

Bisphenol-A and Phthalate Esters: Potential Sources of Resin Components in the Everyday Environments of Preschool Children



M.K. Morgan¹, L.S. Sheldon¹, N.K. Wilson², J.C. Chuang³, C. Lyu²,
C.W. Croghan¹, P.A. Jones¹, and R.C. Fortmann¹.

¹National Exposure Research Laboratory, RTP, NC; ²Battelle, Durham, NC; ³Battelle, Columbus, OH.

Emerging Pollutants Workshop
Chicago, IL
August 12, 2003

Past Research

- Previous research on a small number of children suggests that ingestion (dietary and indirect) is a major route of exposure to environmental chemicals.
- Exposure routes differ depending on the classes of chemicals:
 - *Inhalation > indirect ingestion >> dietary ingestion*
PCBs
 - *Dietary ingestion > indirect ingestion > inhalation*
B2 PAHs, phthalate esters, 2,4-D herbicide
 - *Dietary ingestion > inhalation > indirect ingestion*
Total PAHs, phenols, OP & OC pesticides
- Potential doses may be greater for children than adults in the same households.



The Children's Total Exposure to Persistent Pesticides & Other Persistent Organic Pollutants 'CTEPP' Study

- Pilot study involving approximately 260 preschool children in North Carolina and Ohio.
- Large multimedia and multipathway exposure study of young children.
- Potential exposures that preschool children may have to common pollutants in their everyday environments.

CTEPP : Significance

- Greater understanding of children's aggregate exposure to pollutants.
- Important sources and pathways of exposure that contribute to children's exposures to pollutants.
- Improved approaches for estimating children's exposures and potential doses to pollutants.
- Fill in critical data gaps under the Food Quality Protection Act of 1996.

CTEPP

Objectives

- Measure the aggregate exposures of a small set of preschool children to persistent pesticides and other persistent organic pollutants in their everyday environments.
- Apportion the exposure pathways and identify important exposure media.
- Identify and formulate important hypotheses to be tested in future research.

Study Design

- **Involved approximately 260 preschool children and their adult caregivers.**

States :	North Carolina and Ohio
Counties:	Six in both states; 4 urban and 2 rural
Sampling site :	Child day care centers and residential settings
Socioeconomic status:	Low-income and middle/upper-income

- **Stratification**

- *Child day care vs. home*
- *Urban vs. rural*
- *Low-income vs. middle/upper-income*

Study Procedures

- **Samples collected over 48-hour sampling periods:**

- **Food**

- **Drinking Water**

- **Hand Wipes**

- **Beverages**

- **Indoor Air**

- **Play Area Soil**

- **Urine**

- **Outdoor Air**

- **Indoor Floor Dust**

Sample Collection

- Play Area Soil
- Outdoor and Indoor Air
- Indoor Floor Dust

SOIL SAMPLE



OUTDOOR AIR SAMPLE



INDOOR AIR SAMPLE



INDOOR FLOOR DUST SAMPLE

HVS3



Sample Collection

Primary adult caregiver and child:

- Hand Wipes
- Duplicate Diets
- Urine Samples

HAND WIPE SAMPLE



SOLID AND LIQUID FOOD SAMPLES



8.29.2001 10:38

URINE SAMPLE



Additional Sampling

If pesticide(s) were applied within 7 days of or during the 48-hr monitoring period:

- PUF Roller for Transferable Residues
- Hard Floor Surface Wipe
- Food Preparation Surface Wipe
- Urine (not pooled)

