Biomonitoring: A public health and public interest perspective

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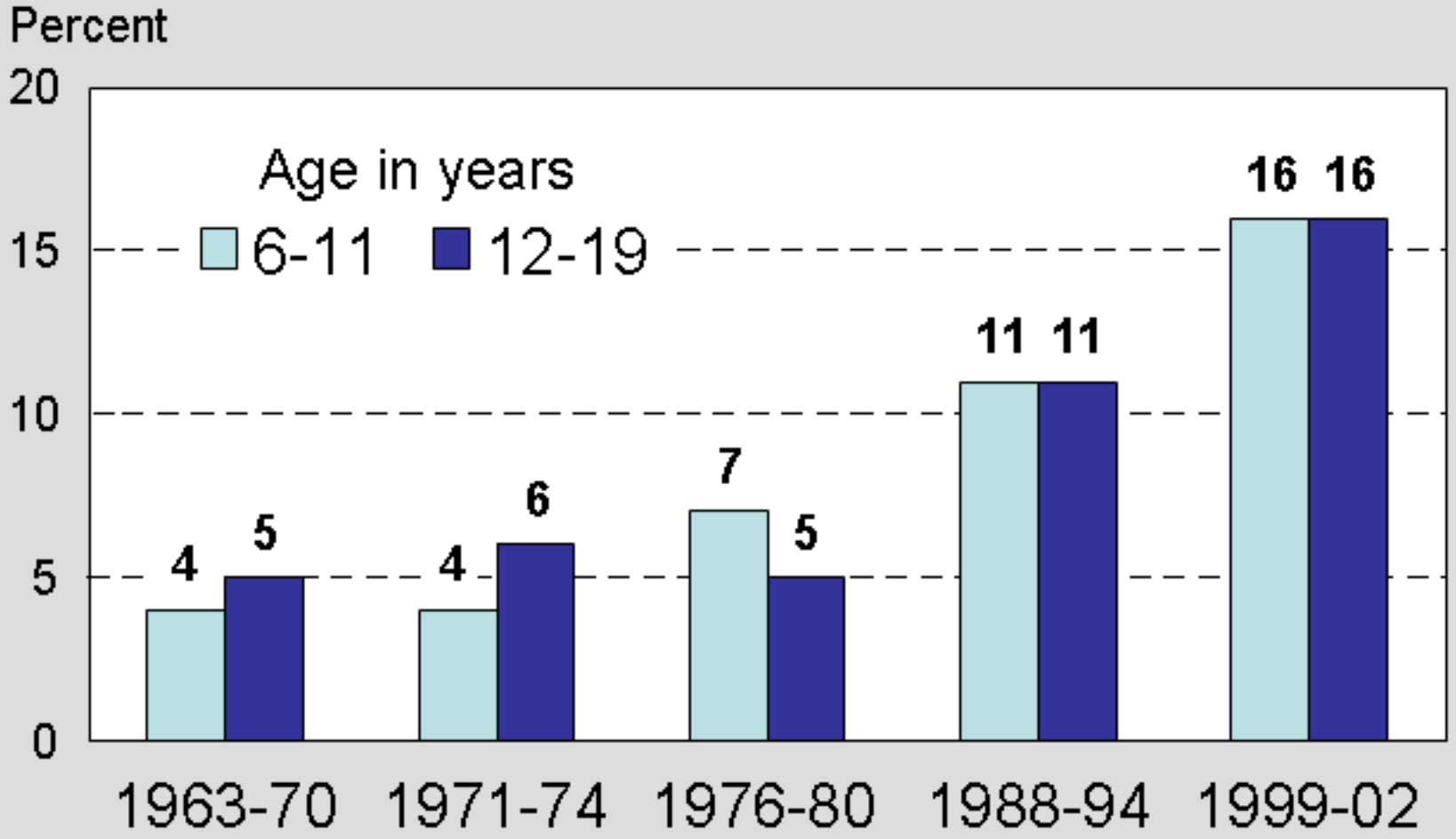
ENVIRONMENTAL DEFENSE

finding the ways that work

Why do we need to do more extensive biomonitoring?

- Hazard testing of most chemicals is grossly inadequate
- Exposure modeling is faulty at best
- "Ground truth" is essential for prioritization of resources
- Temporal trends of epidemics suggest environmental causes

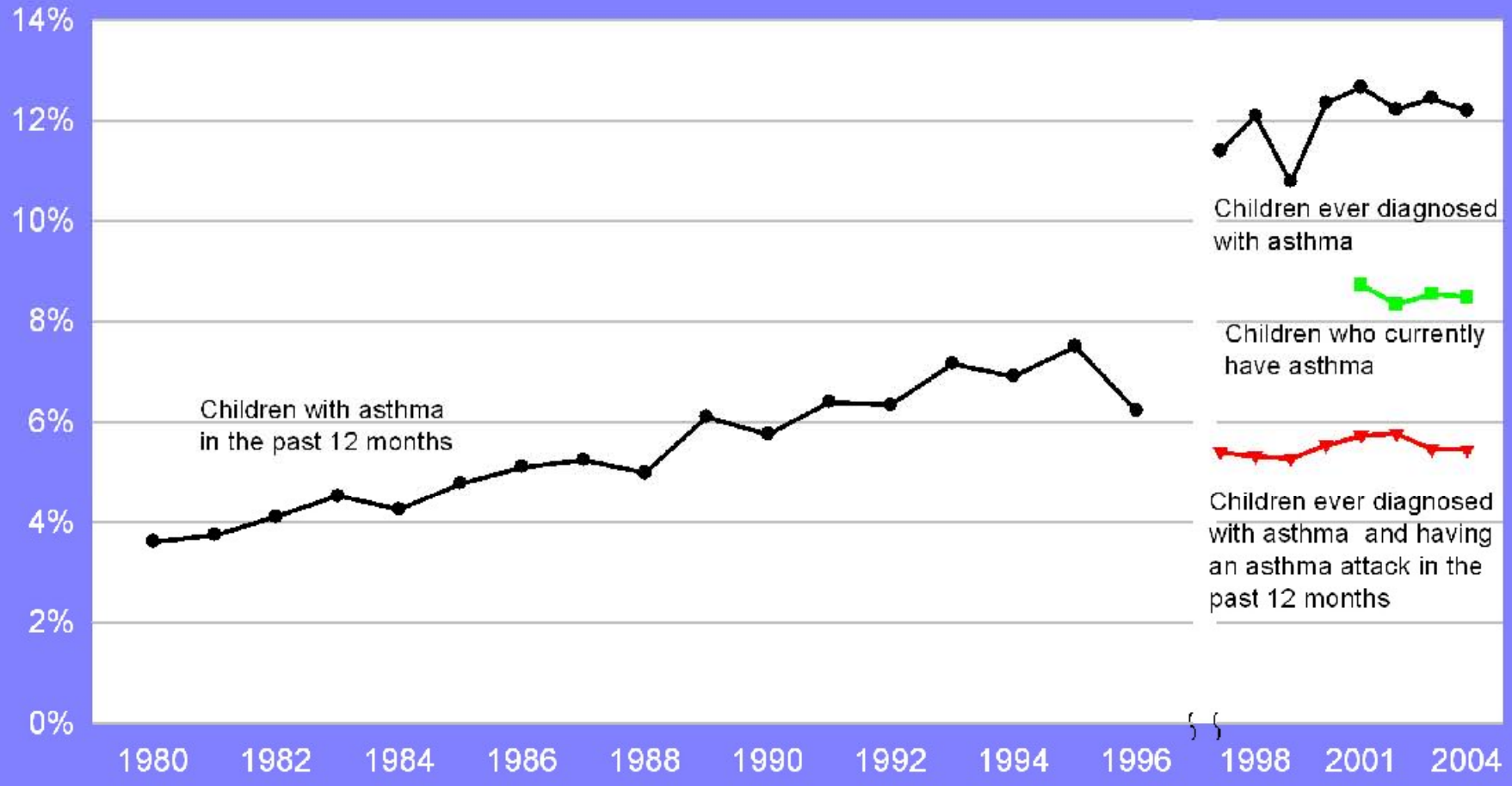
Figure 1. Prevalence of overweight among children and adolescents ages 6-19 years



