

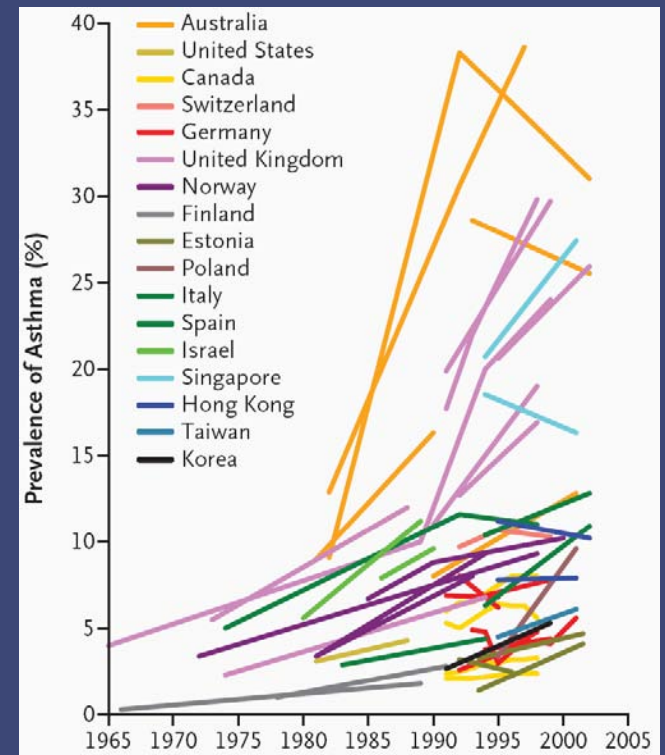
Residential Pesticide Exposure: Lessons learned from Boston's Healthy Public Housing Initiative

John D. Spengler
Harvard School of Public Health

EPA Office of Pesticide Programs
June 5, 2007

THE ASTHMA PROBLEM

- **Prevalence increasing worldwide**
- **Currently affects 5-10% of US**
 - >17 million Americans affected
- **Incidence, severity increasing**
- **Highest in industrialized countries**
- **Leading chronic illness among children**
 - Prevalence among children rose from 3.6% (1980) to 5.8% (2005)*
- **In the US, costs exceed \$14 billion/yr**



*(NEJM, 2006)

THE ASTHMA PROBLEM

- Asthma rates highest among urban poor

Study Finds Asthma In 25% of Children In Central Harlem

By RICHARD PÉREZ-PEÑA

A study has found that one of every four children in central Harlem has asthma, which is double the rate researchers expected to find and, experts say, is one of the highest rates ever documented for an American neighborhood.

Researchers say the figures, from an effort based at Harlem Hospital Center to test every child in a 24-block area, could indicate that the incidence of asthma is even higher in poor, urban areas than was previously believed.

The Centers for Disease Control and Prevention has estimated that about 6 percent of all Americans have asthma; the rate is believed to

(NYT, 4/19/2003)

Asthma hits N.E. hard, study finds

Diagnosis rates
are higher than
in rest of US

By Stephen Smith
GLOBE STAFF

The asthma epidemic has tightened its chokehold on New England, with one in seven adults and children diagnosed with the respiratory disease and its telltale wheezes and coughs, according to a report being released today.

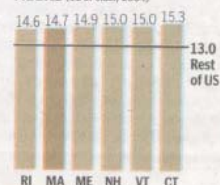
The government-funded study shows the disease takes a higher toll in New England than in the rest of the country.

And although the precise cause remains a mystery, here, as elsewhere, the burden of the condition weighs most heavily on the poor.

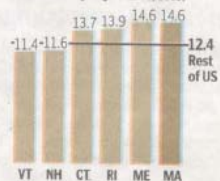
The study, based on telephone surveys, estimates that the number of adults and children in the six New England states who report ever having been diagnosed with

PERCENTAGE EVER DIAGNOSED WITH ASTHMA

Adults (18 or older, 2004)



Children (younger than 18, 2003)

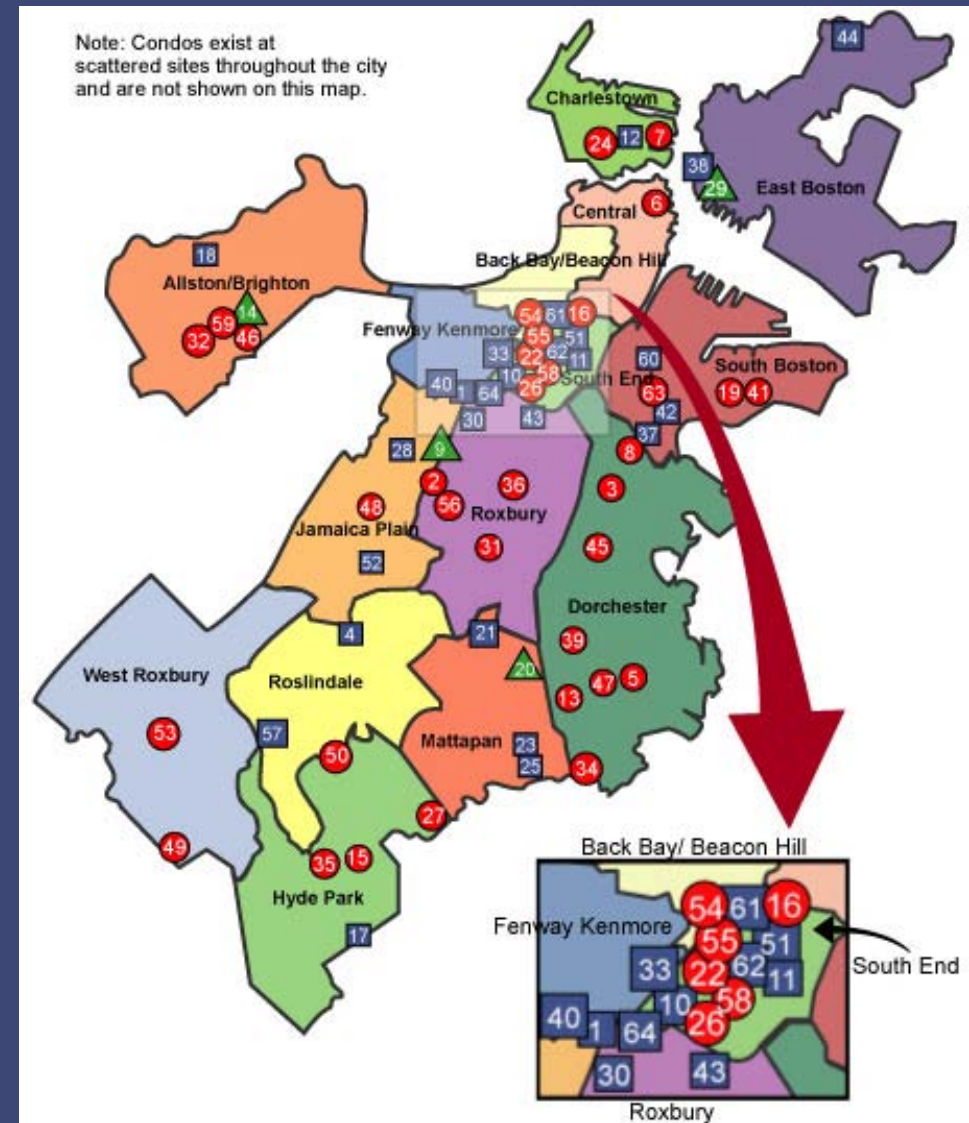


SOURCE: National Survey of Children's Health
JAMES BENNETT/GLOBE STAFF

(Boston Globe, 3/27/2006)

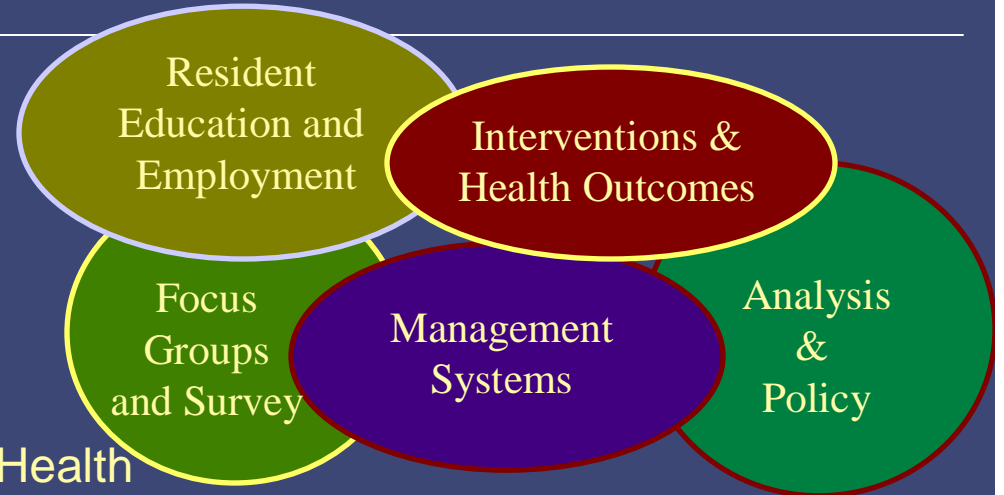
Boston Public Housing

- Boston Public Housing Facts
 - Largest apartment owner in Boston
 - 15,000 units in 68 developments
 - 25,000 residents (10,000 children)
 - Average Income: 17% of Boston-area median
 - < \$10,000 for a family of four