TRANSFERABLE RESIDUE SAMPLE



HARD FLOOR SURFACE WIPE SAMPLE



FOOD PREPARATION SURFACE WIPE SAMPLE



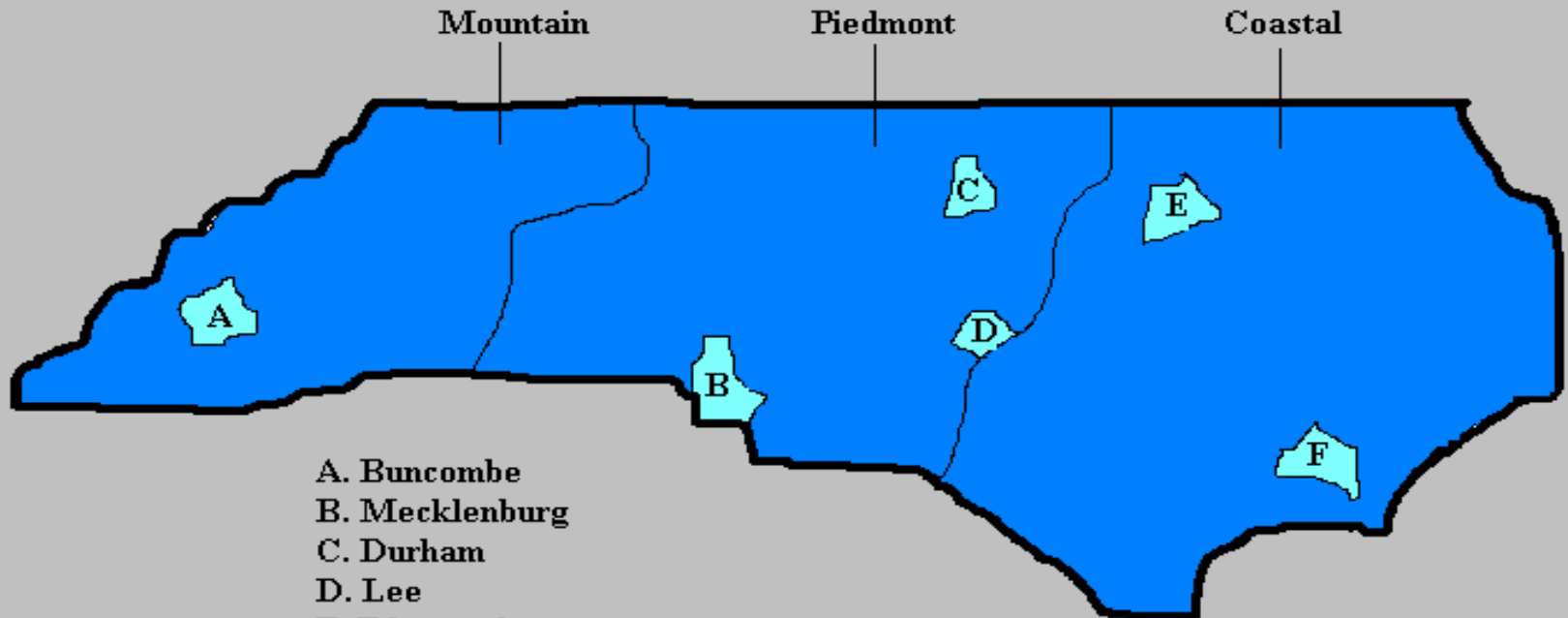
Study Procedures

- **Supplemental information:**
 - Food diaries
 - Child day care menus
 - Activity diaries
 - Videotape 10% of children
- **Information on aggregate exposures and absorbed doses**
 - Urine as biomarker of exposure

North Carolina

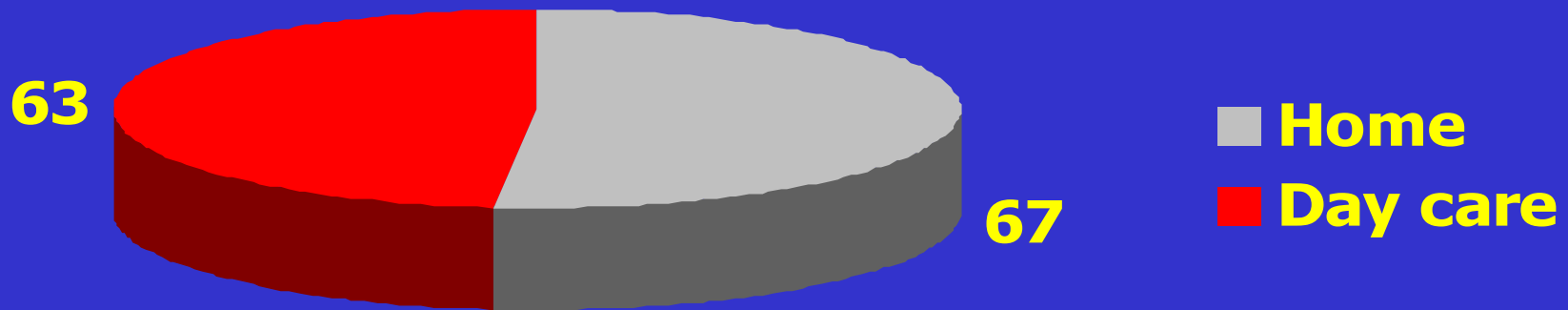
- Six counties:
 - Urban: *Buncombe, Durham, Edgecombe, Mecklenburg*
 - Rural: *Jones, Lee*
- Recruitment: February 2000 - February 2001
- Field sampling: July 2000 - March 2001
- Sample analysis: completed February 2003
- Final NC CTEPP database: completed August 2003

