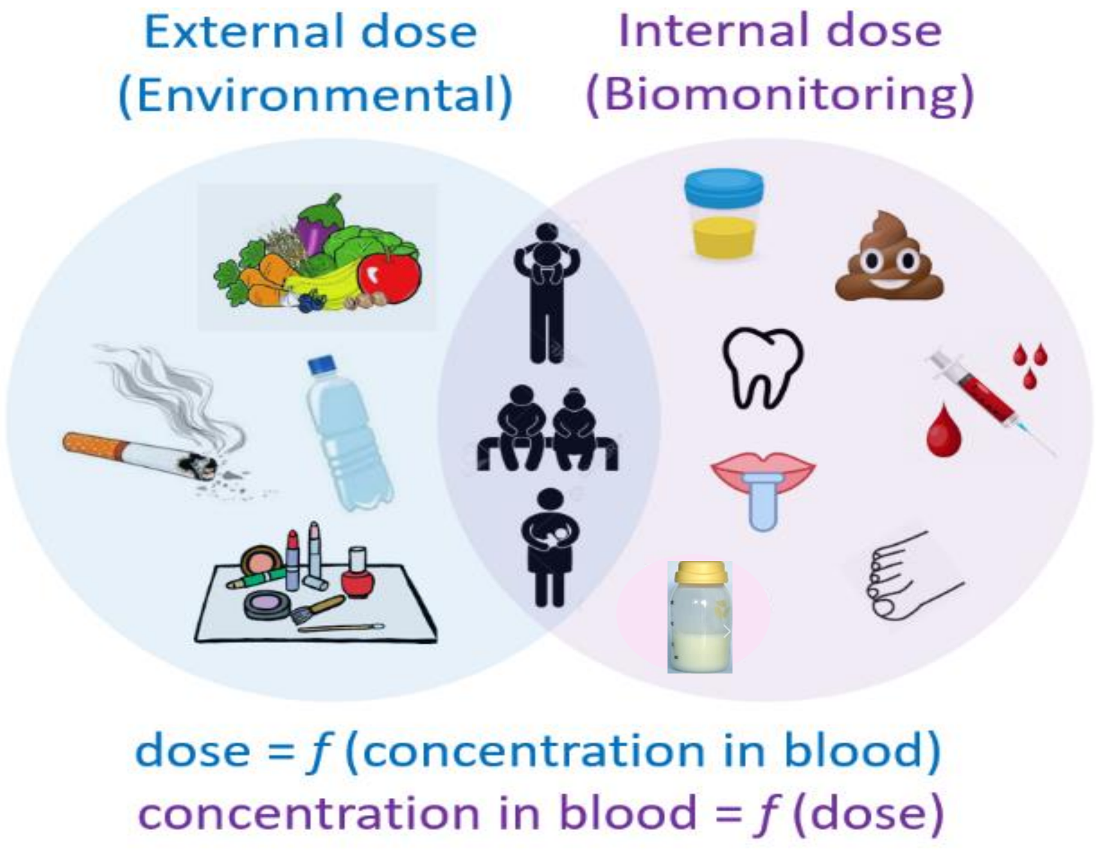
ECHO
Environmental influences on Child Health Outcomes
A program supported by the NIH

Assessment of exposure to chemicals of uncertain body burden and multi-panel chemical assay for analysis in ECHO

Kurunthachalam Kannan, PhD
Department of Pediatrics, New York University School of Medicine

Jessie P. Buckley, PhD, MPH
Environmental Health and Engineering & Epidemiology
Johns Hopkins University Bloomberg School of Public Health

Exposure Assessment



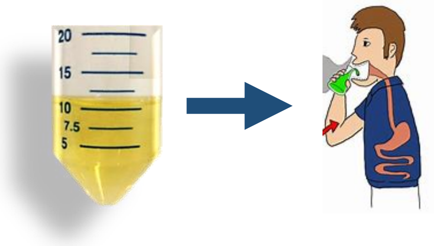
External dose = Internal dose:
All exposure sources are accounted for