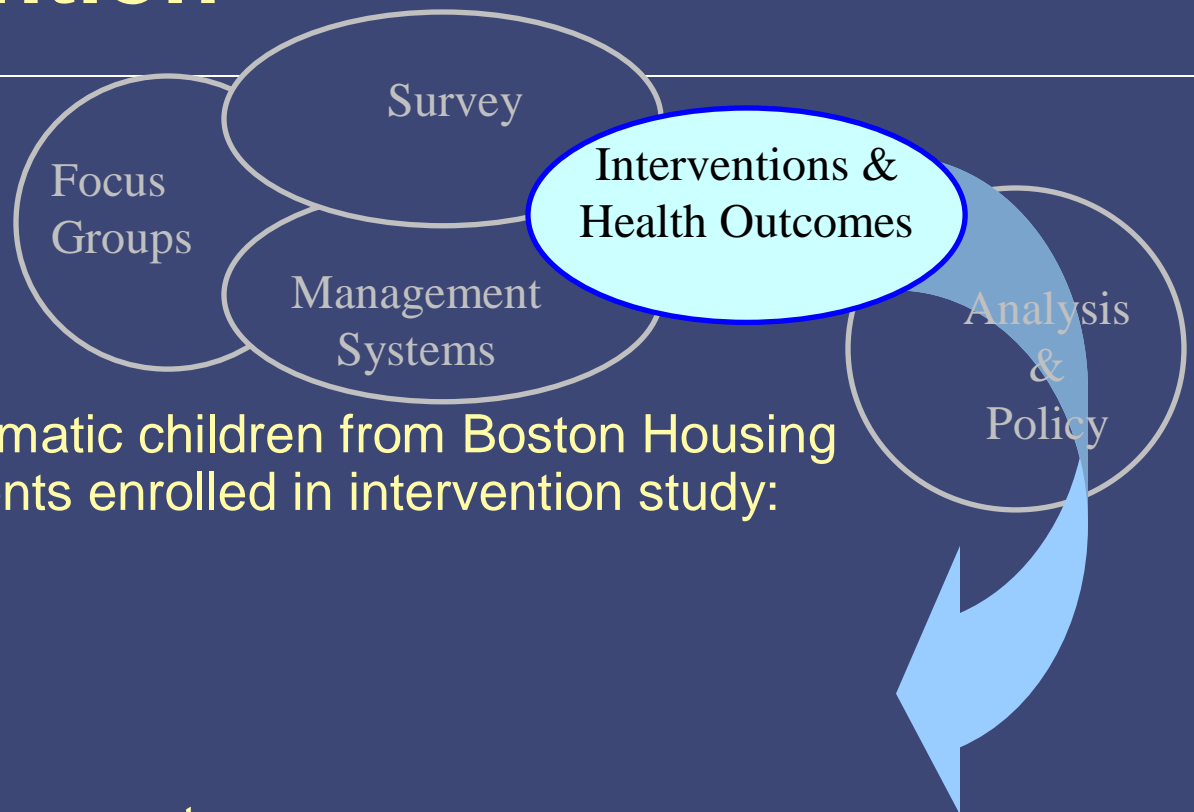


Healthy Public Housing Initiative Collaborators

- Public/Government
 - Boston Housing Authority
 - Boston Public Health Commission
- Universities
 - Boston University School of Public Health
 - Harvard University School of Public Health
 - Tufts University School of Medicine
- Community
 - Committee for Boston Public Housing, Inc.
 - Franklin Hill Tenant Task Force, Inc.
 - West Broadway Tenant Task Force, Inc.
- Funding
 - HUD
 - W.K. Kellogg Foundation
 - Boston Foundation



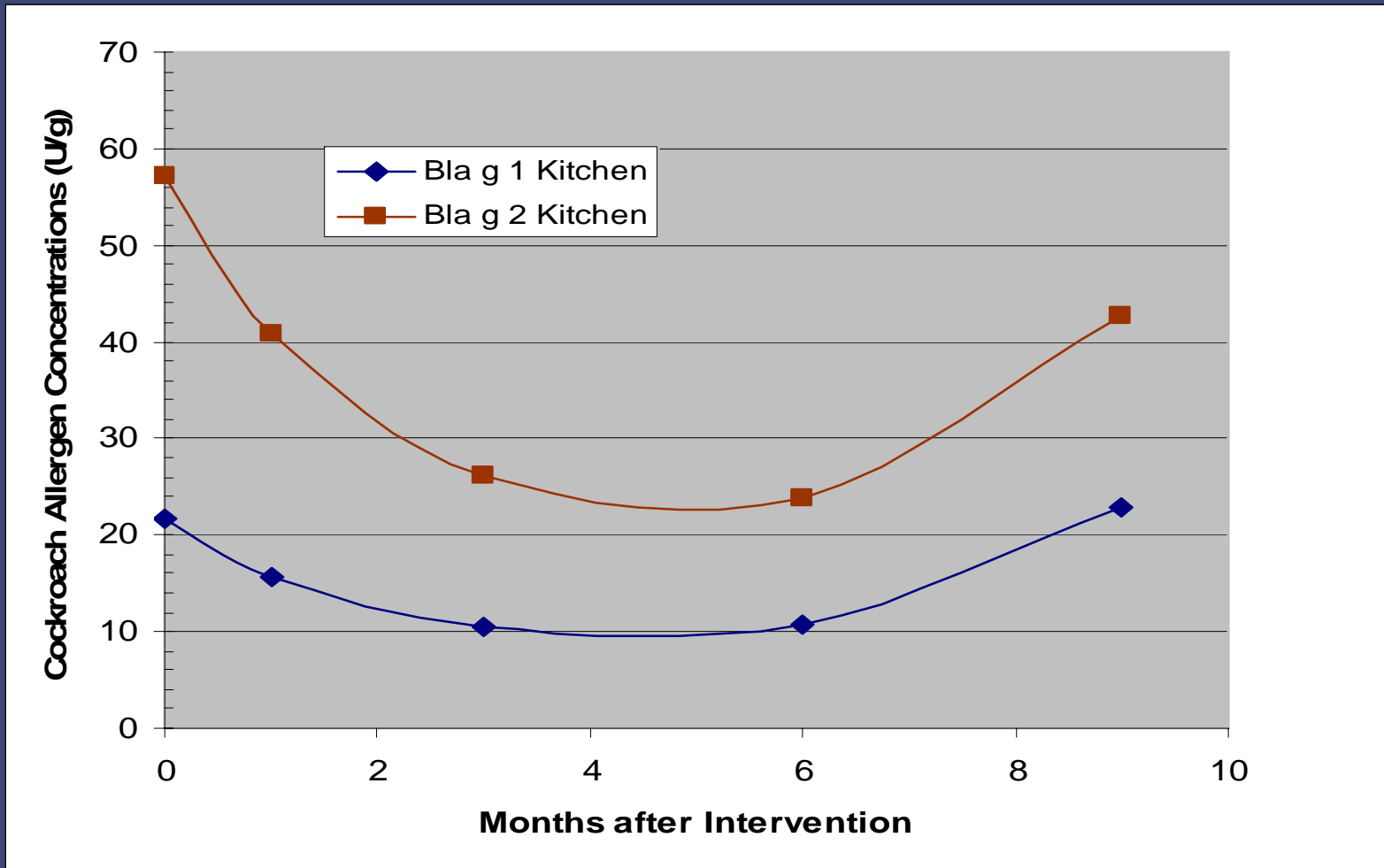
HPHI intervention



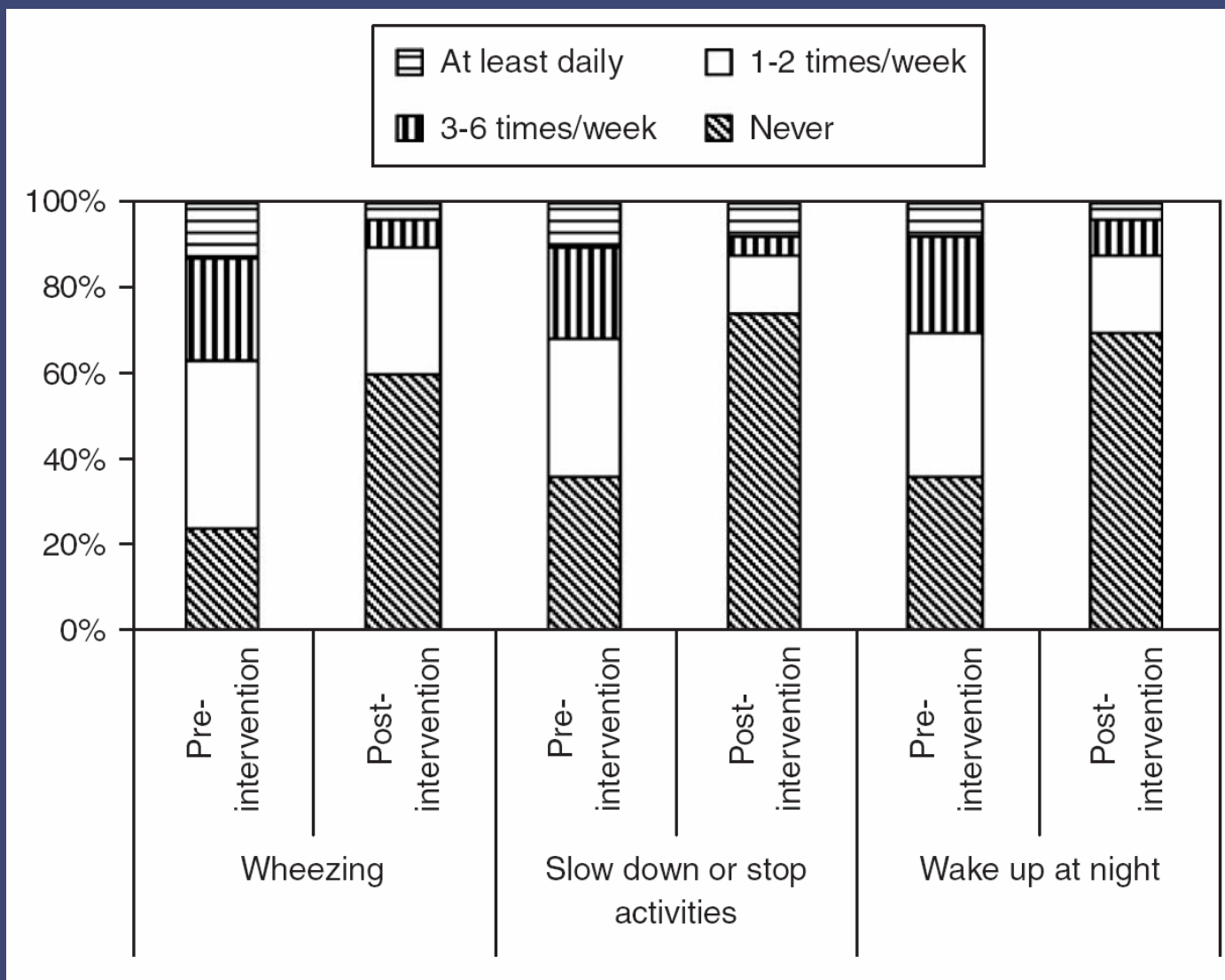
- 60 families with asthmatic children from Boston Housing Authority developments enrolled in intervention study:
 - West Broadway
 - Washington Beech
 - Franklin Hill
- Health data
- Environmental Measurements
- Interventions
 - Clinical – Asthma case management: training, access to peak flow meters, monthly diaries and maintaining an appropriate medication regimen.
 - Environmental – IPM, new mattresses, pillow covers, air purifier, plastic ware, minor home improvements, industrial cleaning.