North Carolina



- A. Buncombe
- B. Mecklenburg
- C. Durham
- D. Lee
- E. Edgecombe
- F. Jones

NC Recruitment Results



Final Response Rates: Home 59%, Day care 53%

North Carolina

- Six counties:
 - Urban: *Buncombe, Durham, Edgecombe, Mecklenburg*
 - Rural: *Jones, Lee*
- Recruitment: February 2000 - February 2001
- Field sampling: July 2000 - March 2001
- Sample analysis: completed February 2003
- Final NC CTEPP database: completed August 2003

CTEPP: Targeted Pollutants

- Polycyclic Aromatic Hydrocarbons (e.g., benzo[a]pyrene)
- Phthalates (benzyl butyl, dibutyl)
- Phenols (e.g., pentachlorophenol, bisphenol-A)
- Polychlorinated Biphenyls (PCBs)
- Organochlorine Pesticides (e.g., lindane, DDT, heptachlor)
- Organophosphorus Pesticides (chlorpyrifos, diazinon)
- Acid Herbicides (e.g., 2, 4-D, dicamba)
- Triazine Pesticide (atrazine)
- Pyrethroid Pesticides (e.g., cyfluthrin, cis/trans-permethrin)

Reason for Selection: Compounds are possible carcinogens, endocrine disruptors, teratogens, neurotoxins, ubiquitous, or residues are common indoors or in food or water.

A. Phthalate Esters

- ' Dibutyl phthalate (DBP)
- ' Benzyl butyl phthalate (BBP)

B. Bisphenol-A (BPA)

Phthalate Esters

A. Plasticizers in polyvinyl chloride (PVC) products:

- ' floor tiles
- ' children's toys
- ' synthetic leather
- ' carpet backings
- ' shower curtains
- ' adhesives

-- Larger molecular weight phthalates (e.g., benzyl butyl phthalate)

B. Solvents and fixatives:

- ' Personal care products (perfumes, hairsprays, nail polishes)

-- Smaller molecular weight phthalates (e.g., dibutyl phthalate)

Bisphenol-A

Industrial chemical commonly used to make polycarbonate plastics and epoxy resins.

- ' **Reusable bottles (bottled water, baby bottles)**
- ' **Tableware (plates, cups)**
- ' **Digital media (DVDs, CDs)**
- ' **Electronics (cell phones, computers)**
- ' **Dental sealants**
- ' **Protective liners in metal cans (food, beverages)**

Analytical Issues: Phthalate Esters

A) Background contamination of phthalates in the field and lab blanks for all media.

Possible sources:

gauze pads

latex gloves

solvents

nitrile gloves

filtration cartridges

pipette holders

B) Surrogate recovery standard (SRS) – benzyl butyl phthalate-d₄

- major interferences in certain media (wipes, air, dust, soil)
- change to alternative SRS (e.g., benzyl butyl phthalate-d₁₀) that could reduce interferences

Analytical Issues: Bisphenol-A

A) Surrogate recovery standard (SRS) – bisphenol-A-d₆

- major interferences in certain media (wipes, air, dust, solid food)
- change to alternative SRS (e.g., bisphenol-A-d₁₀) that could reduce interferences

B) Background contamination in the field and lab blanks for a few wipe samples.

PRELIMINARY RESULTS

Mean method quantitation limits (MQLs) for DBP, BBP and BPA in multimedia samples

Medium	Unit	DBP	BBP	BPA
Soil	ug/g	0.03	0.05	0.01
Outdoor air	ug/m ³	0.06	0.18	0.002
Indoor air	ug/m ³	0.06	0.18	0.002
Indoor floor dust	ug/g	0.33	0.51	0.05
Hand wipe	ug/sample	0.39	0.80	0.03
Liquid food	ug/mL	0.10	0.07	0.001
Solid food	ug/g	0.24	0.17	0.002
Floor wipe	ug/m ²	2.7	5.5	0.20
Food prep. wipe	ug/m ²	2.7	5.5	0.20

^a Sample data were adjusted for the background contamination of phthalates in all media and for bisphenol-A in wipe samples.