External dose < Internal dose:
Existence of unaccounted sources of exposure

Phthalate Exposure Dose

Urinary Concentration → Exposure Dose

$$DI = CV \times \frac{M_1}{M_2} \times \frac{1}{f}$$



DI is the total daily intake of phthalates (μg/day)

C **is the urinary phthalate metabolite concentration (μg/L)**

V **is human daily excretion volume of urine (L/day)**

2010 - Median total phthalate conc in urine: 240 ug/L
Median exposure dose in the US population: ~550 ug/d

Sources of phthalate exposure

A Survey of Phthalates and Parabens in Personal Care Products from the United States and Its Implications for Human Exposure

Ying Guo and Kurunthachalam Kannan* | *Environ. Sci. Technol.* 2013, 47, 14442–14449

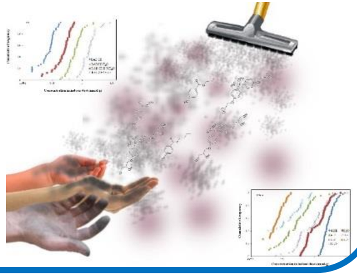
Perfumes, deodorants, nail polish - 10s - 1000s of μg/g

Adult female exposure: 22 μg/day

DEP

Comparative Assessment of Human Exposure to Phthalate Esters from House Dust in China and the United States

Ying Guo[†] and Kurunthachalam Kannan[†,‡,*] *Environ. Sci. Technol.* 2011, 45, 3788–3794



Concentrations in indoor air: 100s – 5000s ng/m^3

Concentrations in indoor dust: 10s - 100s of μg/g

Adult female exposure: 16 μg/day

Environmental Health Perspectives • VOLUME 121 | NUMBER 4 | April 2013

Phthalate Concentrations and Dietary Exposure from Food Purchased in New York State

Arnold Schecter,[1] Matthew Lorber,[2] Ying Guo,[3] Qian Wu,[3,4] Se Hun Yun,[3,4] Kurunthachalam Kannan,[3,4] Madeline Hommel,[1] Nadia Imran,[1] Linda S. Hynan,[5] Dunlei Cheng,[1] Justin A. Colacino,[6] and Linda S. Birnbaum[7,8]