Cockroach Allergen Trends

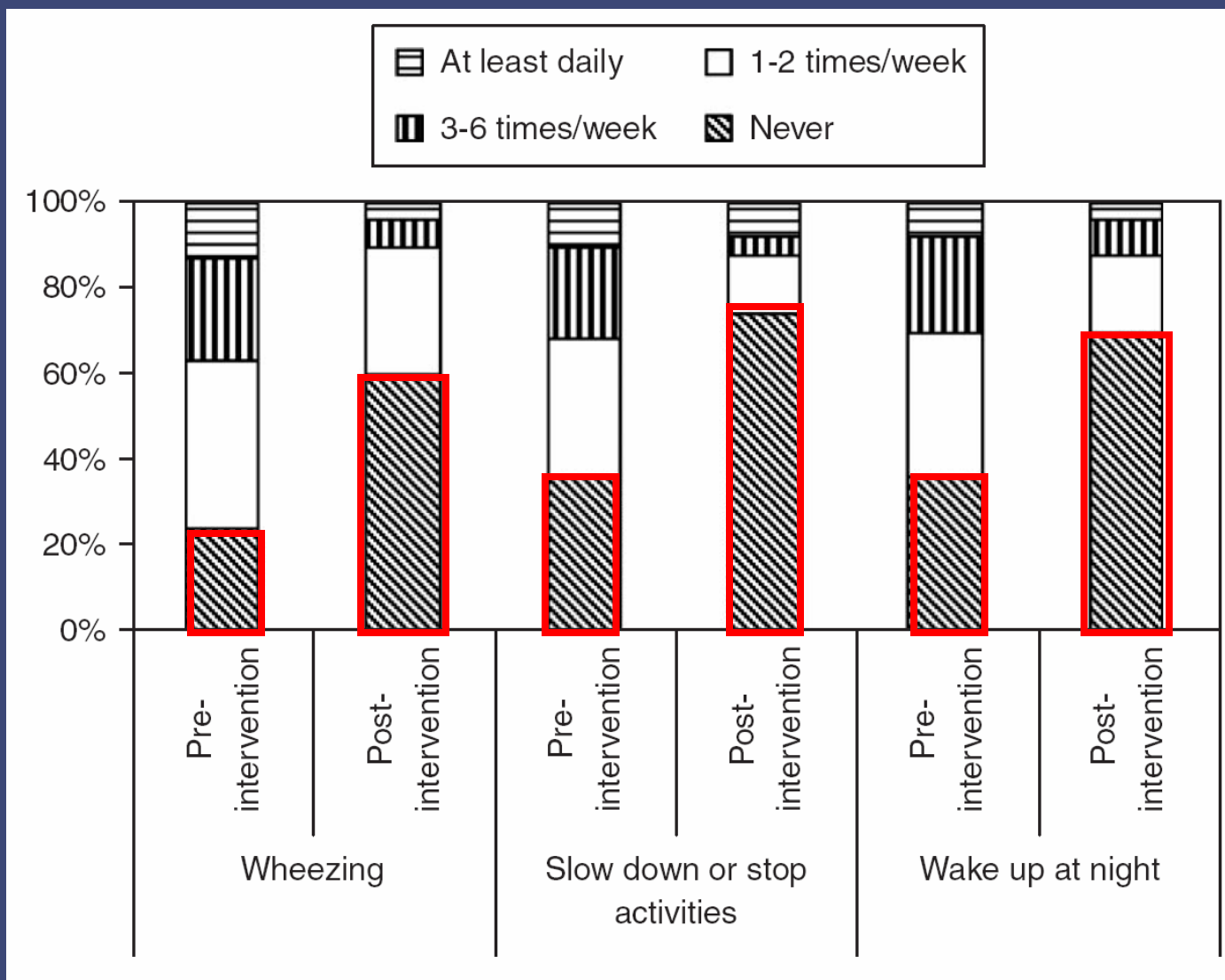
To sustain - need development-wide approach



HPHI Results - Asthma Symptoms



HPHI Results - Asthma Symptoms



Why Pesticides?

Pesticide Use to Control Pests in Inner City leads to:

- Misuse & illegal use
- Preference for high impact pesticides
- Pesticides Persist Indoors

Potential Health Effects

- Acute Exposure – irritation to the eyes, nose and throat; acute central nervous system (CNS) damage, e.g., headaches, dizziness, blurred vision
- Chronic Exposure – fetal development, damage to CNS, immune system, kidneys, reproductive system and increased risk of cancer

Household Pesticides

- Organophosphates
 - Black Jack Roach & Ant Killer
 - Raid Ant Bait
 - Raid Ant Controller
- Pyrethroids
 - Black Jack Roach & Ant Killer
 - Raid Ant & Roach Killer
 - Hot Shot Roach & Ant Killer
 - Tempo 20 WP Insecticide
 - Chinese Chalk



Target Analytes Oral LD50 in Rat (mg/kg)

Organophosphates

- Chlorpyrifos* (135-163)
- Diazinon* (300-400)

Pyrethroids

- Cyfluthrin* (590)
- Cypermethrin (250)
- Deltamethrin* (135)
- Esfenvalerate (458)
- Permethrin (383)
- Bifenthrin (70)
- Cyhalothrin (114)
- Allethrin (1100)
- Resmethrin (>2500)
- Sumithrin (>3500)
- Tetramethrin (>5000)

Source - EXTTOXNET. A Pesticide Information Project of Cooperative Extension Offices of Cornell University, Michigan, Oregon State and University of California at Davis.

Background - Exposures

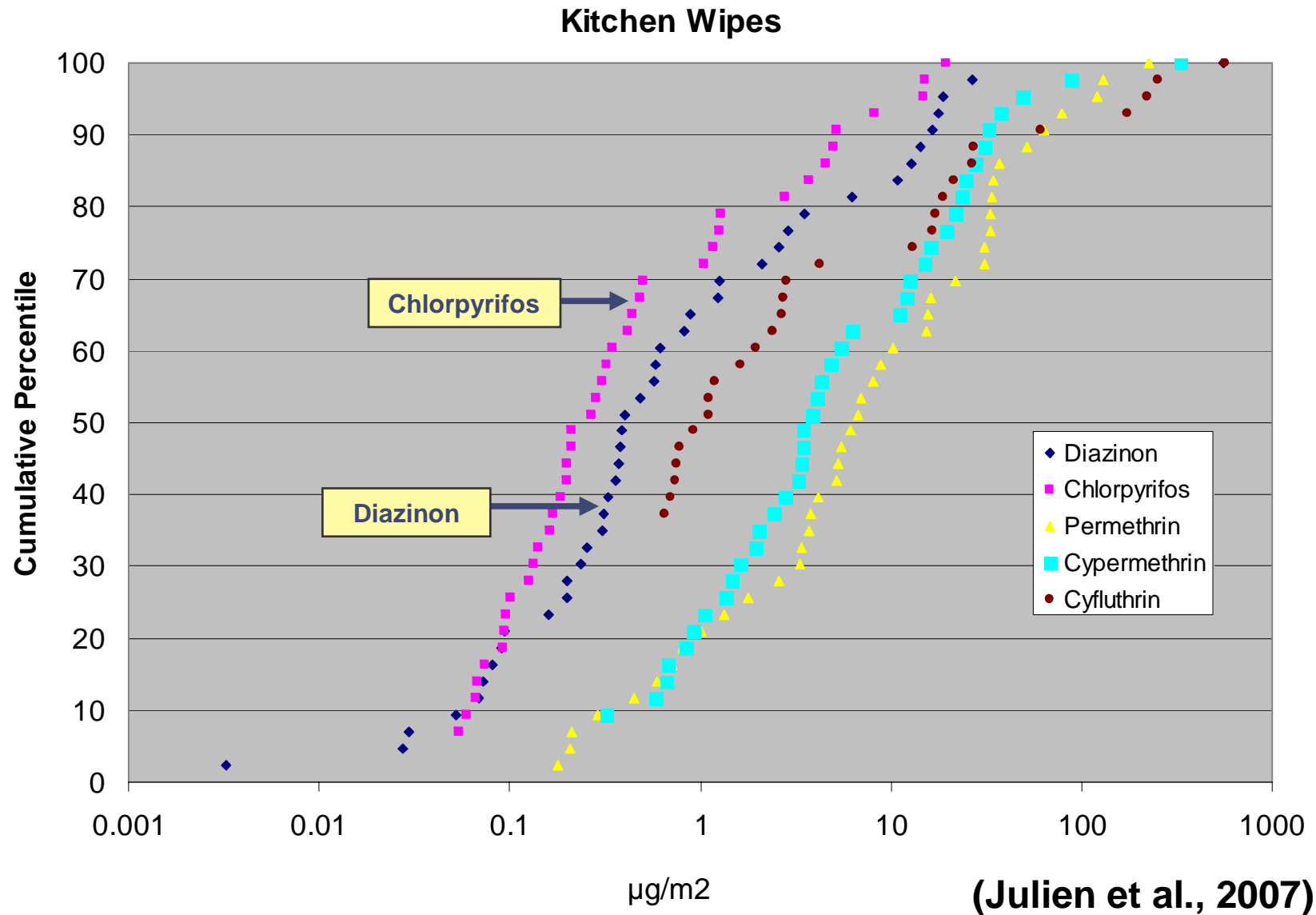
Healthy Public Housing Initiative (HPHI) provided valuable data about real-world exposures