Percentage of samples by medium containing detectable levels of DBP at/above the method detection limit (MDL) and method quantitation limit (MQL)

Medium	Homes			Day Care Centers		
	N	≥MDL	≥MQL	N	≥MDL	≥MQL
Soil	62	47%	35%	30	60%	40%
Outdoor air	78	44%	41%	42	64%	43%
Indoor air	128	100%	99%	60	100%	100%
Indoor floor dust	117	100%	100%	57	100%	100%
Hand wipes	76	84%	83%	31	90%	84%
Liquid food	63	33%	30%	36	28%	22%
Solid food	72	32%	29%	35	29%	20%
Floor wipe	26	100%	100%	----	----	----
Food prep. wipe	13	85%	85%	----	----	----

Percentage of samples by medium containing detectable levels of BBP at/above the method detection limit (MDL) and method quantitation limit (MQL)

Medium	Homes			Day Cares		
	N	≥MDL	≥MQL	N	≥MDL	≥MQL
Soil	77	47%	39%	38	26%	18%
Outdoor air	80	10%	10%	42	12%	12%
Indoor air	115	38%	31%	48	42%	21%
Indoor floor dust	116	100%	100%	57	100%	100%
Hand wipes	81	68%	60%	31	52%	42%
Liquid food	82	4%	4%	55	15%	11%
Solid food	72	4%	3%	39	8%	8%
Floor wipe	28	100%	96%	----	----	----
Food prep. wipe	15	67%	67%	----	----	----

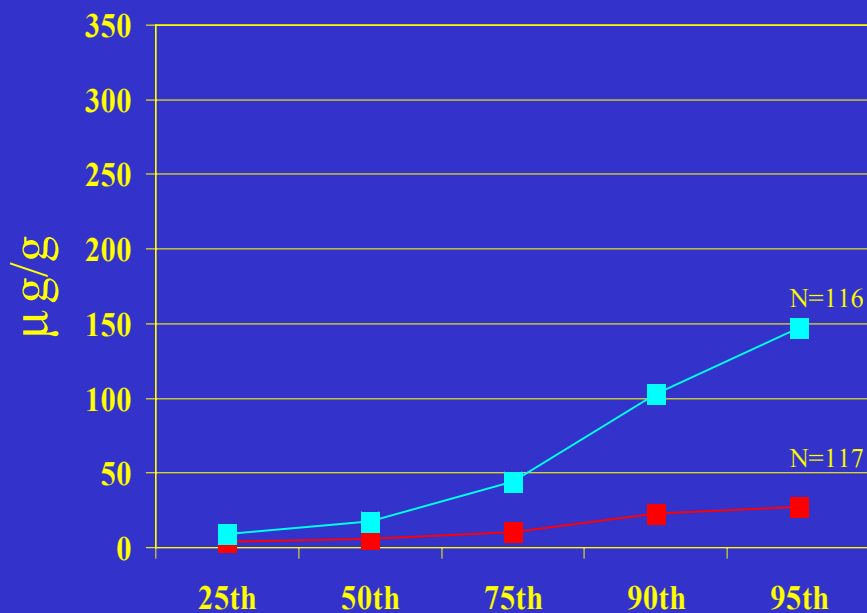
Percentage of samples by medium containing detectable levels of BPA at/above the method detection limit (MDL) and method quantitation limit (MQL)

Medium	Homes			Day Cares		
	N	≥MDL	≥MQL	N	≥MDL	≥MQL
Soil	97	52%	3%	30	73%	0%
Outdoor air	127	72%	11%	63	63%	32%
Indoor air	128	85%	52%	60	68%	23%
Indoor floor dust	52	100%	17%	35	100%	46%
Hand wipes	92	95%	93%	31	100%	100%
Liquid food	125	79%	24%	63	76%	51%
Solid food	129	94%	72%	61	97%	74%
Floor wipe	28	82%	75%	----	----	----
Food prep. wipe	18	89%	89%	----	----	----

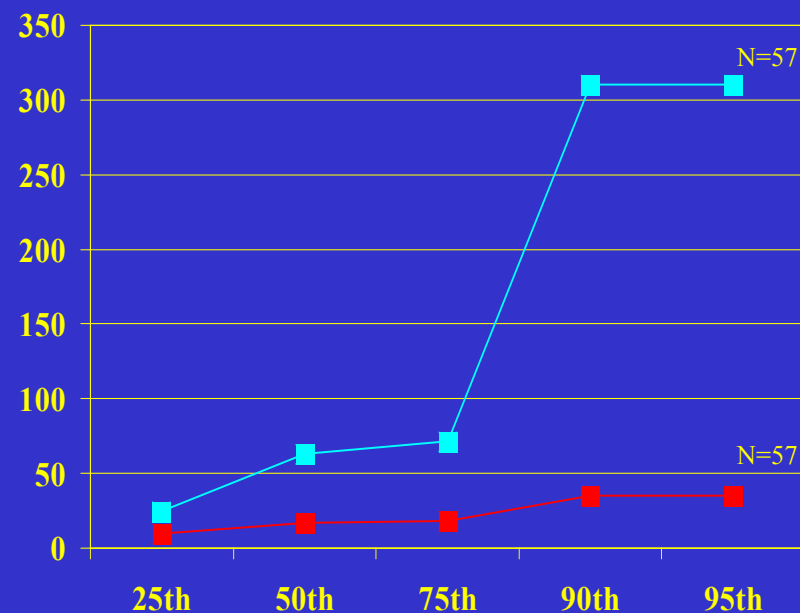
Concentrations of DBP and BBP in indoor floor dust samples at preschool children's homes and day care centers