Concentrations in food: few – 100 ng/g

Adult female exposure: 60 μg/day

DEHP

DBP

Unknown sources of phthalate exposure

Total
550 µg/d

>

Known sources
22+16+60 = 98 µg/d

Only one-fifth of the exposure sources is accounted for

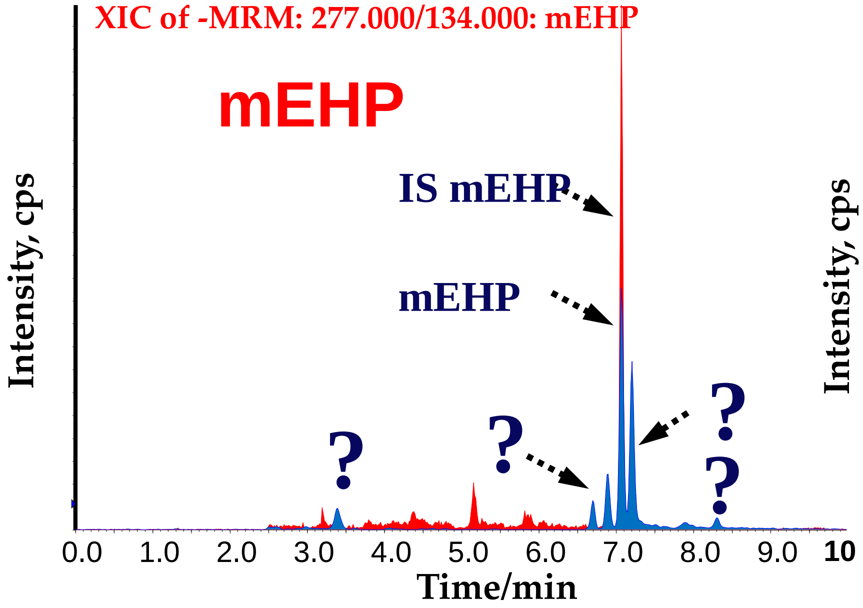


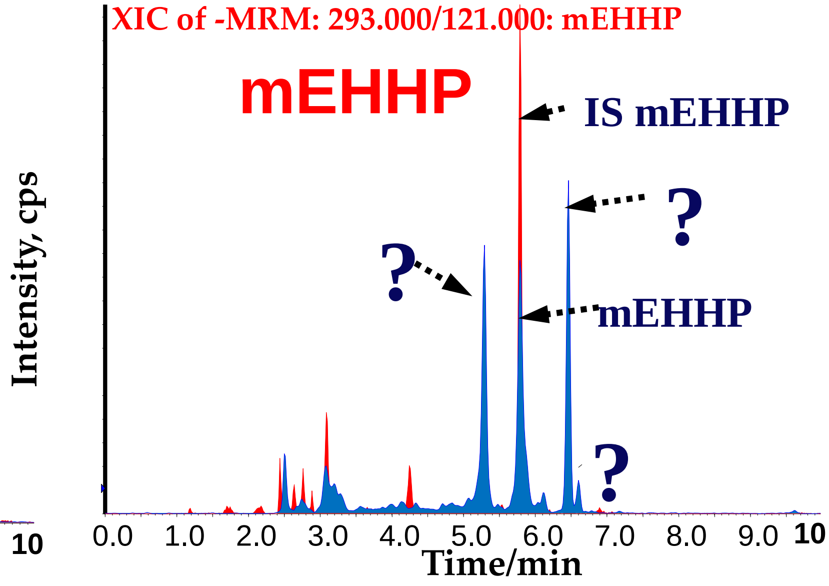



Pads Panty liners

Microplastics exposure dose: up to 10 mg/d

Many unknown phthalate metabolites in urine – not measured





Secondary metabolites and adducts

Many unknown phthalate metabolites exist in urine

Biomarkers to elucidate adverse outcome pathways in human diseases

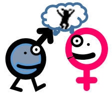
ORIGINAL ARTICLES: ENVIRONMENT AND EPIDEMIOLOGY

Urinary bisphenol A, phthalates, and couple fecundity: the Longitudinal Investigation of Fertility and the Environment (LIFE) Study

Germaine M. Buck Louis, Ph.D.,[a] Rajeshwari Sundaram, Ph.D.,[a] Anne M. Sweeney, Ph.D.,[b] Enrique F. Schisterman, Ph.D.,[a] José Maisog, M.D., M.S.,[a] and Kurunthachalam Kannan, Ph.D.[c]

[a] Division of Intramural Population Health Research, Eunice Kennedy Shriver National Institute of Child Health and Human Development, Rockville, Maryland; [b] Department of Epidemiology and Biostatistics, Texas A&M Rural School of Public Health, College Station, Texas; and [c] Division of Environmental Health Sciences, Wadsworth Center, New York State Department of Health and the Department of Environmental Health Sciences, The University at Albany, Albany, New York

Buck Louis et al. Fertility and Sterility (2014), 101, 1359

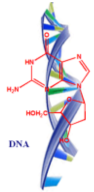


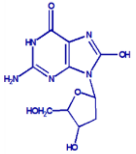
Phthalate exposure in males increases time to achieve pregnancy in women

↓ ??

Phthalates affect semen quality parameters; plasma oxidative enzymes ⇧

↓ ?





8-OHdG

Elevated oxidative stress biomarkers in urine

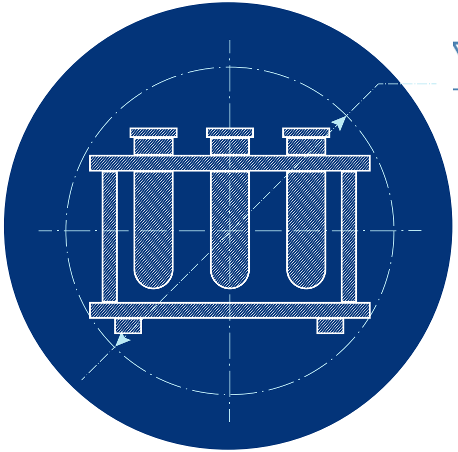
↓ ?