NOTE: Excludes pregnant women starting with 1971-74. Pregnancy status not available for 1963-65 and 1966-70. Data for 1963-65 are for children 6-11 years of age; data for 1966-70 are for adolescents 12-17 years of age, not 12-19 years.
SOURCE: CDC/NCHS, NHES and NHANES

Measure D1

Percentage of children with asthma



SOURCE: U.S. EPA. America's Children and the Environment. www.epa.gov/envirohealth/children

DATA: Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey

Note: The survey questions for asthma changed in 1997; data before 1997 cannot be directly compared to data in 1997 and later.

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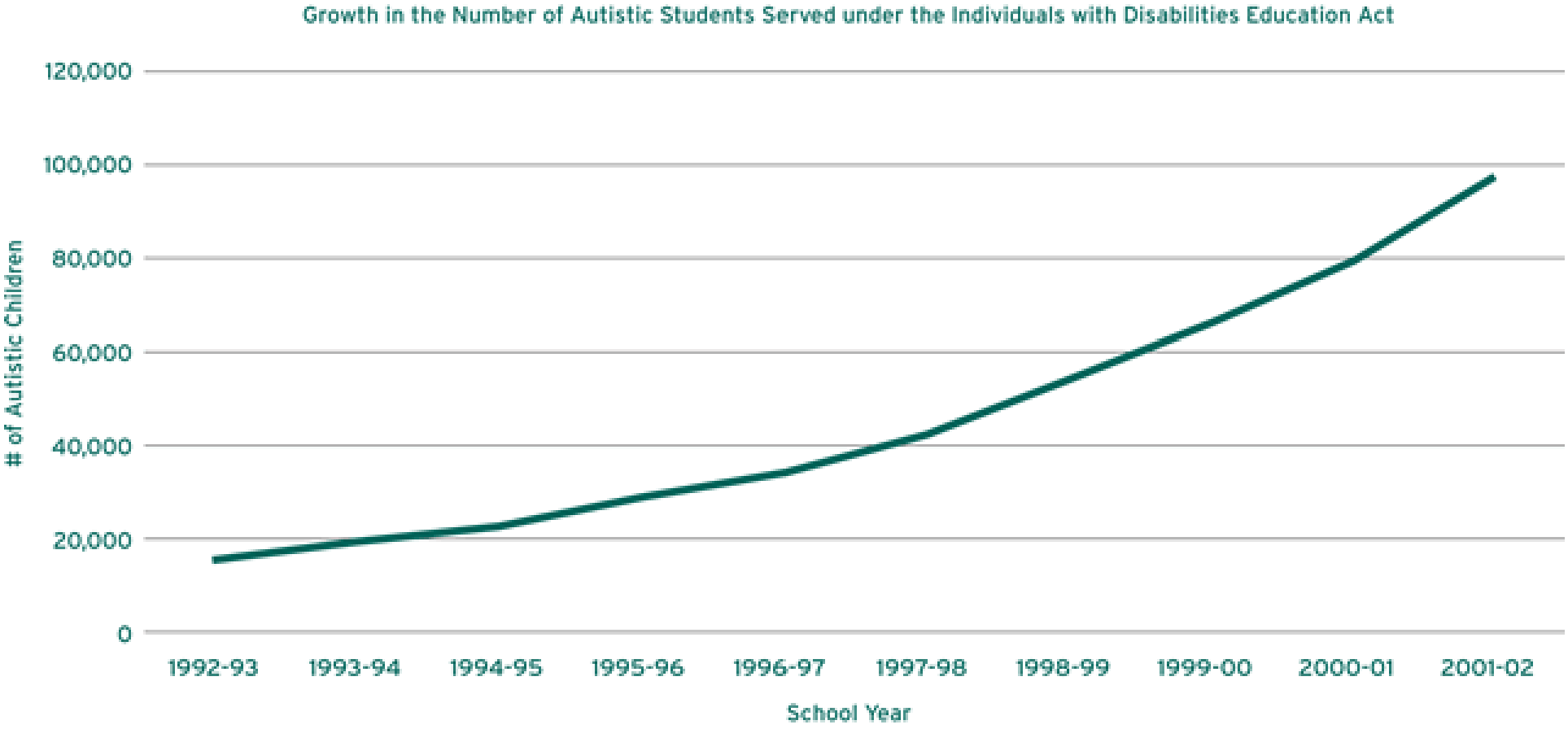
Autism on the Rise (Figure 1)

Over the last decade, the number of students diagnosed with autism in America's schools has increased more than fivefold.