HOMES



DAY CARE CENTERS



Percentiles

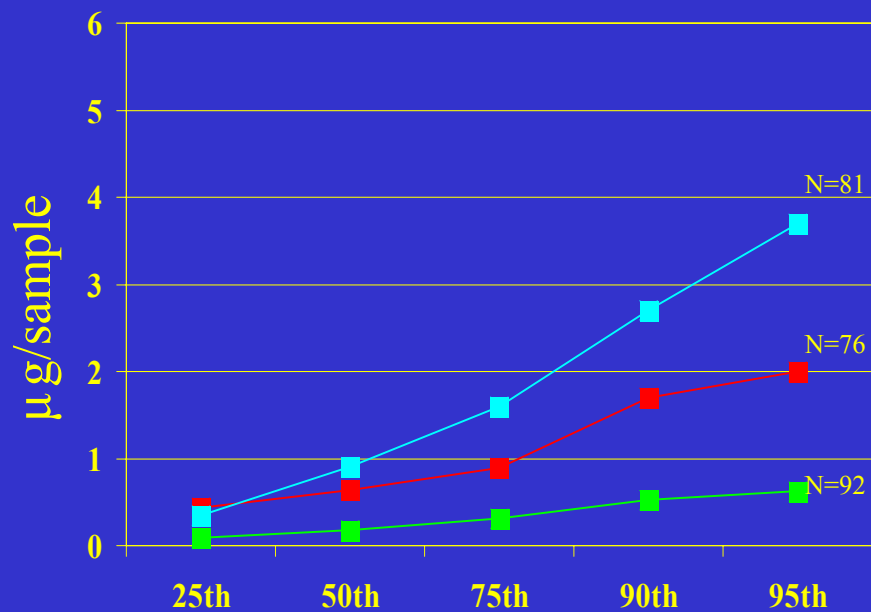
^a Data values below the MDL were assigned $\frac{1}{2}$ the lowest MDL value by matrix.

^b BPA had a low number of detects at homes (17%) and day care centers (46%).

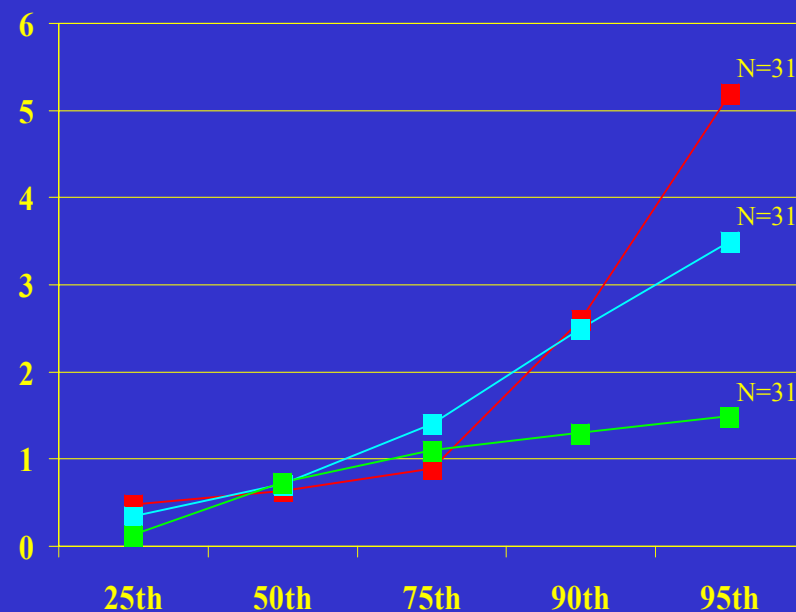
Concentrations of DBP, BBP and BPA in hand wipe samples at preschool children's homes and day care centers