Infertility / adverse reproductive health

HHEAR Laboratory and Data Analysis Services

Researchers who want to add or expand exposure analysis to their studies of human health

Expert consultation on exposure analysis, study design, and methods



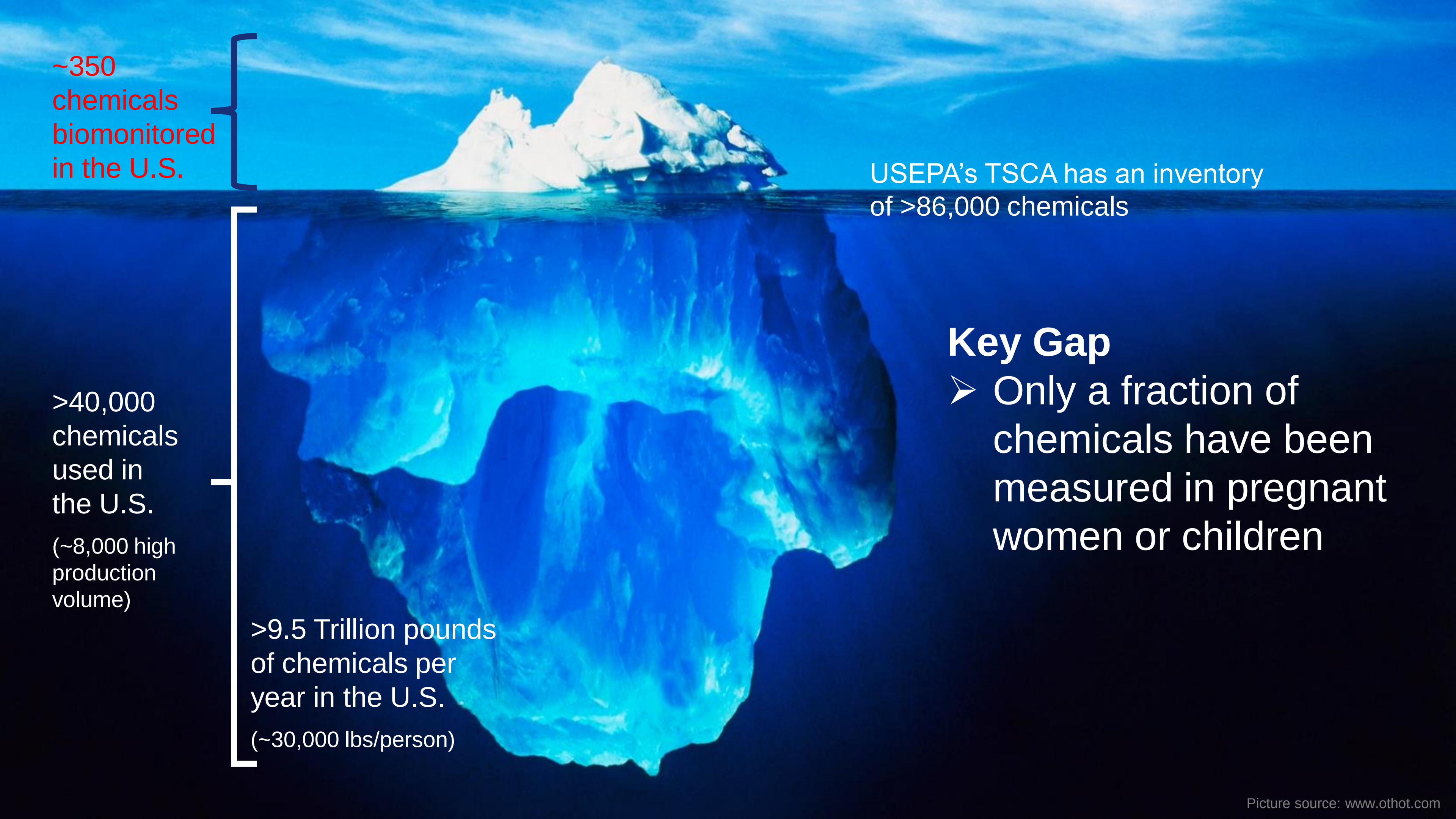
Statistical analysis, data integration and interpretation