SOURCE: U.S. Department of Education

The smoking tailpipe…

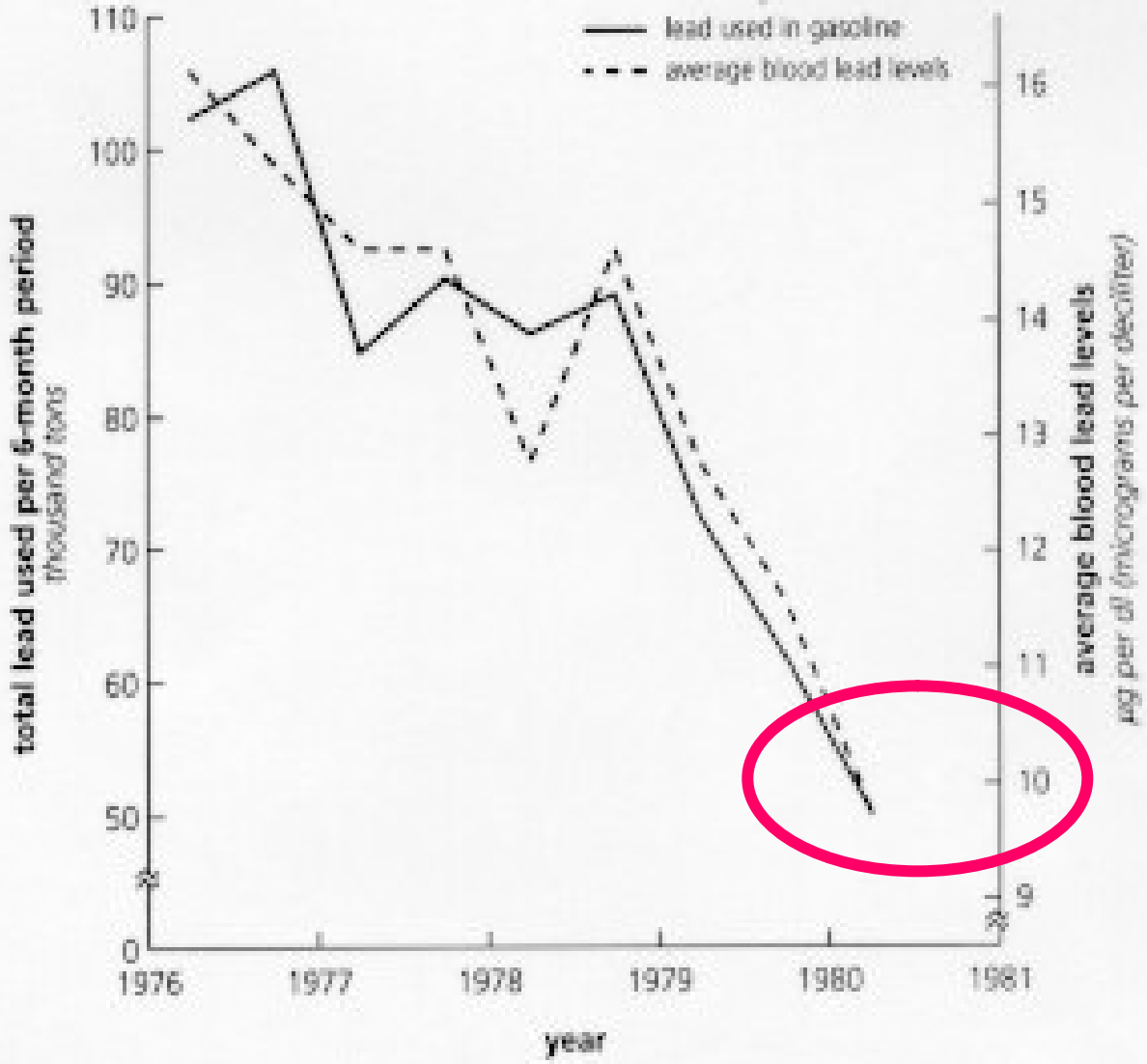
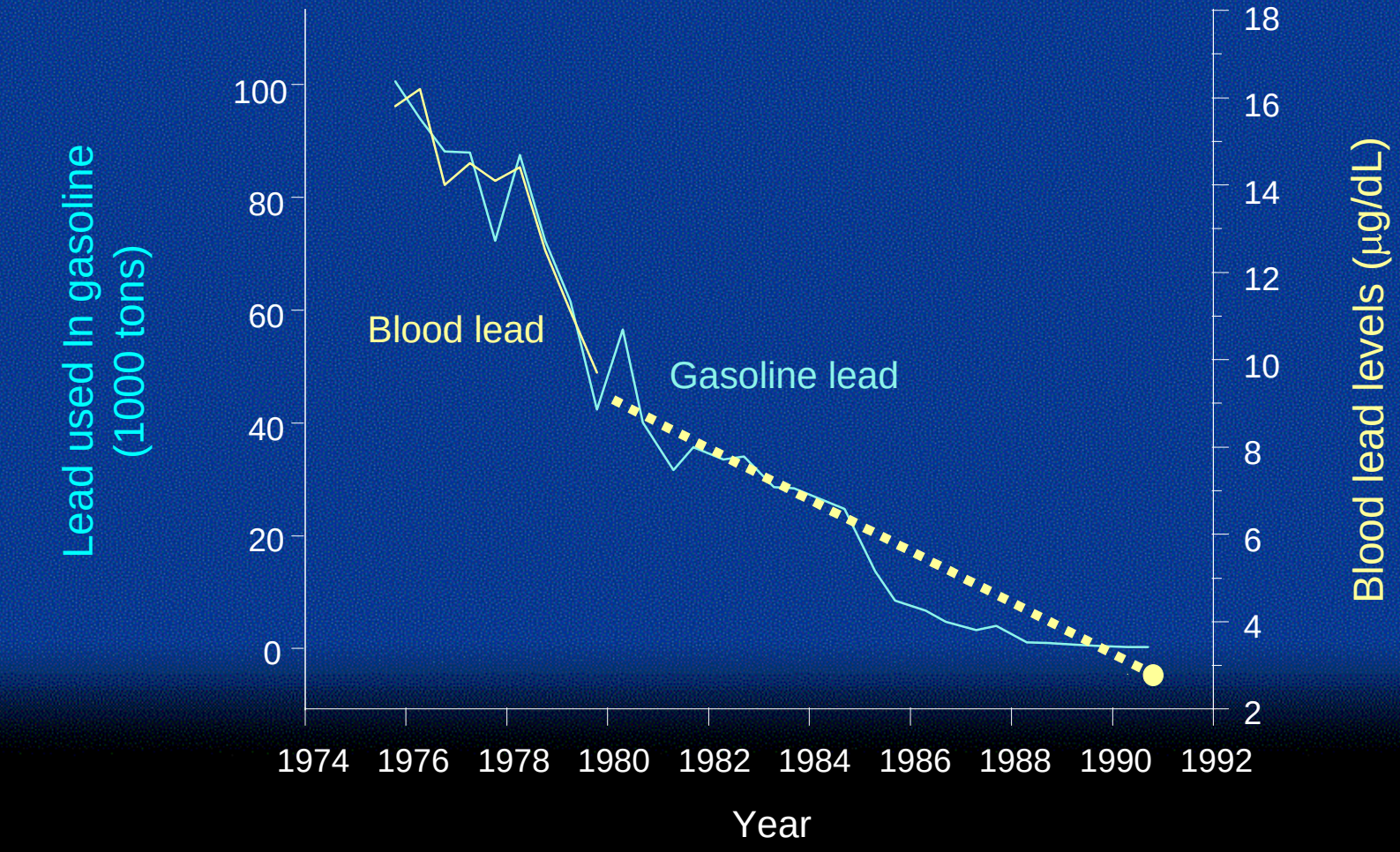