HOMES



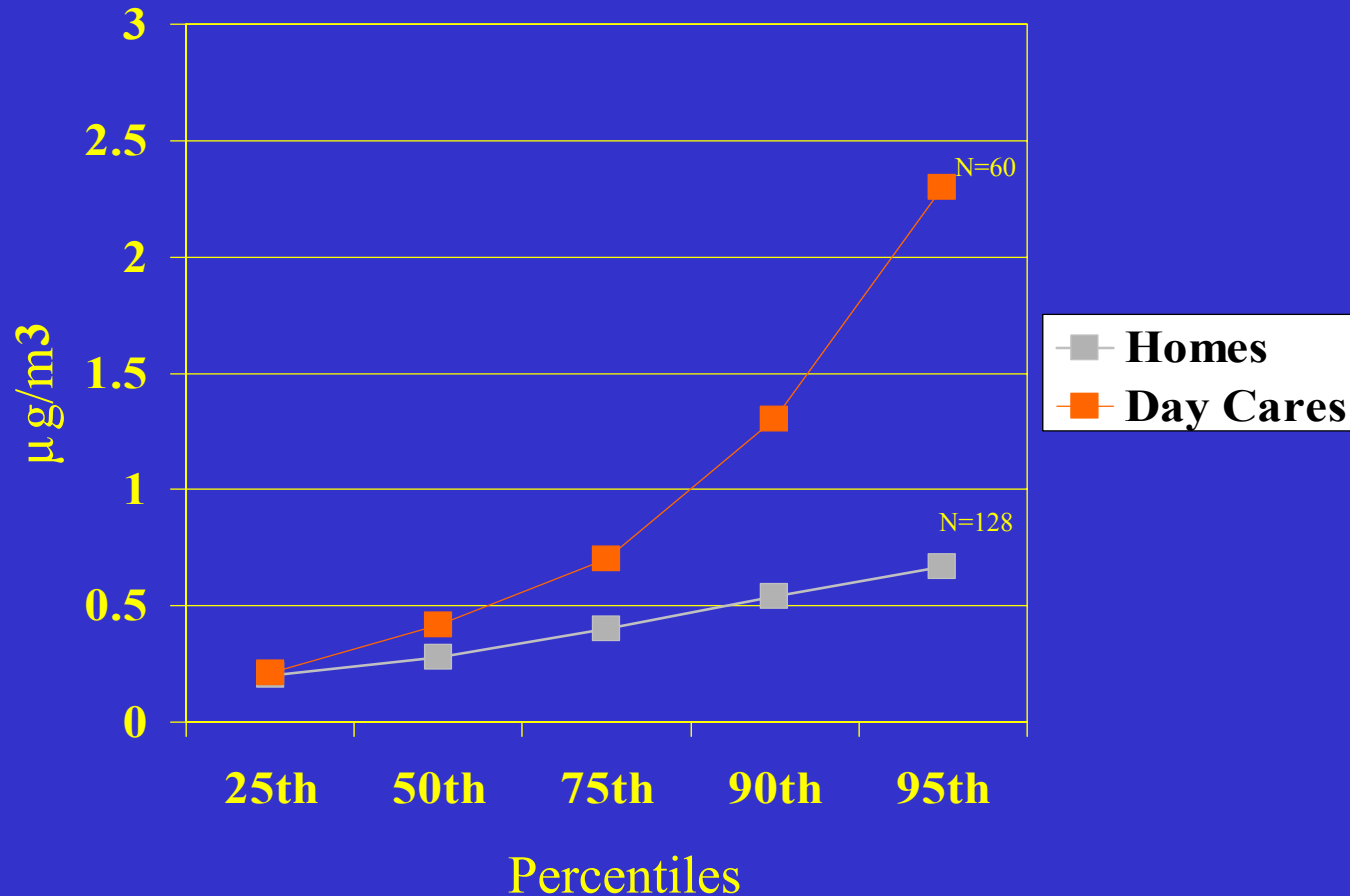
DAY CARE CENTERS



Percentiles

^aData values below the MDL were assigned $\frac{1}{2}$ the lowest MDL value by matrix

Concentrations of DBP in indoor air samples at preschool children's homes and day care centers