A data repository and associated data science tools

Targeted (hypothesis driven) analysis of biological samples

Untargeted (discovery driven) analysis of biological samples

Targeted and untargeted analysis of environmental samples



~350 chemicals biomonitored in the U.S.

USEPA's TSCA has an inventory of >86,000 chemicals

>40,000 chemicals used in the U.S.

(~8,000 high production volume)

>9.5 Trillion pounds of chemicals per year in the U.S.

(~30,000 lbs/person)

Key Gap

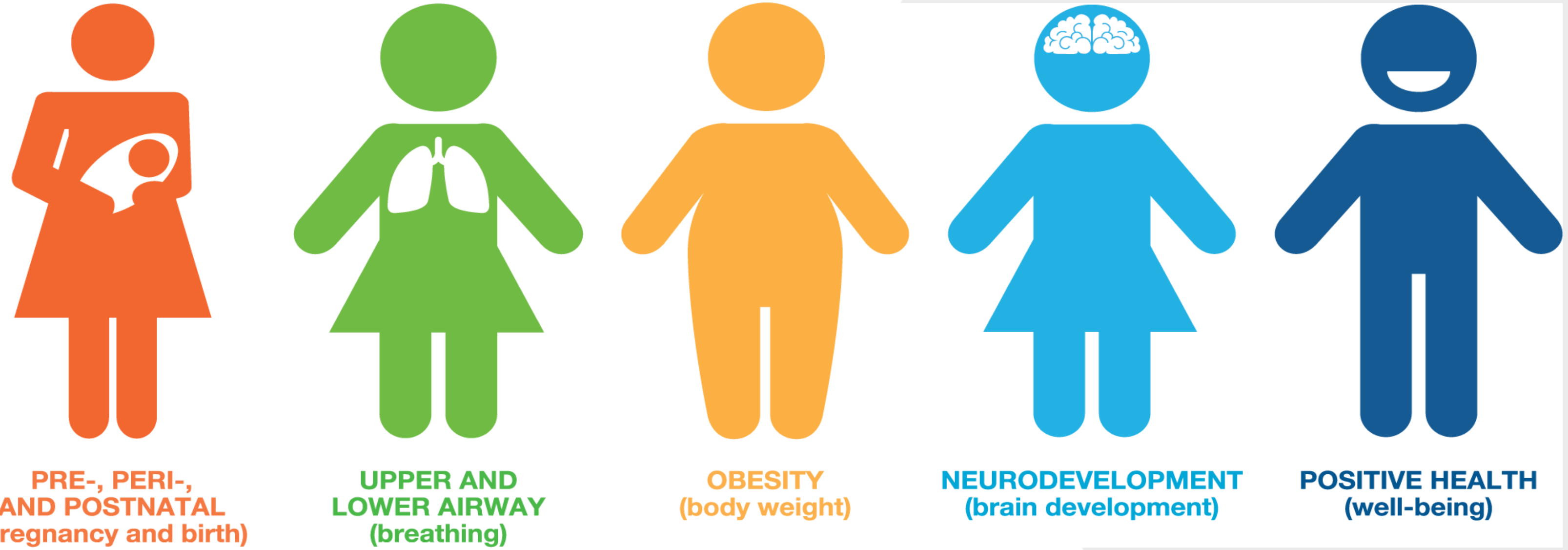
- Only a fraction of chemicals have been measured in pregnant women or children

Picture source: www.othot.com

ECHO’S CHEMICAL EXPOSURE WORKING GROUP

Goals:

- Develop **recommendations** for chemical exposures to be measured in ECHO cohorts
- Support **science** evaluating chemical exposures and child health effects



Identifying and prioritizing candidate chemicals

Review

A Section 508–conformant HTML version of this article
is available at https://doi.org/10.1289/EHP5133.