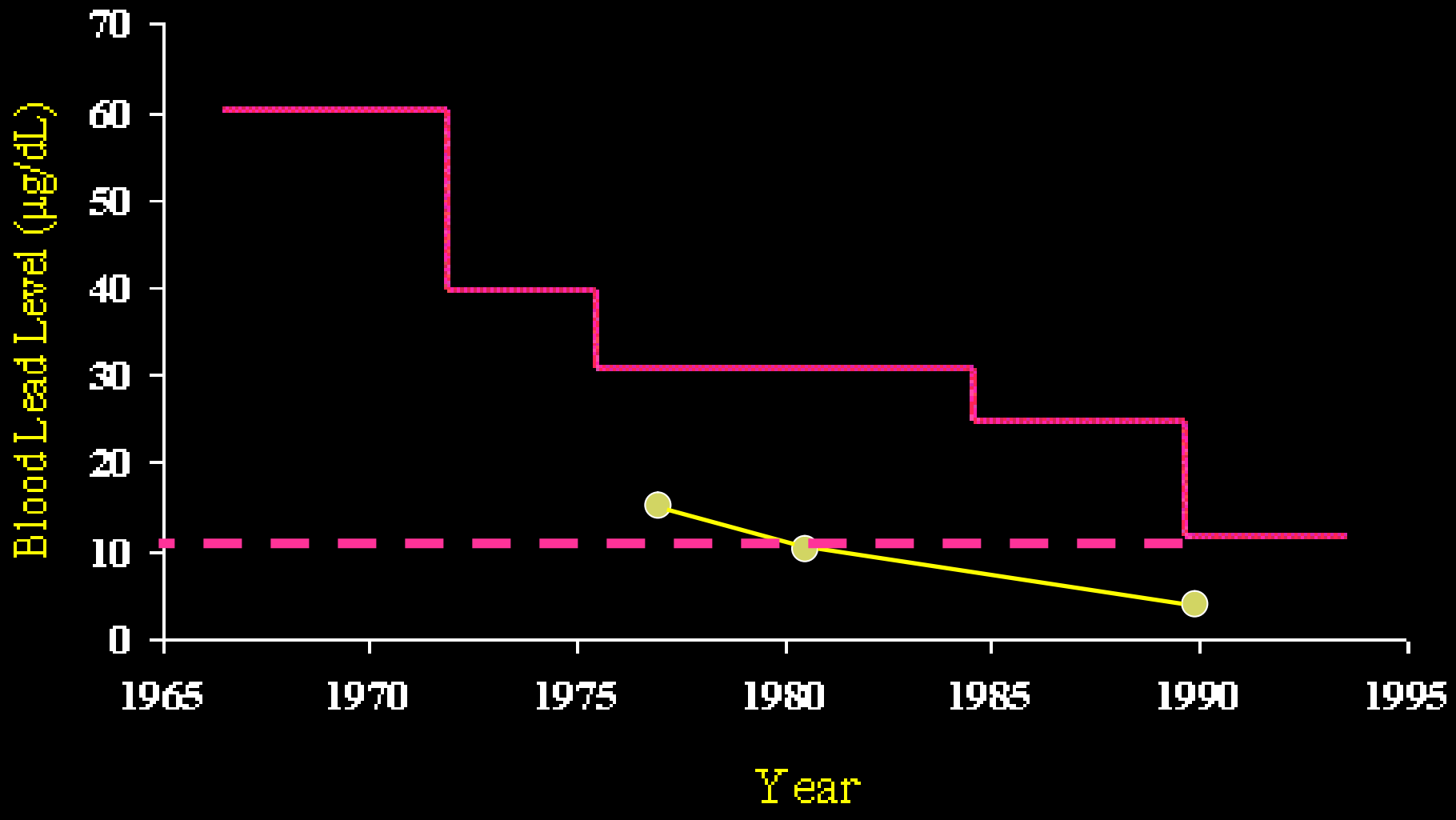
Figure 2: Decreases in blood lead values and amounts of lead used in gasoline during 1976–80. Source: ATSDR, 1988.

NHANES III (1988-1994) Showed Blood Lead Levels Continued to Decrease as Gasoline Levels Declined



Blood Lead Level of Concern

Historic Perspective



http:www.chicagolead.org/EducationalTools/LevelOfConcern.gif

Lessons from Lead

- Surprise ubiquity
- Clear hazard at high dose
- Data allowed study of low dose effects
- Biomonitoring provided the "smoking gun"