Kitchen Wipe Sample Prevalence/Loadings* ($\mu\text{g}/\text{m}^2$) (N=42)

Analyte	%>LOD (n)	Min	Median	75th pct	Max
Chlorpyrifos	100 (42)	0.03	0.3	1.3	20
Permethrin	100 (42)	0.21	6.8	33.0	227
Diazinon	98 (41)	<LOD	0.4	2.6	556
Cypermethrin	90 (38)	<LOD	3.7	16.2	331
Cyfluthrin	71 (30)	<LOD	1.1	16.4	567
Esfenvalerate	67 (28)	<LOD	0.7	2.5	17
Cyhalothrin	26 (11)	<LOD	<LOD	0.4	4
Deltamethrin	16 (7)	<LOD	<LOD	<LOD	45

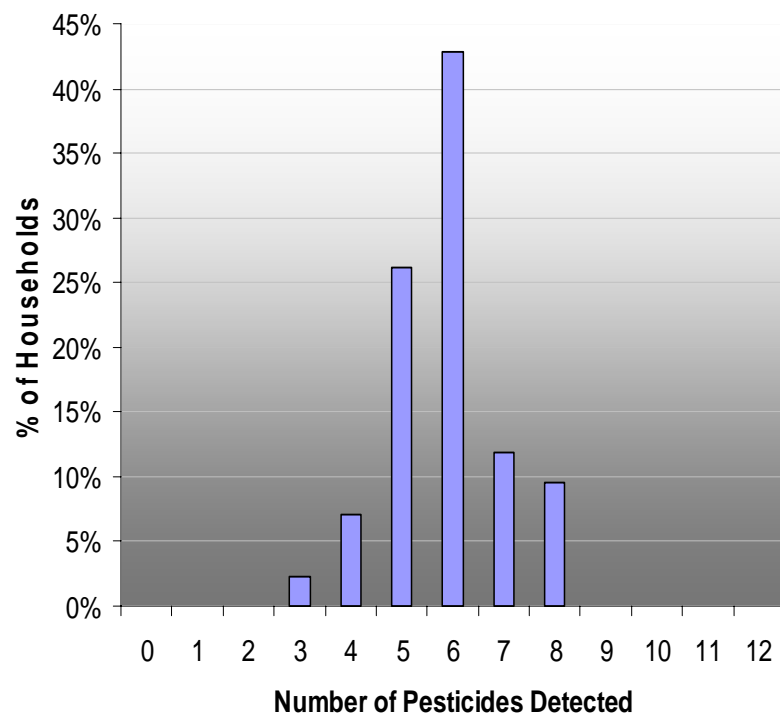
* Julien et al. 2007

Cumulative Frequency Distributions (N=42)



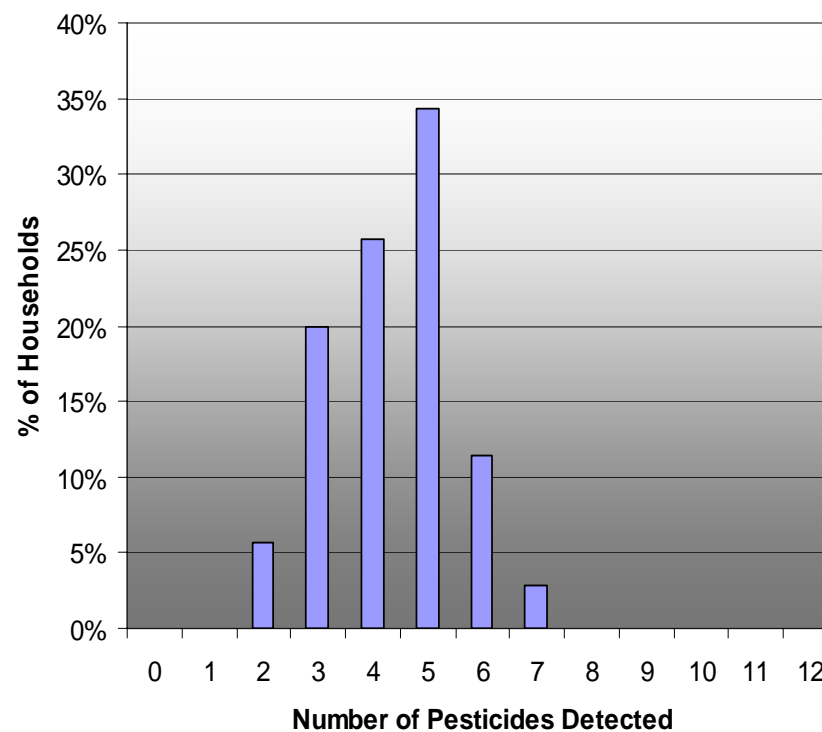
Prevalence of Pesticides Detected

Kitchen Floor Wipes (N=42)



Kitchen Floor Wipes

Vacuum Dust (N=35)



Vacuum Dust

(Julien et al., 2007)

Overview

Key Findings

- Every home had at least 3 pesticides, some as many as 8
- Chlorpyrifos found in every home
 - 2 years following withdrawal from sales
- Restricted pesticides were widespread
 - e.g. Tempo – need for educational campaign
- IPM works, but these principles need to be applied at building or development level in these settings

Insights

- Need for sustainable interventions
- Need to incorporate these principles into design and renovation standards
- Need for partnerships

HPHI II

Boston Healthy Pest Free Housing Initiative

■ Partners

- Boston Public Health Commission – lead agency
- Boston Housing Authority
- Committee for Boston Public Housing
- West Broadway Task Force

■ Activities

- Hiring and training of BHA residents to serve as health advocates
- In-home asthma and environmental education
- Expansion of IPM in public housing
- Bodega education program
- Pesticide buyback program
- Distribution of Home SAFE kits

■ Major funders - W.K. Kellogg Foundation and EPA

Overview

Some current efforts

- HUD-funded study of pesticide and chemical exposures in two low-income, predominantly African-American communities (Gary Adamkiewicz)
 - 200 homes will be sampled
 - Gadsden County, Florida and Roxbury, Massachusetts
 - Rural/urban differences
 - Residential use
 - Occupational (“take home” exposures)
 - Local transport of agricultural applications
- Risk assessment of pesticide residues found in HPHI homes (Jon Levy)
 - Goal is to put these exposures in context
 - EPA SHEDS model (Stochastic Human Exposure and Dose Simulation)

Recent Studies

Pesticide loadings of select organophosphate and pyrethroid pesticides in urban public housing

RHONA JULIEN^a, GARY ADAMKIEWICZ^a, JONATHAN I. LEVY^a, DEBORAH BENNETT^{a,b},
MARCIA NISHIOKA^c AND JOHN D. SPENGLER^a

^aHarvard School of Public Health
^bUniversity of California, Berkeley
^cBattelle Memorial Institute

An Intervention to Reduce Residential Insecticide Exposure during Pregnancy among an Inner-City Cohort

Megan K. Williams,¹ Dana B. Barr,² David E. Camann,³ Linda A. Cruz,¹ Elizabeth J. Carlton,¹ Mejico Borjas,¹ Andria Reyes,¹ Dave Evans,¹ Patrick L. Kinney,¹ Ralph D. Whitehead Jr.,² Frederica P. Perera,¹ Stephen Matsoanne,⁴ and Robin M. Whyatt¹

¹Columbia Center for Children's Environmental Health, Mailman School of Public Health, Columbia University, New York, New York, USA;

²National Center for Environmental Health, Battelle Memorial Institute, San Antonio, TX, USA;

Impact of Prenatal Chlorpyrifos Exposure on Neurodevelopment in the First 3 Years of Life Among Inner-City Children

Virginia A. Rauh, ScD^a, Robin Garfinkel, PhD^a, Frederica P. Perera, DrPH^a, Howard F. Andrews, PhD^a, Lori Hoepner, MPH^a, Dana B. Barr, PhD, DLS^b, Ralph Whitehead, MPH^b, Deliang Tang, DrPH^a, Robin W. Whyatt, DrPH^a

^aColumbia Center for Children's Environmental Health, Mailman School of Public Health, Columbia University, New York, New York; ^bNational Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, Georgia

The authors have indicated they have no financial relationships relevant to this article to disclose.

Recent studies

Rauh et al., 2006

- Associations between prenatal exposure to chlorpyrifos (cord blood) on 3-year neurodevelopment and behavior in a sample of inner-city minority children.

- Highly exposed children scored lower on
 - Bayley Psychomotor Development Index (6.5 points)
 - Bayley Mental Development Index (3.3 points)

- Children with high levels of exposure were significantly more likely to experience:
 - Psychomotor Development Index delays
 - Mental Development Index delays
 - attention problems
 - attention-deficit/hyperactivity disorder problems
 - pervasive developmental disorder problems at 3 years of age.