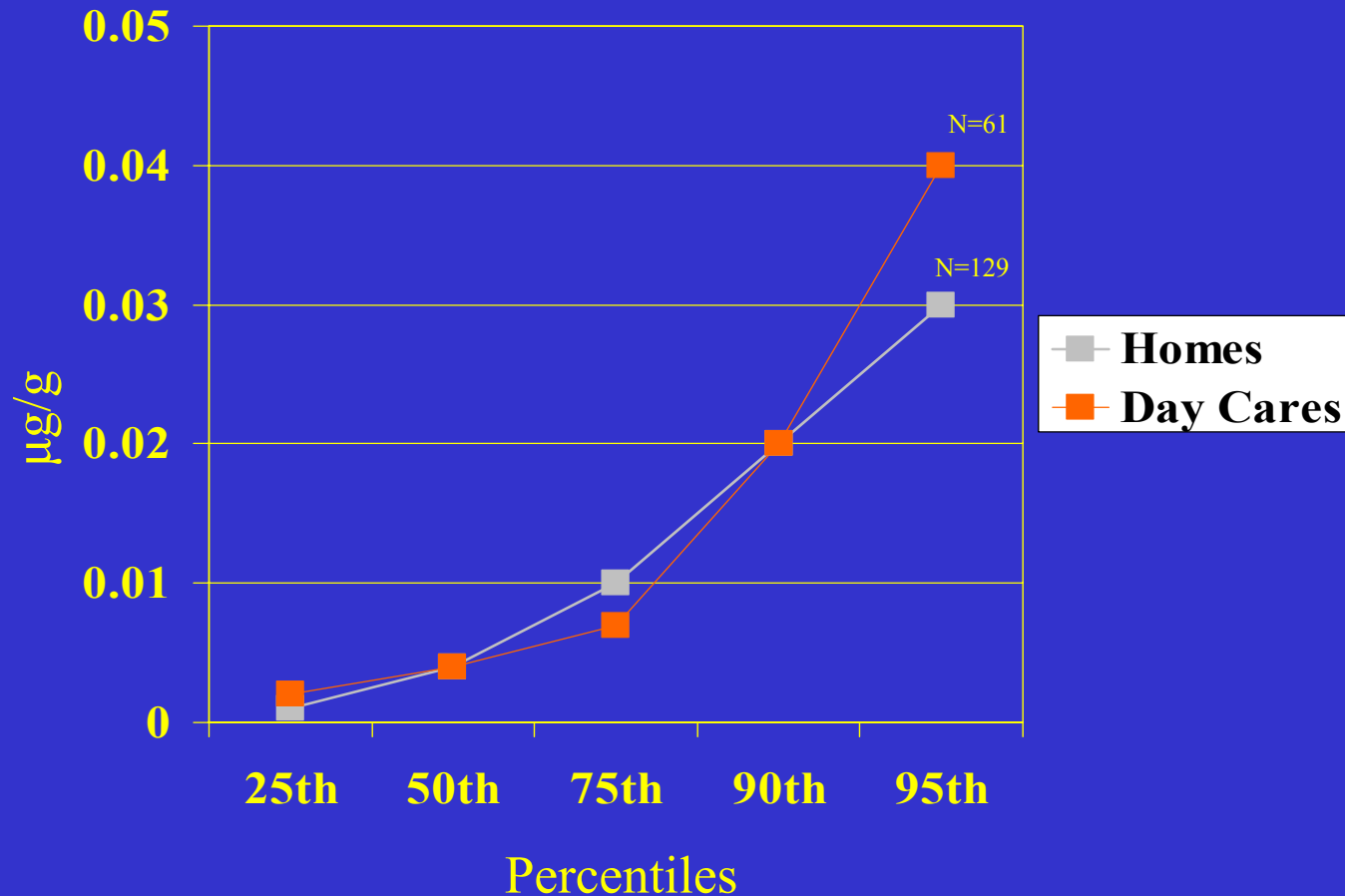


^a Data values below the MDL were assigned $\frac{1}{2}$ the lowest MDL value by matrix.

^b BBP had a low number of detects at homes (31%) and day care centers (21%).

^c BPA had a low number of detects at homes (52%) and day care centers (23%).

Concentrations of BPA in solid food samples at preschool children's homes and day care centers