The "Kehoe" Paradigm

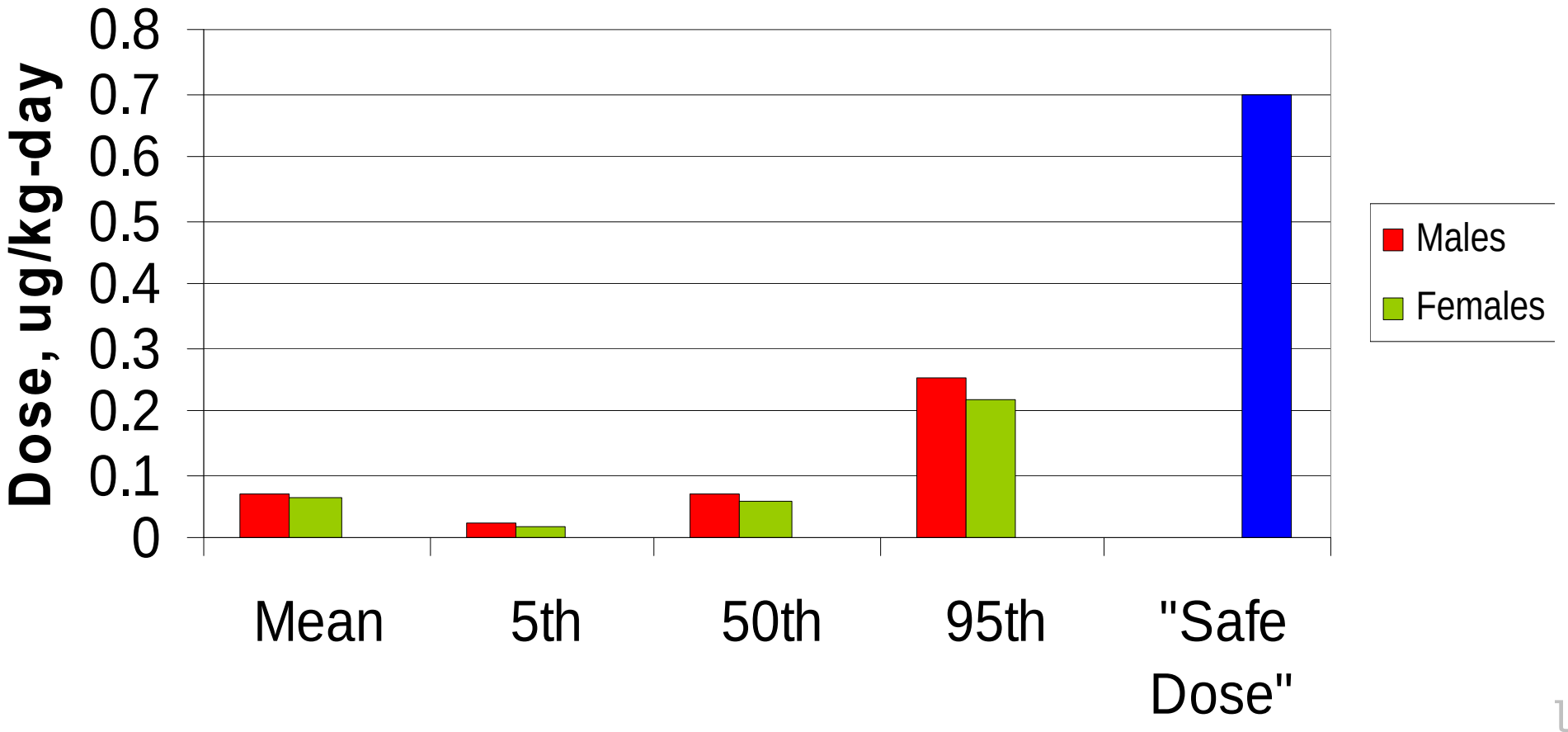
"If it is shown . . . that an actual danger to the public is had as a result of treatment of gasoline with lead, the distribution of gasoline with lead in it will be discontinued"

Robert Kehoe, M D (1925)

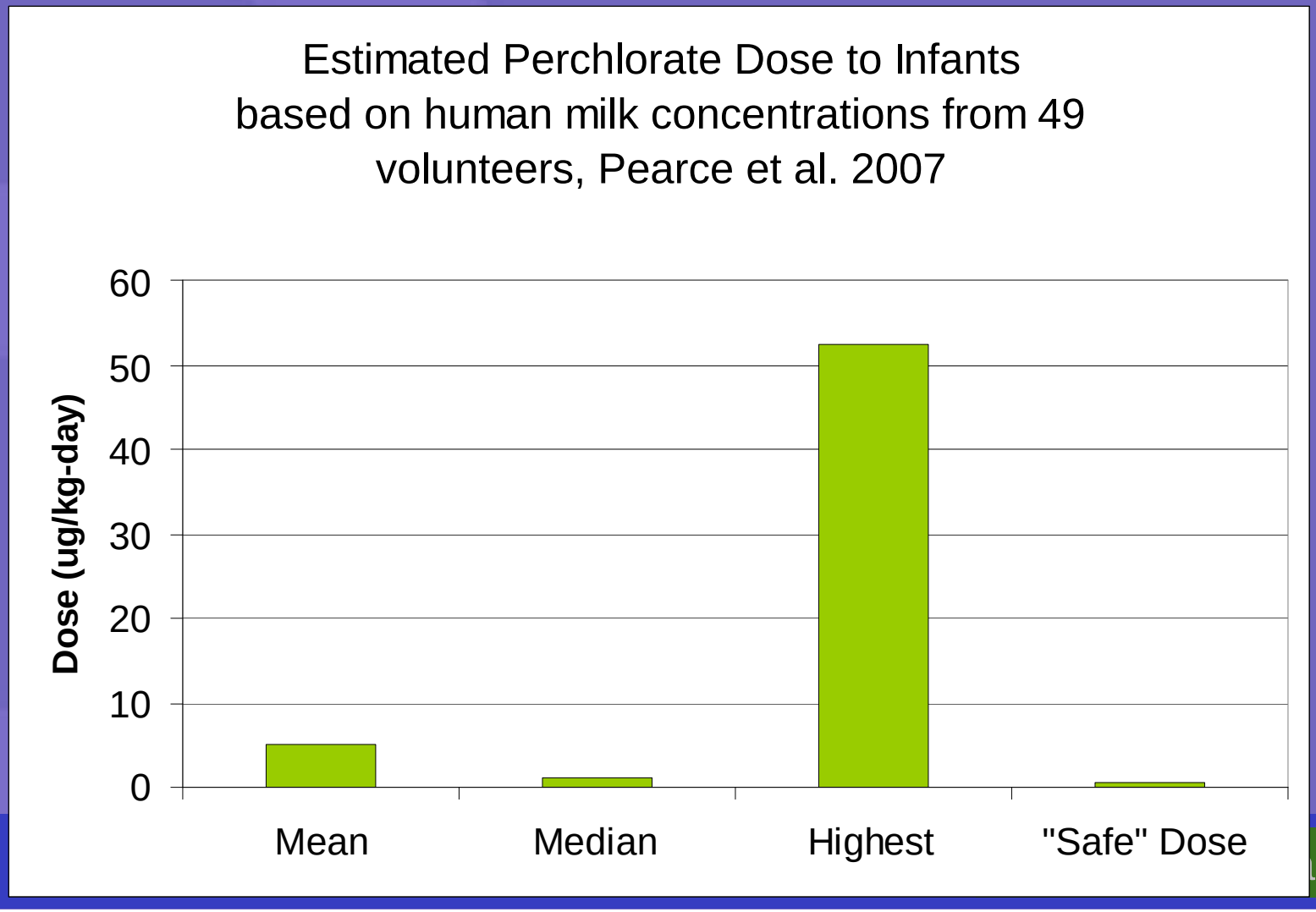
Estimated Perchlorate Exposure based on Urine Concentrations