Big Picture

- Structural IPM is needed in many low-income communities
 - Development-wide approaches necessary
- Need collaborations across agencies
- Need to translate research into effective programs



Chemicals in Commerce

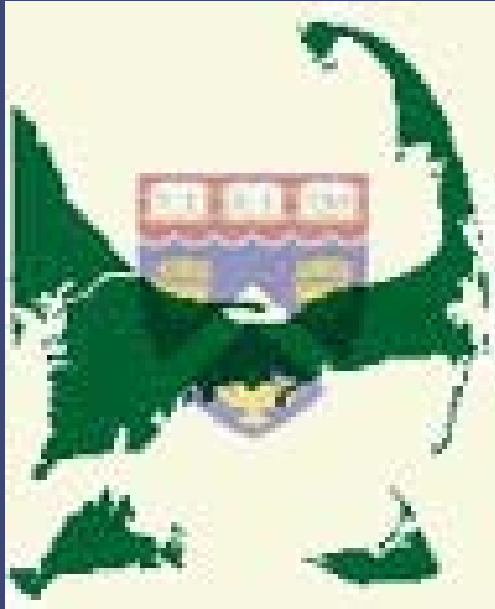


- Plastics
- Disinfectants
- Flame retardants
- Pest control
- Adhesives
- Detergents
- Cleaners
- Emulsifiers
- Latex paints

Limited Tox Testing of Chemicals

- **Toxic Substances Control Act (TSCA) 1976**
 - To require testing, EPA needs “substantial evidence” of “unreasonable risk”
 - EPA required to analyze risk and benefits of less burdensome regulatory alternatives and substitutes
- As of 1979, there were 62,000 chemicals with 200 new chemicals introduced each year
- There are 3000 chemicals produced in quantities greater than 1 million pounds/year
 - 43% have no testing for basic toxicity
 - 7% has complete toxicity testing, except for endocrine activity
- Only 5 chemicals banned under TSCA

Synthetic Organic Compounds in Indoor Air and Dust



- Excess Breast Cancer on Cape Cod, MA
- Historical use of pesticides on cranberry bogs, golf courses and mosquito control
- Potential endocrine disruption compounds exposure in homes



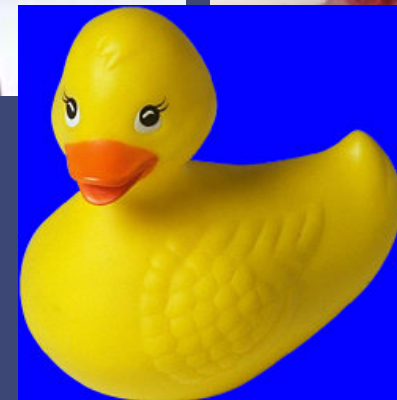
SILENT SPRING INSTITUTE
researching the environment and women's health

Air and Dust Sampling in the Cape Cod Study

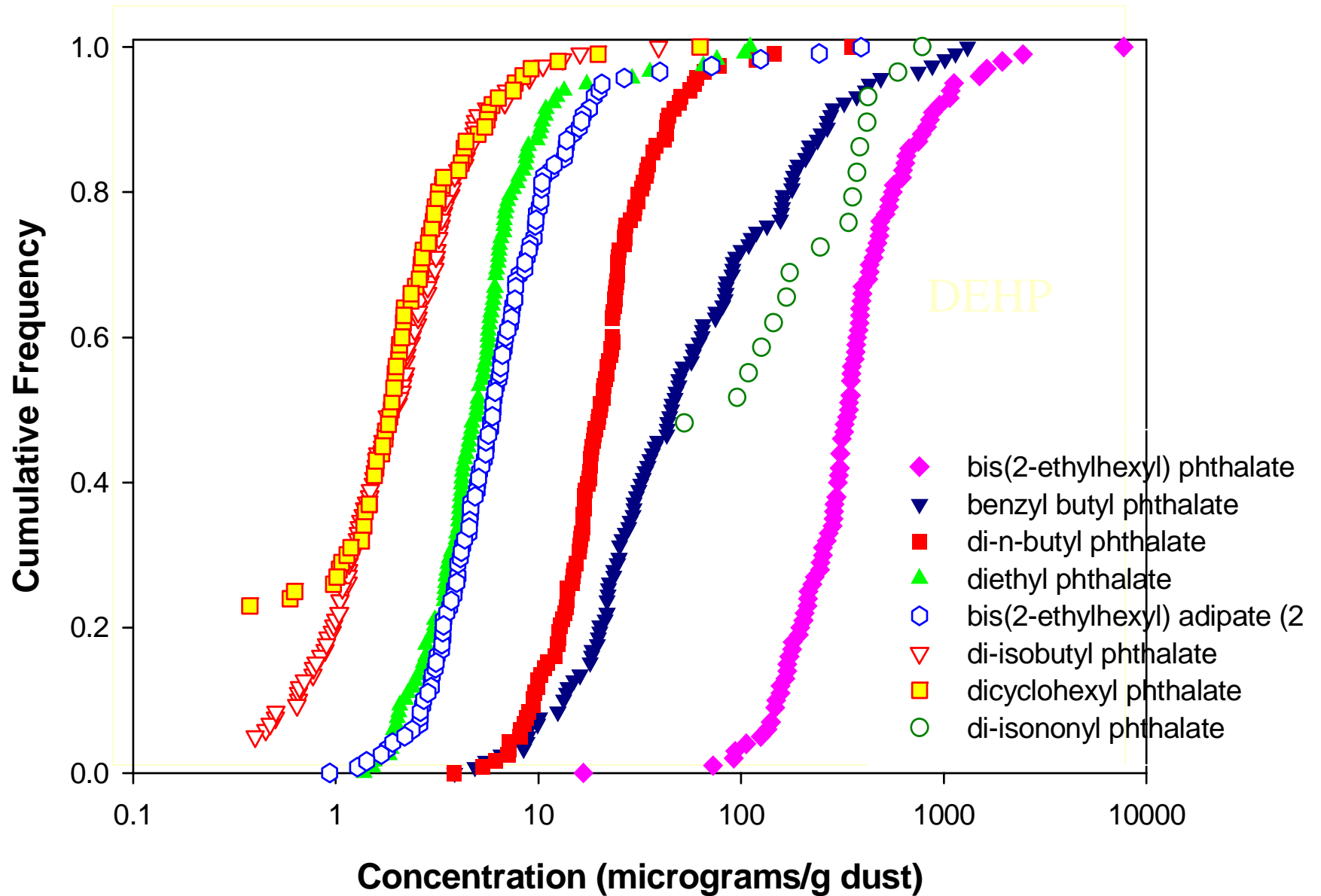


Phthalates

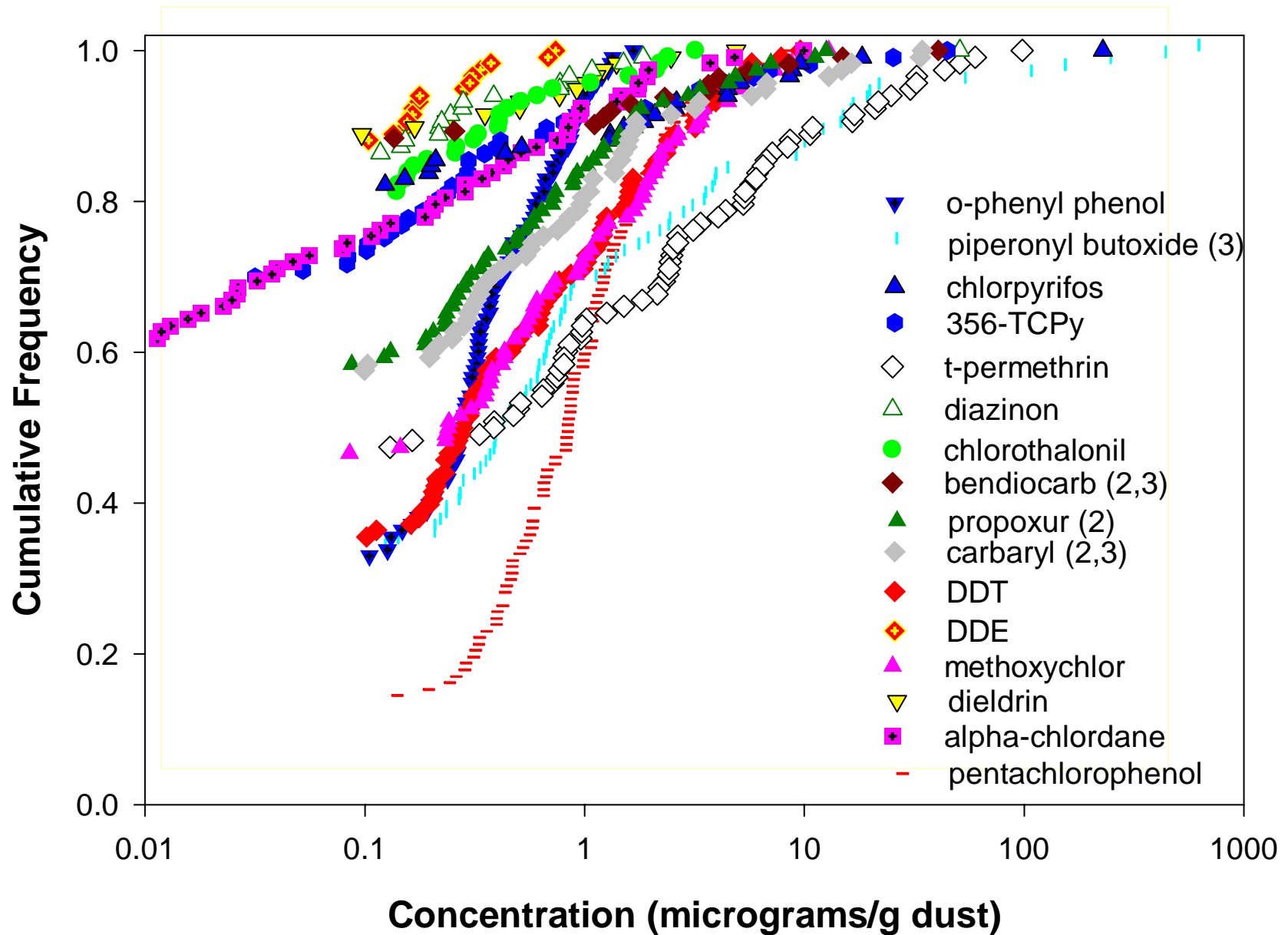
- Used as softeners, or plasticizers, in polyvinyl chloride (PVC, vinyl) products
 - children's toys
 - building products (vinyl flooring)
 - blood bags
- As solvents and additives in some consumer products
 - cosmetics
 - personal care products
- **Possible** health effects
 - endocrine disruption
 - carcinogen
 - allergy/asthma