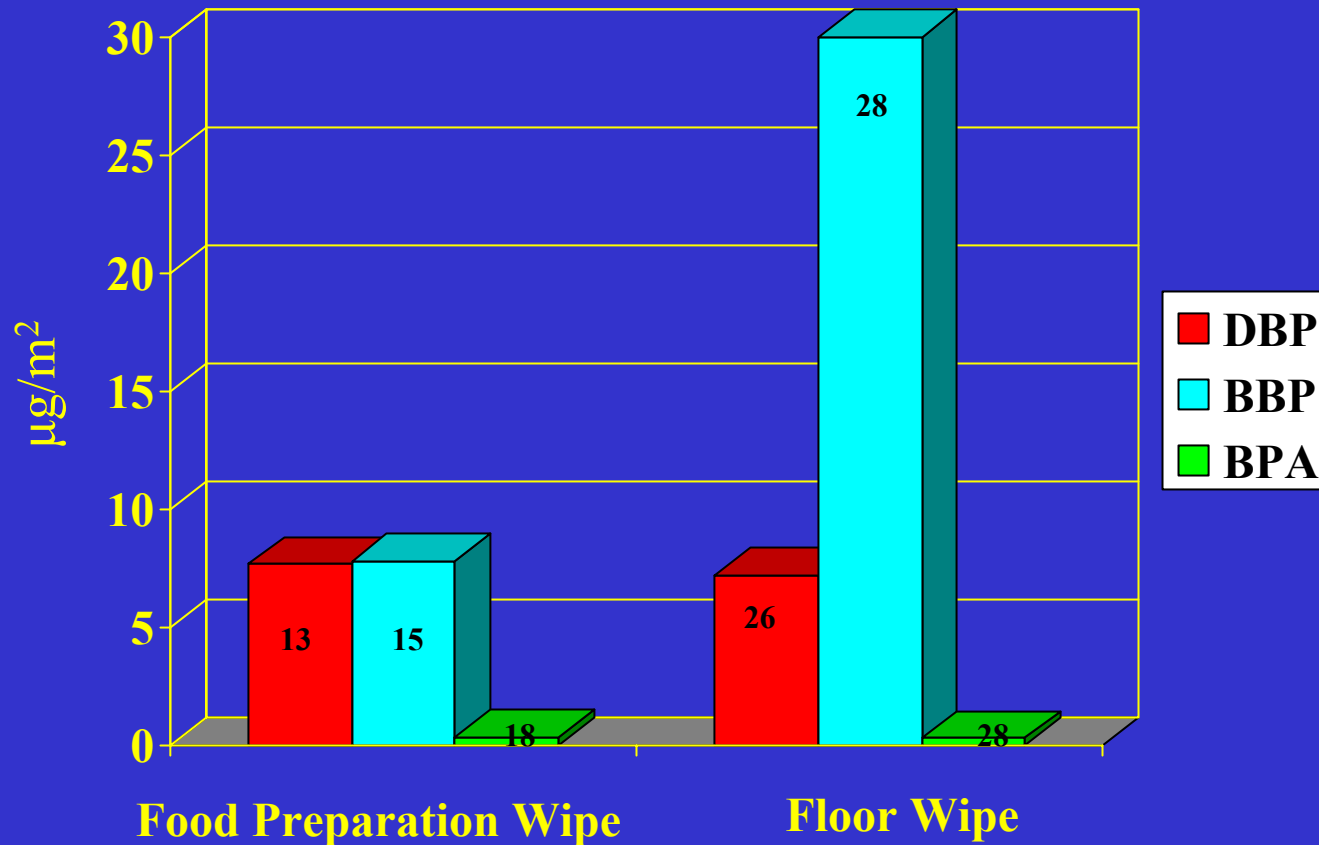


^a Data values below the MDL were assigned $\frac{1}{2}$ the lowest MDL value by matrix.

^b DBP had a low number of detects at homes (29%) and day care centers (20%).

^c BBP had a low number of detects at homes (3%) and day care centers (8%).

Median concentrations of DBP, BBP and BPA in floor and food preparation wipe samples at preschool children's homes



^a Data values below the MDL were assigned ½ the lowest MDL value by matrix

Conclusions

- DBP, BBP and BPA were detected in all media. However, they were detected the most often in the following:
 - ' DBP - indoor air, indoor floor dust and wipes
 - ' BBP – indoor floor dust and wipes
 - ' BPA – solid food and wipes
- Hard floors (e.g., vinyl flooring) in homes may be important sources of BBP exposure for preschool children.
- The results suggest that these preschool children were potentially exposed to low levels of DBP, BBP and BPA in their everyday environments.

Acknowledgements

- **U.S. EPA National Exposure Research Laboratory**
E. Streib, K. Thomas, E. Betz, C. Stevens
- **Battelle Memorial Institute**
S. Gordon, M. Brinkman, S. Anderson, F. Patterson, J. Satola
- **Parents, children, and child day care centers**

Disclaimer: This work has been funded wholly by the United States Environmental Protection Agency under contract #68-D-99-011 to Battelle. It has been subjected to Agency review and approved for publication.

Disclaimer: This work has been funded wholly by the United States Environmental Protection Agency under contract #68-D-99-011 to Battelle. It has been subjected to Agency review and approved for publication.