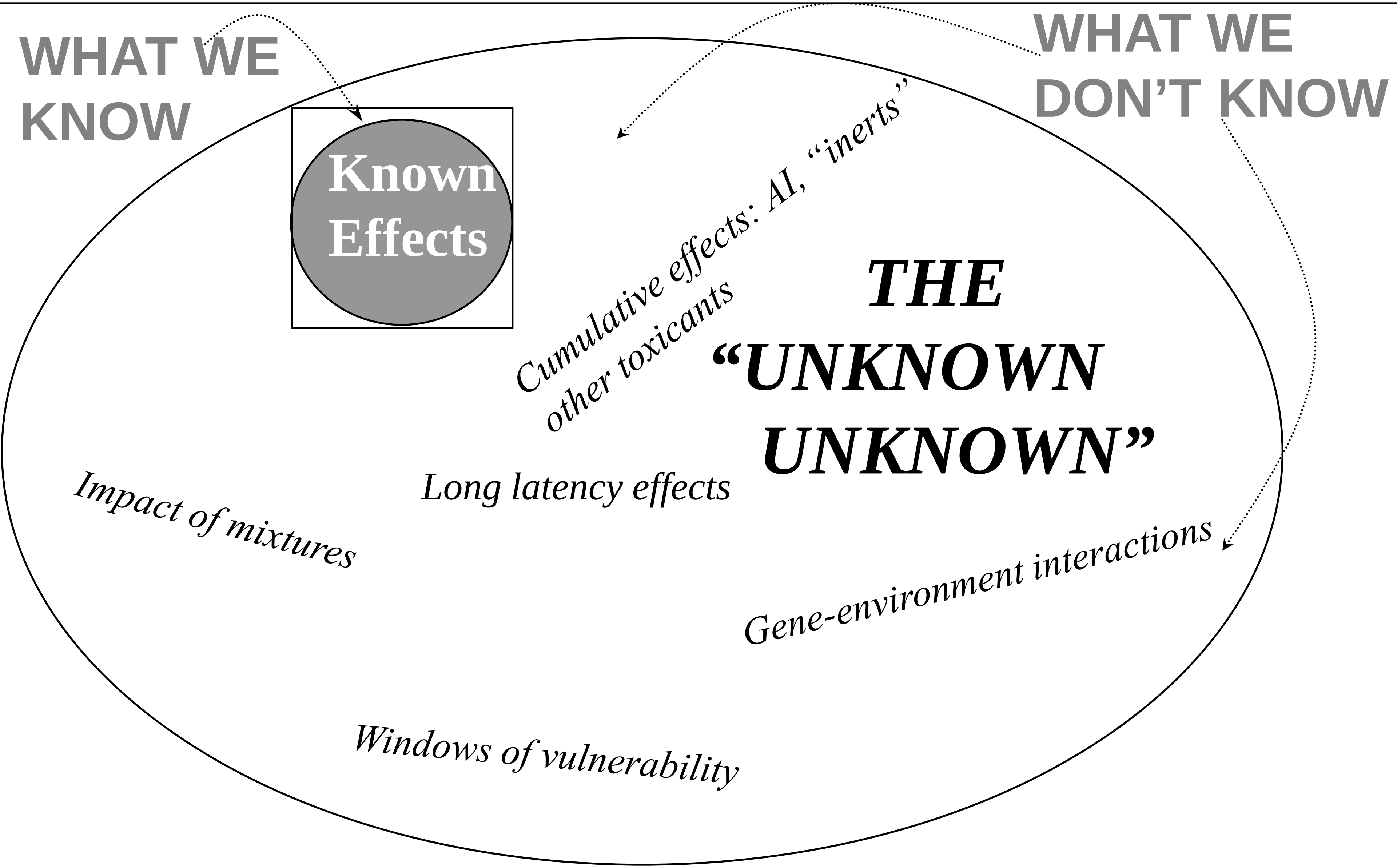
  Or simply & often non-specific “pesticide exposure”

- Animal models + well designed human studies demonstrate OP exposures that are being experienced by U.S. children/pregnant women may have adverse neurodevelopmental consequences

- Prenatal and very early life exposure are of high concern

- Animal and human investigations of other chronic health endpoints raise concern but are less robust and better characterization is needed (cancer, birth outcomes, asthma, endocrine disruption)

Evidence base: the big picture



Reducing exposure and impact

Use pesticides ONLY when the benefits outweigh the risks

- Avoid cosmetic or scheduled use of pesticides in/around the home
- Use integrated pest management (IPM), non-chemical pest controls

If pesticides are used:

- Store in original containers with child-proof seals, out of reach, in a locked cabinet
- Know safe use guidelines
  - Label, PPE, re-entry,
- Use least hazardous chemicals, least dangerous mode of application

Thank you

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