Phthalates in Dust



Pesticides in Dust



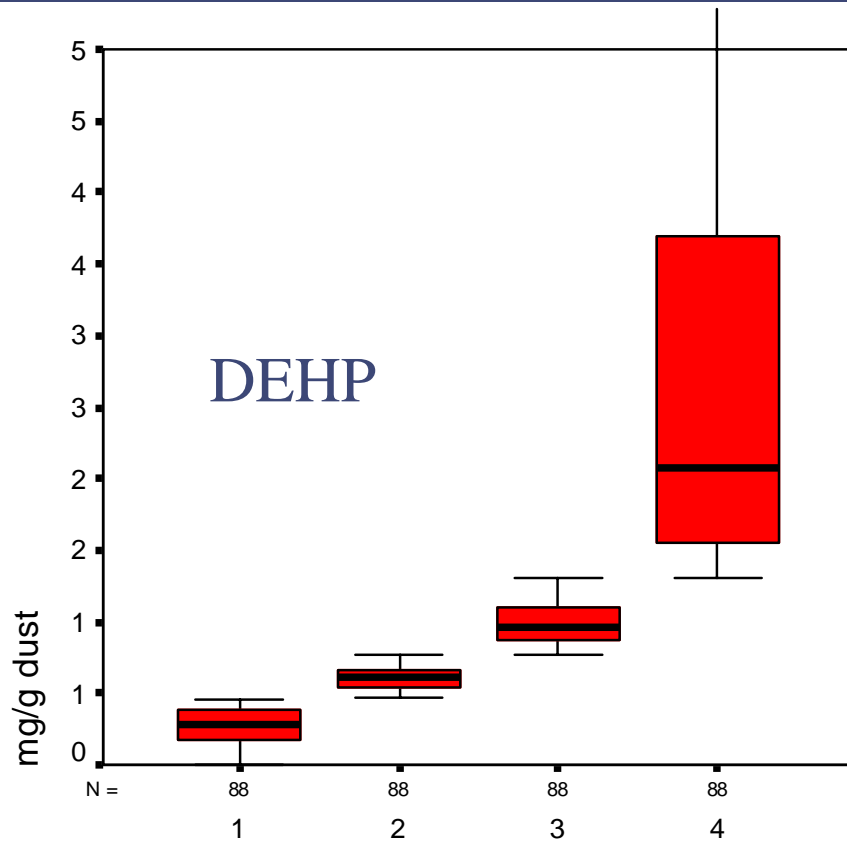
Asthma/Allergic Symptoms in Children and Phthalates

- Dust was collected above floor level on a filter in children's bedroom
- 346 valid samples (Dust samples >25 mg)
- Six phthalates identified
 - DEP
 - DIBP
 - DnBP
 - BBzP
 - DEHP
 - DINP

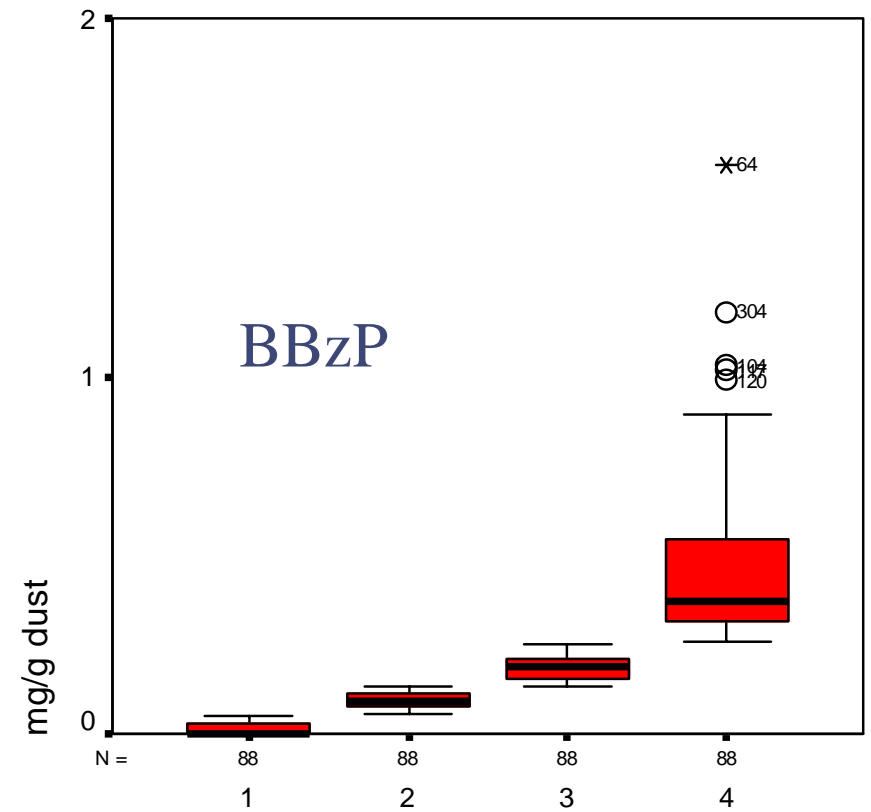


(Bornehag et al., EHP 2004)

Quartiles of phthalates in dust

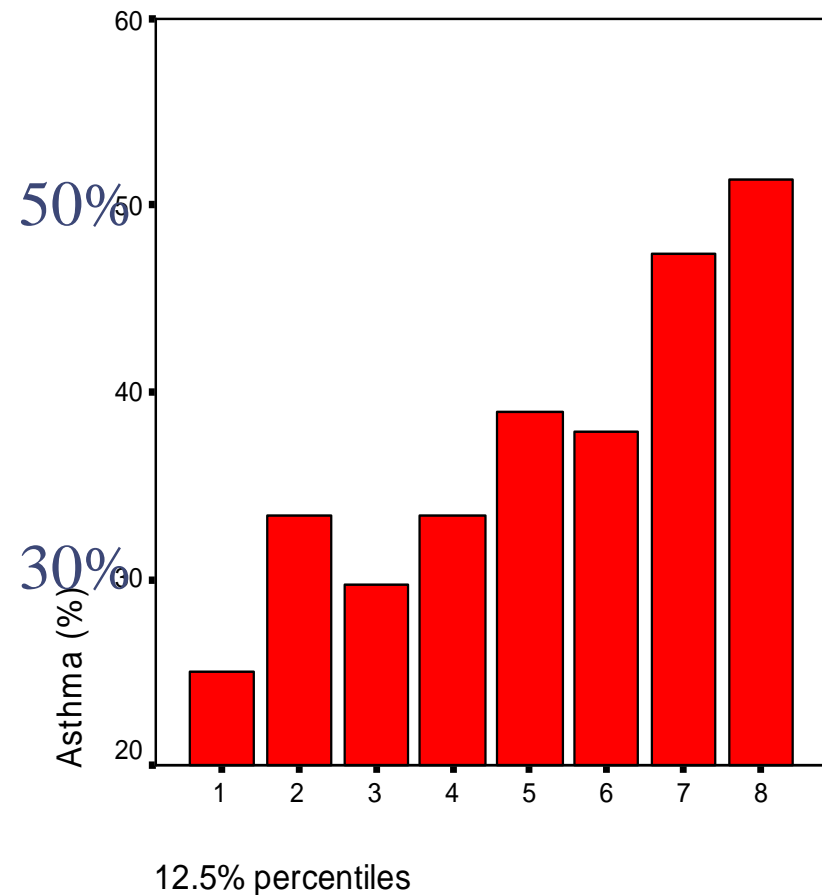
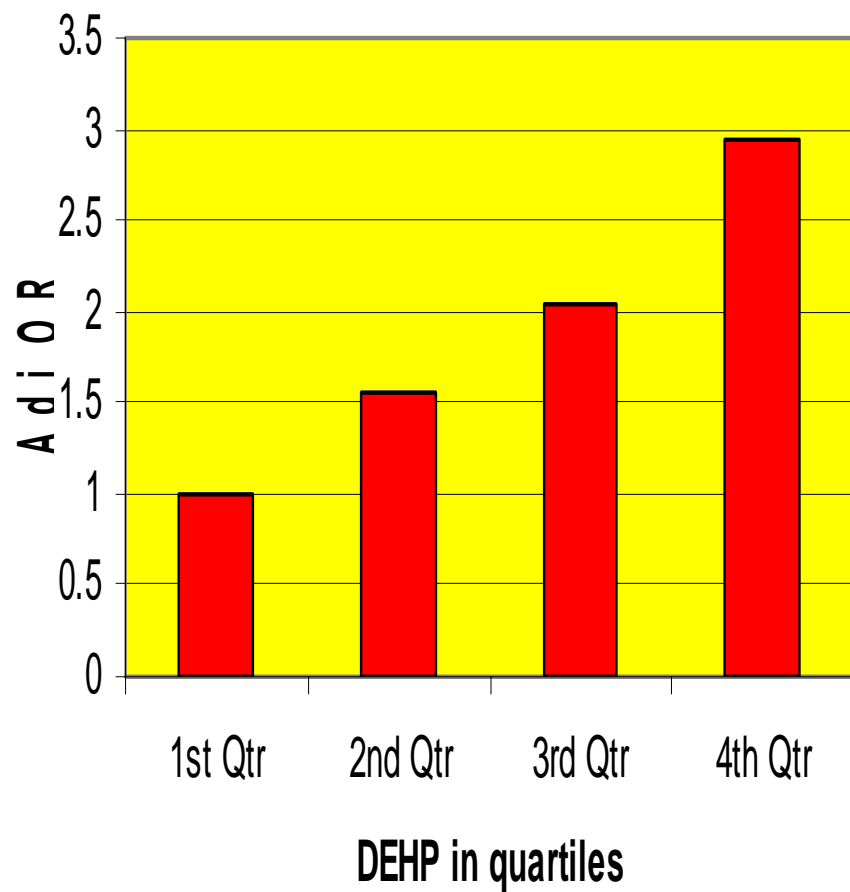