Identifying and Prioritizing Chemicals with Uncertain Burden of Exposure: Opportunities for Biomonitoring and Health-Related Research

Edo D. Pellizzari,[1] Tracey J. Woodruff,[2] Rebecca R. Boyles,[3] Kurunthachalam Kannan,[4] Paloma I. Beamer,[5] Jessie P. Buckley,[6] Aolin Wang,[2] Yeyi Zhu,[7,8] and Deborah H. Bennett[9] (Environmental influences on Child Health Outcomes)

[1]Fellow Program, RTI International, Research Triangle Park, North Carolina, USA
[2]Program on Reproductive Health and the Environment, Department of Obstetrics, Gynecology and Reproductive Sciences, University of California, San Francisco, San Francisco, California, USA
[3]Bioinformatics and Data Science, RTI International, Research Triangle Park, North Carolina, USA
[4]Wadsworth Center, New York State Department of Health, Albany, New York, USA
[5]Department of Community, Environment and Policy, Zuckerman College of Public Health, University of Arizona, Tucson, Arizona, USA
[6]Department of Environmental Health and Engineering, Johns Hopkins Bloomberg School of Public Heath, Johns Hopkins University, Baltimore, Maryland, USA
[7]Northern California Division of Research, Kaiser Permanente, Oakland, California, USA
[8]Department of Epidemiology and Biostatistics, University of California, San Francisco, San Francisco, California, USA
[9]Department of Public Health Sciences, University of California, Davis, Davis, California, USA

We selected 155 chemicals for evaluation based on a rigorous process using extant data. We prioritized chemicals based on:

- Present in consumer products
- Quantifiable in environmental samples
- Potentially toxic chemical structure
- Not previously well-characterized

Background: The National Institutes of Health's Environmental influences on Child Health Outcomes (ECHO) initiative aims to understand the impact of environmental factors on childhood disease. Over 40,000 chemicals are approved for commercial use. The challenge is to prioritize chemicals for biomonitoring that may present health risk concerns.

Objectives: Our aim was to prioritize chemicals that may elicit child health effects of interest to ECHO but that have not been biomonitored nationwide and to identify gaps needing additional research.

Methods: We searched databases and the literature for chemicals in environmental media and in consumer products that were potentially toxic. We selected chemicals that were not measured in the National Health and Nutrition Examination Survey. From over 700 chemicals, we chose 155 chemicals and created eight chemical panels. For each chemical, we compiled biomonitoring and toxicity data, U.S. Environmental Protection Agency exposure predictions, and annual production usage. We also applied predictive modeling to estimate toxicity. Using these data, we recommended chemicals either for biomonitoring, to be deferred pending additional data, or as low priority for biomonitoring.

Environmental Health Perspectives, (2019) 127, 126001

Developing chemical assay panel

- 7 chemical panels; ~48 compounds
- Majority of them have urinary biomarkers; PFASs in serum
- Some are GC type and some are LC type chemicals
- To the list add routinely measured flame retardants, plasticizers, phenols and pesticides that have similar properties and can be analyzed in the same method