n=1532 Individuals,

Blount et al. 2007b

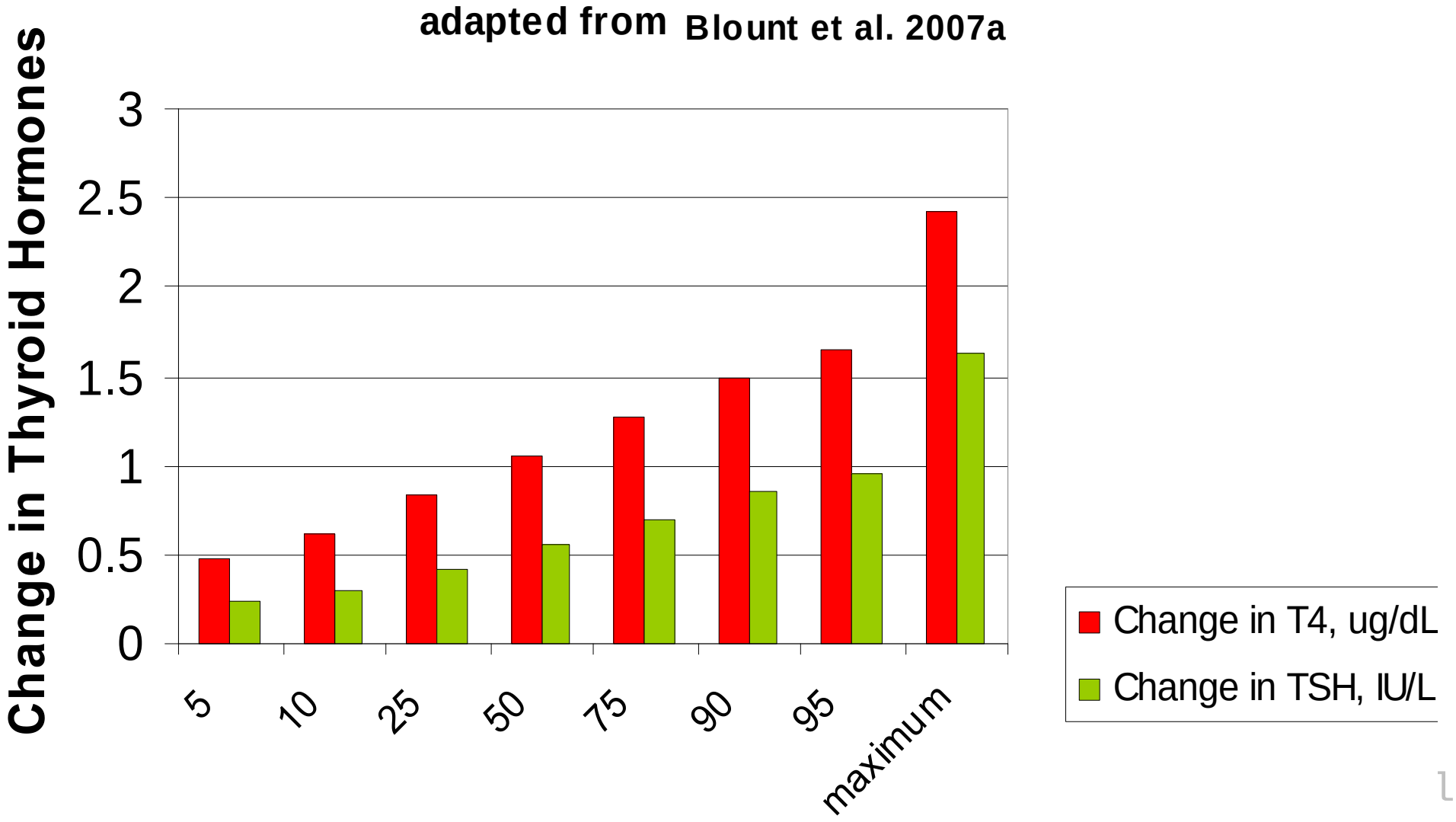


Infants in Boston Exposed to Perchlorate above "Safe" Levels



Perchlorate affects thyroid function in women with low iodine intake well below "safe dose"

adapted from Blount et al. 2007a



The smoking armchair?

Environmental Health

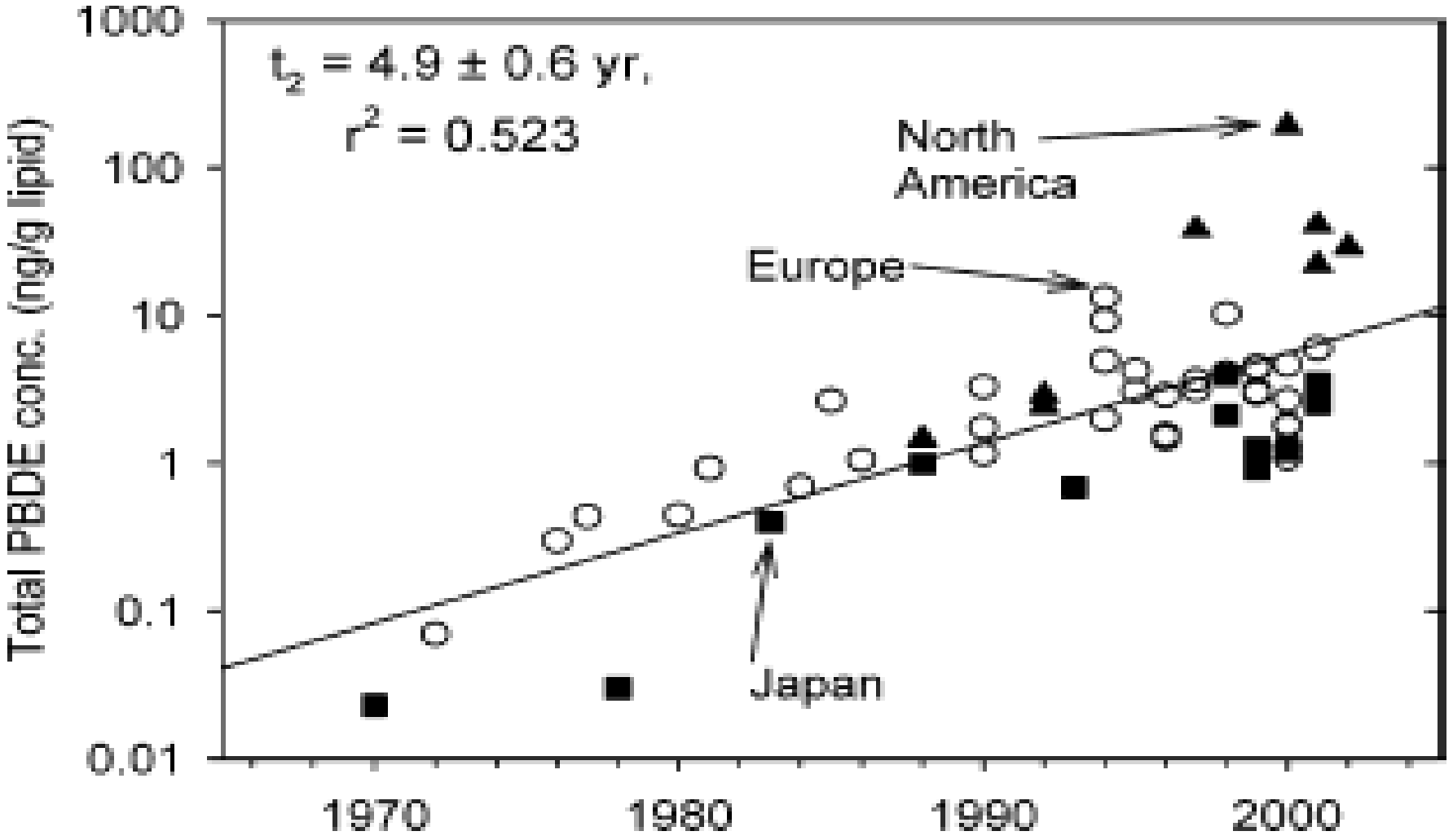


FIGURE 1. Total PBDE concentrations (ΣPBDE) in human blood, milk, and tissue (in ng/g lipid) shown as a function of the year in which the samples were taken; see Table 2. The three symbol types indicate the location from which the samples were collected. The overall regression is shown.