NTILES of DEHPCD



NTILES of BBPCD

DEHP Odds Ratio for Asthma and % Asthma



PBDE Flame Retardants

- Polybrominated diphenyl esters
- Persistent
- Bioaccumulates
- Breast milk concentrations approaching toxic levels in Canadian women

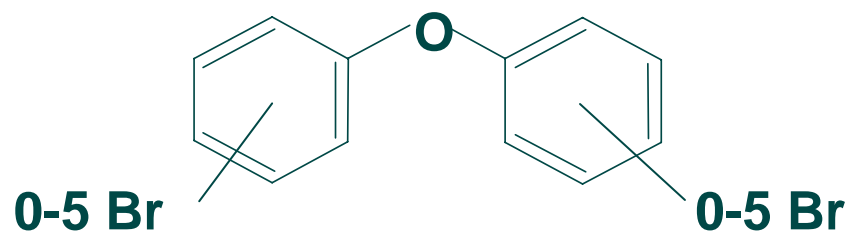
FROM: *Environ Sci Technol*,35:274A-275A, 2001



Polybrominated Flame Retardants (PBDEs): A Cautionary Tale

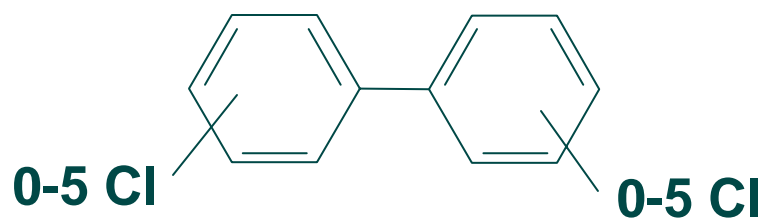
- 
- 
- Deborah C. Rice, Ph.D.
 - Environmental and Occupational Health Program
 - Maine Center for Disease Control and Prevention
 - Augusta, ME

PCBs and PBDEs Have Similar Structures

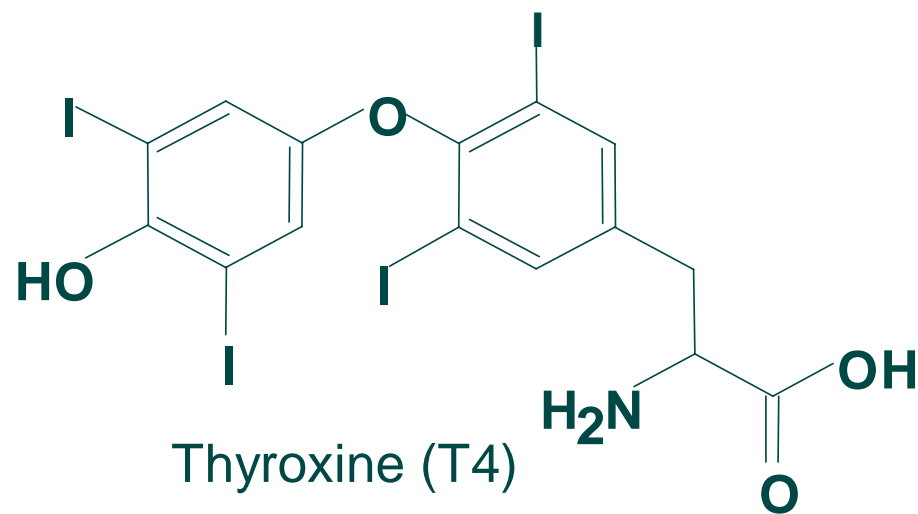


Polybrominated diphenyl
ethers (PBDEs)

209 possible congeners

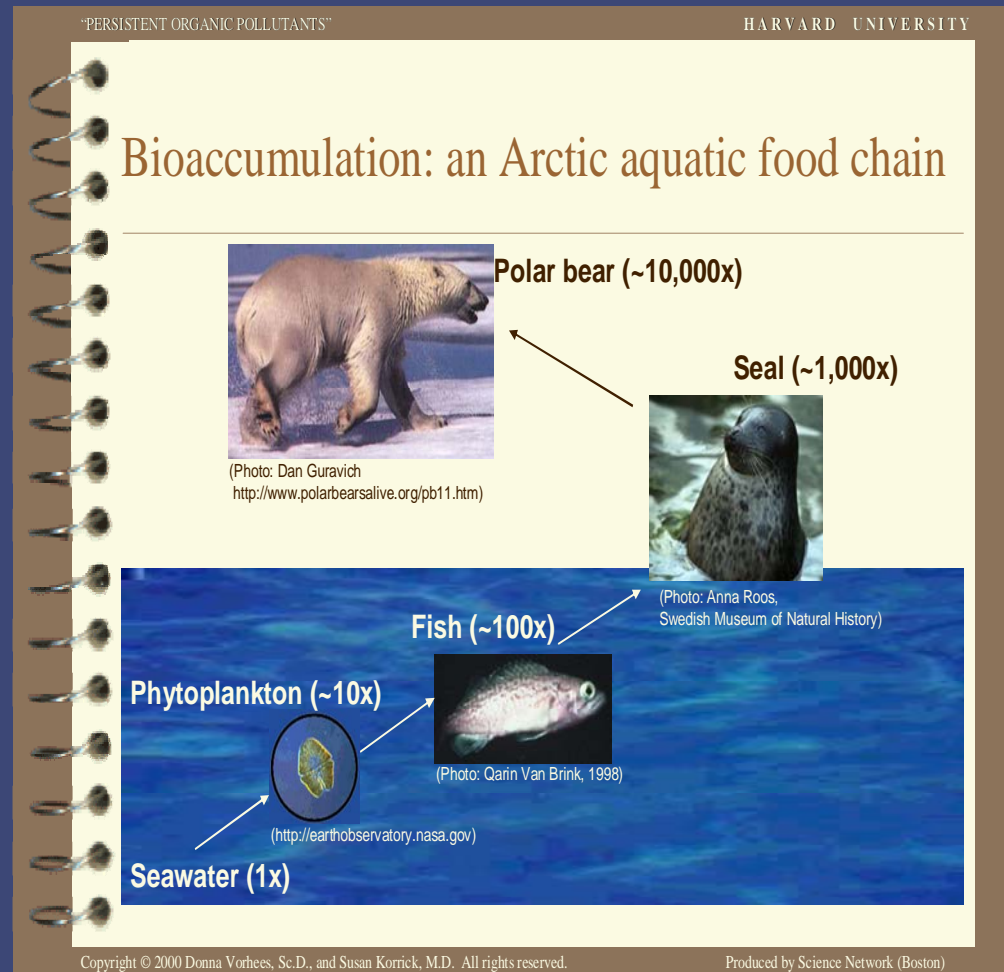


Polychlorinated biphenyls (PCBs)