Alternative flame retardants	
Bis(2-ethylhexyl) tetrabromophthalate (BEH-TEBP)	Melamine
Hexabromobenzene (HBBz)	Cyanuric acid**
Hexabromocyclododecane (HBCD)	
Alternative plasticizers	
Bis(2-ethylhexyl) adipate (DEHA)	Bis(2-ethylhexyl)-1,4-terephthalate (DEHT)
Aromatic amines	
2-Methoxyaniline (Anisidine)	2,4-Diaminotoluene***
2-Methylaniline	4,4'-Diaminodiphenylmethane***
3,4-Dichloroaniline	
Environmental phenols	
Bisphenol A diglycidyl ether (BADGE)	3,3',5,5'-Tetrabromobisphenol A (TBBPA)
BADGE derivatives**	2,2',6,6'-Tetrachlorobisphenol A (TraTBA)
Bisphenol AF (BPAF)	4-n-Nonylphenol
Bisphenol B	3,3',5-Trichlorobisphenol A (TrCBA)***
Organophosphate esters	
2,2-Bis(chloromethyl) propane-1,3-diyltetrakis(2-chloroethyl) bisphosphate (V6)	Tris(2-butoxyethyl) phosphate (TBOEP)
2-Ethylhexyl diphenyl phosphate (EHDPP)	Tris(2-ethylhexyl) phosphate (TEHP)
Bis(2-ethylhexyl) phosphate (BEHP)	
Perfluoroalkyl substances	
Perfluorobutanoic acid (PFBA)	Perfluorotridecanoic acid (PFTrDA)
Perfluorohexanoic acid (PFHxA)	Perfluorooctadecanoic acid (PFODA)***
Perfluoropentanoic acid (PFPeA)	
Pesticides	
Azoxystrobin	Neonicotinoids**
Benomyl	Propiconazole
Captan	Pyrimethanil
Chlorpropham	Tebuconazole
Cyprodinil	Difenoconazole***
Dicloran	Metribuzin***
Glyphosate**	Pyraclostrobin***
Iprodione	Tetraconazole***
Metalaxyl	Triclopyr***

Multi-class chemicals: Phthalate metabolites including replacement phthalates, environmental phenols including novel bisphenols, organophosphate esters, hydroxyl PAHs and current use pesticides

Multi-Class Chemical Biomarker Panel (n=121)
Phthalates and other plasticizers (n=45): 37 metabolites of 25 parent compounds: dimethyl phthalate, diethyl phthalate, di-iso-propylphthalate, dipropylphthalate, di-iso-butyl phthalate, dibutyl phthalate, dipentyl phthalate, di-n-hexyl phthalate, di-octylphthalate, benzylbutyl phthalate, di-n-heptylphthalate, di-n-octyl phthalate, di-2-ethylhexyl phthalate, di-iso-decylphthalate, di-iso-nonyl phthalate, di-iso-nonyl-cyclohexane-1,2-dicarboxy, di-(2-propylheptyl) phthalate, diethyl terephthalate, di-tert-butyl terephthalate, dibenzyl terephthalate, tri-n-butyl phosphate, tri-iso-butyl phosphate, triphenyl phosphate, trimethylphenyl phosphate, tris(1,3-dichloro-2-propyl) phosphate; 9 parent compounds: mono-benzyl terephthalate, triethyl phosphate, tri-n-butyl phosphate, tri-iso-butyl phosphate, tris(2-chloroethyl) phosphate, tripropyl phosphate, triphenyl phosphate, tris(2-butoxyethyl) phosphate, phthalic acid
Phenols (n=45); 6 parabens (methyl, ethyl, n-propyl, n-butyl, benzyl, and heptyl); 6 benzophenones (1, 2, 3, 6, 8 and 4-hyroxy), 2 trichlorophenols (2,4,5 and ,2,4,6), 3 tetrachlorphenols (2,3,5,6; 2,3,4,6; and 2,3,4,5), pentachlorophenol, BPA and 10 replacements (BPF, BPS, BPB, BPZ, BPAP, BPAF, BPP, TBBPA, TCBPA, TeCBPA), 3 BADGEs, triclocarban, triclosan, 2 metabolites of naphthalene (1-hydroxynaphthalene, 2-hydroxynaphthalene), 3 metabolites of fluorene (2-hydroxyfluorene, 3-hydroxyfluorene, 9-hydroxyfluorene), 5 metabolites of phenanthrene (1, 2, 3, 9, 4-hydroxyphenanthrene)
Pesticides (n=31); nitenpyram, thiamethoxam, imidacloprid, acetamiprid, thiacloprid, clothianidin, flonicamid, N-desmethyl, thiamethoxam, N-desmethyl-acetamiprid, thiacloprid-amide, imidaclothiz, 6-chloronicotinic acid, sulfoxaflor, 4-nitrophenol, 2,4-dichlorophenoxyacetic acid, 3,5,6-trichloro-2-pyridinol, trans-3-(2,2-di-chlorovinyl)-2,2-dimethyl cyclopropane-1-carboxylic acid, cis-3-(2,2-di-chlorovinyl)-2,2-dimethyl-cyclopropane-1-carboxylic acid, 3-phenoxybenzoic acid, 4-fluoro-3-phenoxybenzoic acid, 2,4,5-trichlorophenoxyacetic acid, pyrimethanil, dinotefuran, metribuzin, atrazine, cyprodinil, metalaxyl, tebuconazole, propiconazole, tetraconazole, azoxystrobin