Dietary Sources of PBDEs Contribute to Body Burden

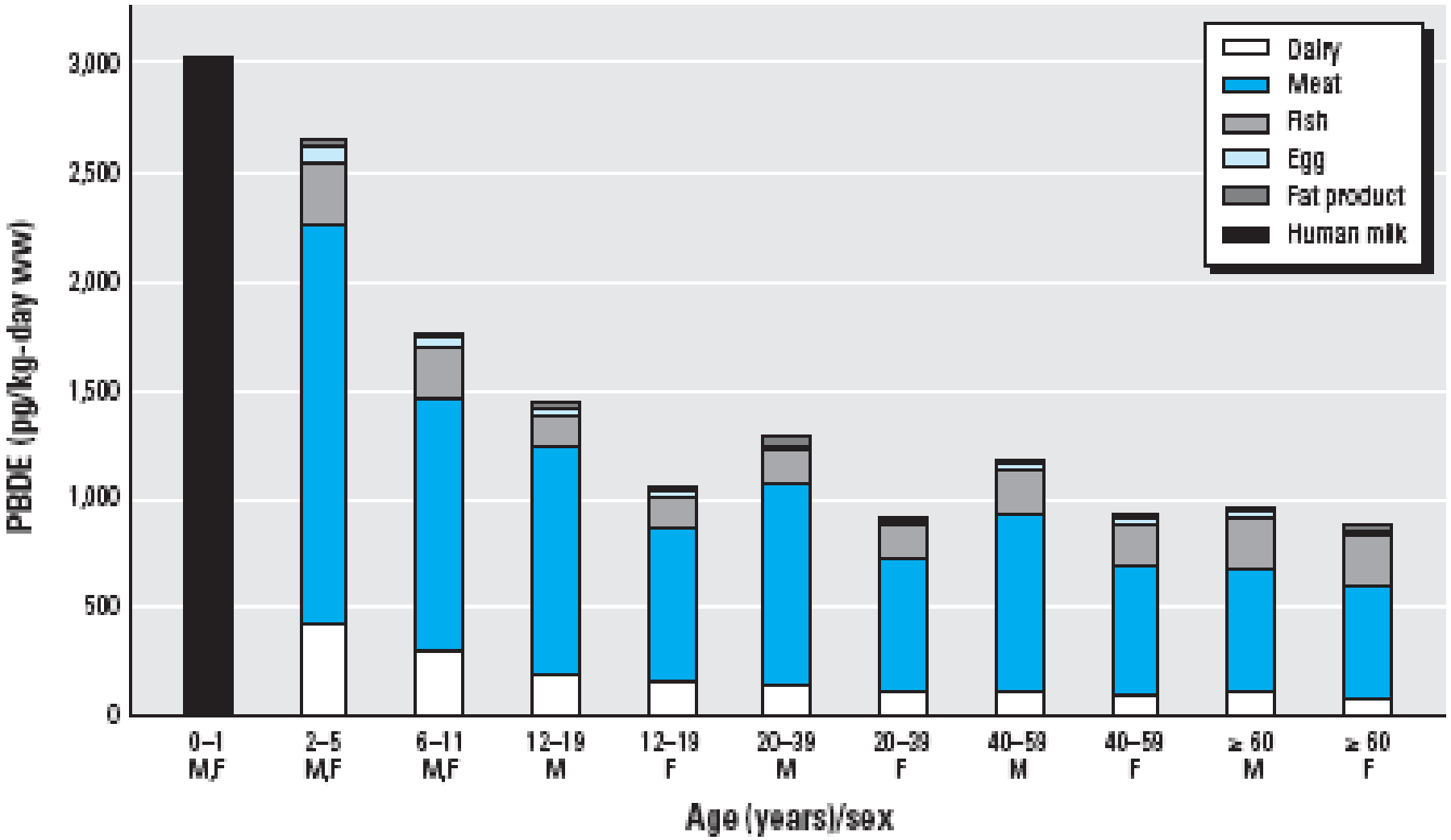


Figure 1. Daily PBDE dietary intake of U.S. population by age and food group (pg/kg body weight) as shown in Table 5. Abbreviations: F, female; M, male.