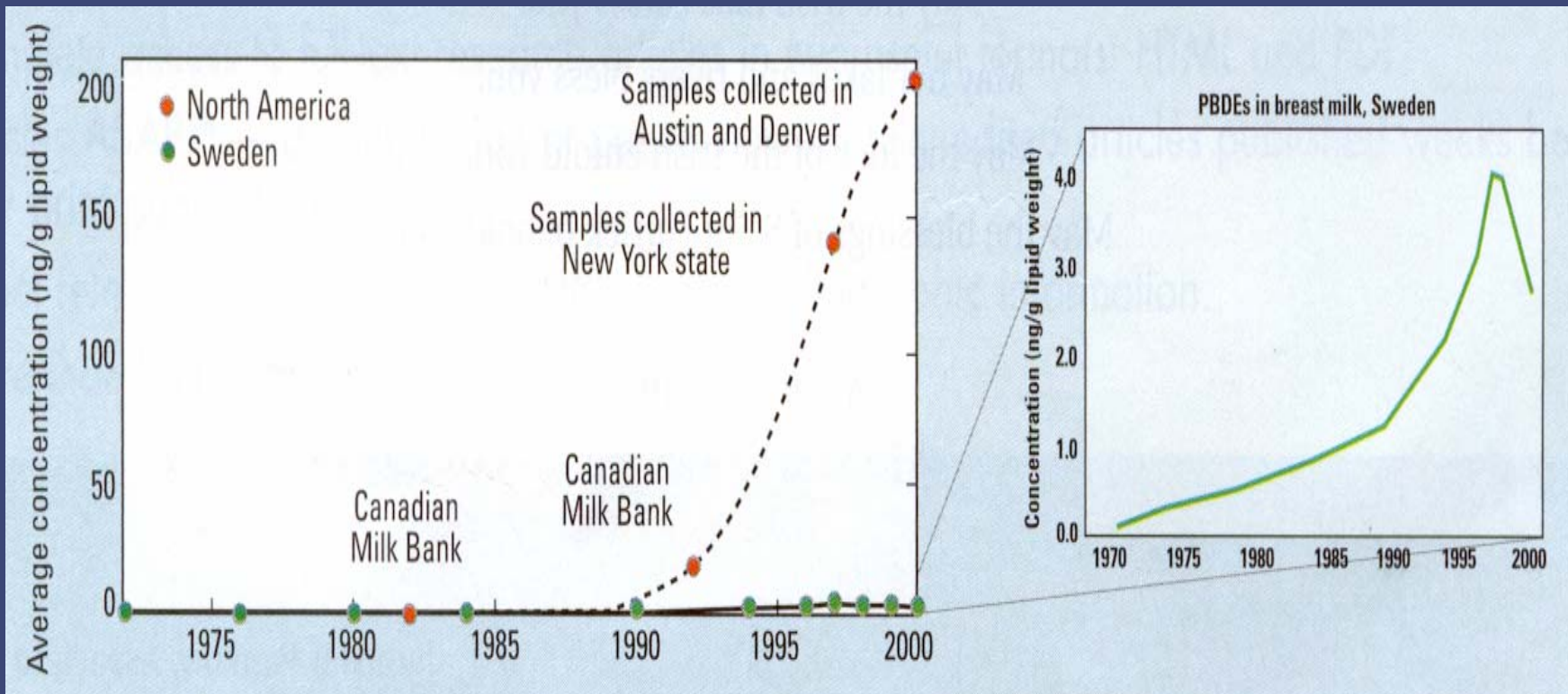


PBDEs flame retardants in foams and plastics

- Acts as EDC via thyroid hormone
 - (Zhou 2001, 2002)
- Detected 2,3 dibromo-1-propanol intermediate in TRIS banned in 1977
- Bioaccumulate



PBDE Rising in Breast Milk in North America



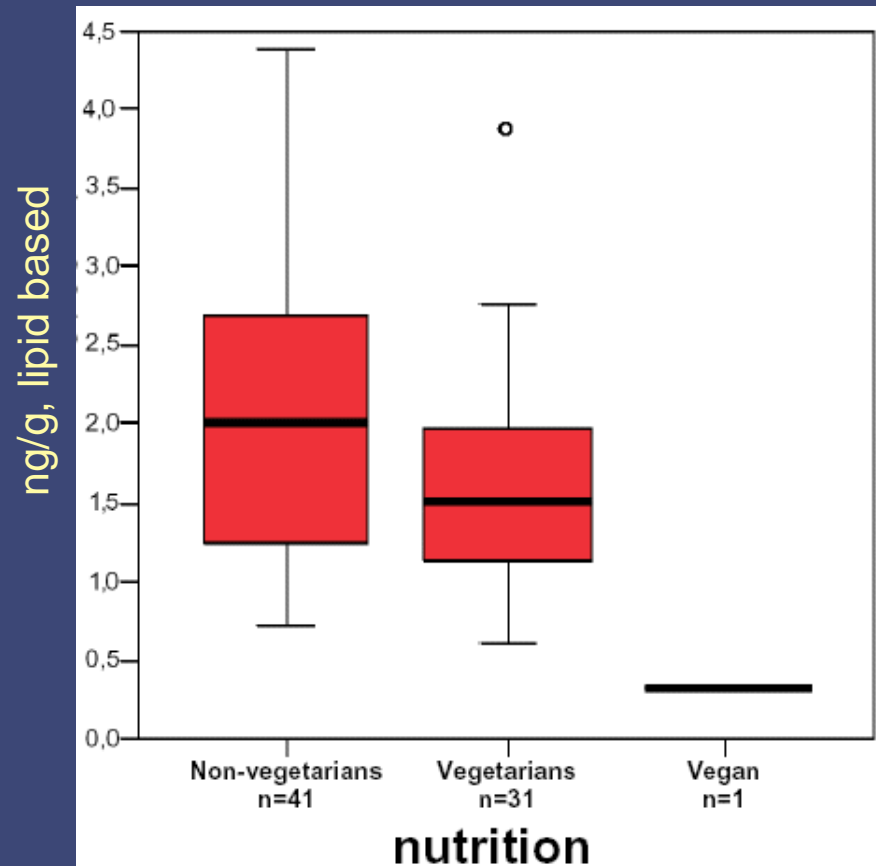
Sources: Canadian Milk Bank and New York state data: Ryan and Patry; Denver, CO and Austin, TX data: Papeke; Swedish data: Noren (FROM: *Environmental Science & Technology*, 36:50A, 2002).

PBDE Levels in Humans

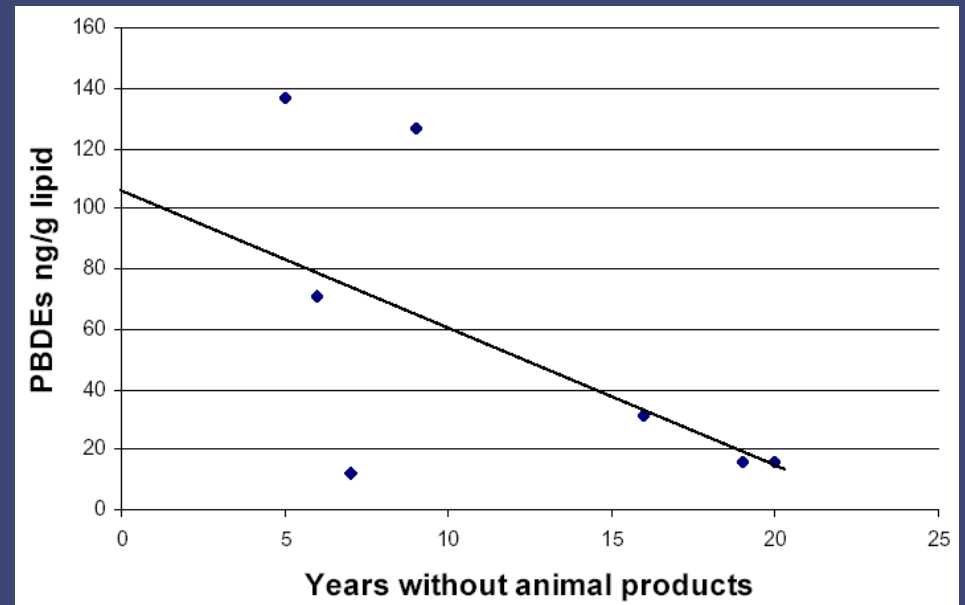
- Levels in humans in the U.S. highest in the world
- Levels in humans have increased exponentially since the 1970s
- Excreted into breast milk
- Cross the placenta
- Highest concentrations were 47 and 99, presumably from penta BDE
- Currently 153 is dominant congener in some samples, perhaps from metabolism
- Levels of 47, 99, 100 in breast milk in Sweden currently decreasing, 153 increasing

(Slide from D. Rice)

PBDEs in Human Milk From Non-Vegetarians, Vegetarians and Vegans



Paepke *et al.*



$r=-0.6, p > 0.05$

Schechter *et al.*

(Slide from D. Rice)

Toxic Effects of PBDEs

- Decreased thyroid hormone
 - 47, 99, 100, 153, various mixtures in several studies
 - decaBDE following postnatal exposure (Rice *et al.*, submitted)
 - decaBDE produced thyroid follicular cell hyperplasia in 2-year cancer assay
- Reproductive hormones and function
 - 47, 99, 153, commercial mixtures
 - decaBDE active after photoactivation
- Developmental neurotoxicity

(Slide from D. Rice)

Toxic Effects of PBDEs

- Suppression of immune function
 - various commercial mixtures, 47
 - others not studied
- Induction of hepatic enzymes
- Carcinogenicity
 - decaBDE only congener assessed
 - carcinogenic in two species and multiple organs

(Slide from D. Rice)

Possible PBDE Effects in Humans (Chao *et al.*, 2006)

- Association between birth outcome and 12 PBDE congeners in breast milk
- DecaBDE levels predicted lower birth weight and length, smaller head circumference
 - five other congeners associated with one or more of these endpoints
- DecaBDE associated with decreased cycle length and decreased duration of menstrual bleeding before covariate adjustment (n = 20)
 - 100 and 153 also associated with decreased cycle length
- Correlations among congeners was not presented, making interpretation difficult with respect to individual congeners

(Slide from D. Rice)

PCBs

- Caulking containing PCBs was in use during the 1960s and 1970s
 - schools
 - hospitals
 - apartment buildings

Joint Sealants: An Overlooked Diffuse Source of Polychlorinated Biphenyls in Buildings

MARTIN KOHLER,^{*,†} JOSEF TREMP,[‡]
MARKUS ZENNEGG,[†] CORNELIA SEILER,[†]
SALOME MINDER-KOHLER,[§]
MARCEL BECK,[§] PETER LIENEMANN,^{||}
LUKAS WEGMANN,[‡] AND PETER SCHMID[†]

(ES&T, 2005)

Soil Contamination from PCB-Containing Buildings

Robert F. Herrick,¹ Daniel J. Lefkowitz,² and George A. Weymouth³

¹Department of Environmental Health, Harvard School of Public Health, Boston, Massachusetts, USA; ²pcbinschools.org, Yorktown, New York, USA; ³International Union of Bricklayers and Allied Craft Workers, Local 3 (Retired), Boston, Massachusetts, USA

(EHP, 2006)

Concluding remarks

- Legacy compounds still with us
- Many important pathways
- Need more comprehensive assessment of chemical toxicity and exposures
- Opportunities for substitution or intervention exist
 - e.g., IPM

THANK YOU