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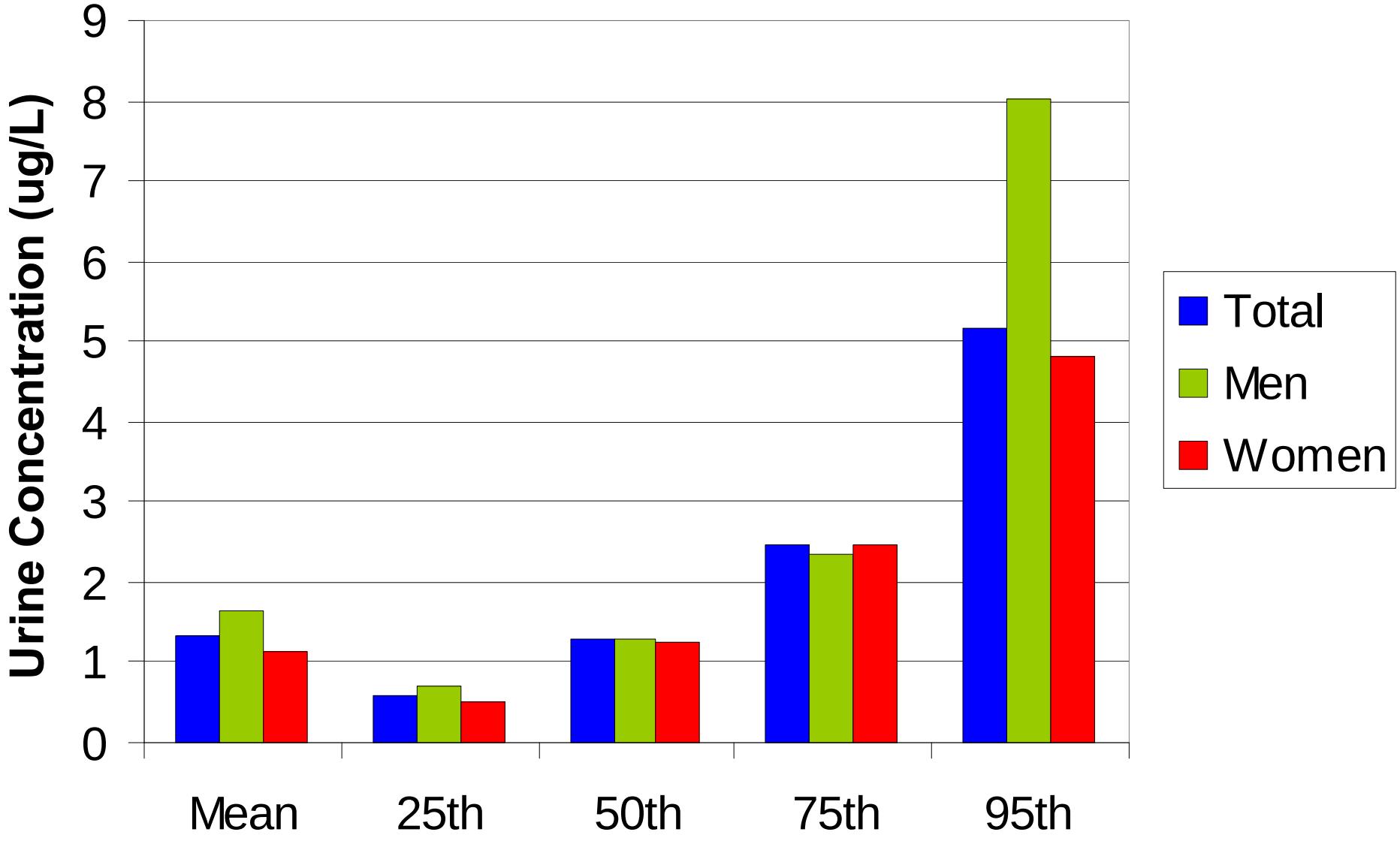
The Smoking Water Bottle?

Environmental Health

Bisphenol A Exposure

Adapted from Calafat et al. 2005



The Estrogenic Effect of Bisphenol A Disrupts Pancreatic β-Cell Function *In Vivo* and Induces Insulin Resistance

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The function of the pancreatic β-cell is the storage and release of insulin, the main hormone involved in blood glucose homeostasis. The results in this article show that the widespread environmental contaminant bisphenol-A (BPA) imitates 17β-estradiol (E_2) effects *in vivo* on blood glucose homeostasis through genomic and nongenomic pathways. The exposure of adult mice to a single low dose (10 μg/kg) of either E_2 or BPA induces a rapid decrease in glycemia that correlates with a rise of plasma insulin. Longer exposures to E_2 and BPA induce an increase in pancreatic β-cell insulin content in an estrogen-receptor–dependent manner. This effect is visible after 2 days of treatment and starting at doses as low as 10 μg/kg/day. After 4 days of treatment with either E_2 or BPA, these mice developed chronic hyperinsulinemia, and their glucose and insulin tolerance tests were altered. These experiments unveil the link between environmental estrogens and insulin resistance. Therefore, either abnormal levels of endogenous estrogens or environmental estrogen exposure enhances the risk of developing type 2 diabetes mellitus, hypertension, and dyslipidemia. *Key words:* bisphenol A, diabetes, endocrine disruptors, estradiol, estrogen receptor, insulin, islet of Langerhans, nongenomic, xenoestrogens. *Environ Health Perspect* 114:106–112 (2006). doi:10.1289/ehp.8451 available via *http://dx.doi.org/* [Online 20 September 2005]

et al. 2002). Recently, a similar receptor has been found in *Drosophila* (Srivastava et al. 2005). E_2 rapidly potentiates β-cell signaling systems and insulin release via this ncmER, an effect that is mimicked by EDCs, including bisphenol A (BPA) (Nadal et al. 2004). BPA is one of the most common chemicals that behaves as an endocrine disruptor. It was the first synthetic estrogen without a steroid structure (Dodds and Lawson 1936), but because of its properties as a cross-linking chemical, BPA was widely chosen by the chemical industry to produce plastic polymers, mainly polycarbonates. Nowadays, it is used in the manufacture of barrier coatings for the inner surfaces of food and beverage cans. High concentrations of BPA have been detected in food and water extracted from autoclaved cans

Is bisphenol A the next health risk to be uncovered through biomonitoring?

- Ubiquity
- Laboratory evidence of hazard at higher dose
- Nascent biomonitoring program

Overall, the available biomonitoring data on bisphenol A indicate that actual human exposure to bisphenol A is far below that which could cause adverse health effects and supports the conclusion that exposure to bisphenol A from all sources poses no known risk to human health.

http://www.bisphenol-a.org/whatsNew/20050504.html

What is the future for biomonitoring?

Disincentives for data generation and disclosure

- TSCA does not require base set of toxicity data for new chemicals
  - Less than 2% existing chemicals scrutinized
- "Confidentiality of sensitive business information is the lifeblood of many chemical companies." – SOCMA "TSCA Compliance Fundamentals Workshop" Oct. 2004

Increasing coordination of state and federal activity

- Expansion of CDC and state laboratories
- CDC funding of state biomonitoring programs
- State legislation for biomonitoring programs

CDC funded programs

- New York
  - POPs, PAHs, VOCs, Hg
- New Hampshire
  - As, Hg, phthalates, PBDEs
- Rocky Mountain consortium
  - 6 mining states
  - Heavy metals and arsenic

California Environmental Contaminant Biomonitoring Program

- Plan initiated in 2003; state not funded by CDC
- S.B. 1379 passed in 2006
  - Designed to assess geospatial localization as well as subpopulations
- Scientific Guidance Panel created summer 2007

Minnesota: "Tracking Toxins" bill

- Passed May, 2007
- Provides $2 million to state DHS to set up EH tracking and biomonitoring program
  - Pilot for As, Hg, and perfluorinated compounds

The Coordinated Environmental Public Health Network Act of 2007

- Sponsored by Senator Clinton (D-NY)
- Expands biomonitoring data collection to allow analysis by geographic area and subpopulation

What is needed

- More robust data collection
  - Finer geospatial resolution
  - Individual level information relevant to exposure and risk
- Enhanced research and monitoring program on cumulative risk, including chemical stressors
- Enhanced coordination of state and federal health and environmental surveillance
- Increased research on social issues, including privacy, perception, communication
- Exploratory analyses of pooled samples
  - Focus on vulnerable subpopulations like fetuses, children

Thank You

www.environmentaldefense.org