Goal

Develop a comprehensive high throughput analytical method to measure a multi-class environmental chemicals in urine (saves time and cost and samples)

- **Ultra trace levels (pg to ng concentrations) – quantitation**
- **Lack of analytical standards and internal standards**
- **Toxico-kinetics not known; what is the right biomarker?**
- **Multi-class: Challenging due to different functional groups, solubility, polarity and ionizability**
- **Cost of analysis (multi-class methods reduce cost and time)**

Steps in analytic method development

- Acquire standards: native and labelled internal standards
- Infuse standards and build a mass spec method (GC/LC/mass spec amenability)
- Optimize liquid chromatographic method (column, mobile phase, additives, pH)
- Develop a robust extraction and purification (sample preparation method)
- Optimize analytical parameters for traceability, accuracy, precision, sensitivity and selectivity
- Validate the method; PT samples, SRMs, interlab studies

International Journal of Hygiene and Environmental Health 234 (2021) 113741

Contents lists available at ScienceDirect

International Journal of Hygiene and Environmental Health

journal homepage: www.elsevier.com/locate/ijheh

Quality assurance and harmonization for targeted biomonitoring measurements of environmental organic chemicals across the Children's Health Exposure Analysis Resource laboratory network

Kurunthachalam Kannan [a,*], Alexa Stathis [b], Matthew J. Mazzella [c], Syam S. Andra [c], Dana Boyd Barr [d], Stephen S. Hecht [e], Lori S. Merrill [f], Aubrey L. Galusha [b,g], Patrick J. Parsons [b,g]

[a] *Department of Pediatrics and Department of Environmental Medicine, New York University, School of Medicine, New York, NY, 10016, USA*
[b] *Division of Environmental Health Sciences, Wadsworth Center, New York State Department of Health, Albany, NY, 12237, USA*
[c] *Department of Environmental Medicine & Public Health, Icahn School of Medicine at Mount Sinai, New York, NY, 10029, USA*
[d] *Gangarosa Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta, GA, 30322, USA*
[e] *Masonic Cancer Center, University of Minnesota, Minneapolis, MN, 55455, USA*
[f] *Westat, Rockville, MD, 20850, USA*
[g] *Department of Environmental Health Sciences, University at Albany, Rensselaer, NY, 12144, USA*

MS/MS method

AB SCIEX QTRAP 5500+ triple quadrupole; Exion LC

Example of first 45 chemicals

Details for other chemicals are found on the published paper; JCA 1646 (2021).

Negative and positive ionization modes simultaneously; 2 mass spec methods

Compound name, abbreviation, CAS number, MRM (quantification) transition, collision energy (CE), method classification (MC), and retention time (RT) for 121 target compounds analyzed in the present study.

No.	Compound name	Synonym	CAS number	QT	CE	MC	RT
Plasticizers and metabolites							
1	phthalic acid	PA	88–99–3	165>77	−25	MSM1_NEG	3.77
2	mono-methyl phthalate	mMP	4376–18–5	179>77	−25	MSM1_NEG	4.37
3	mono-ethyl phthalate	mEP	2306–33–4	193>77	−25	MSM1_NEG	5.06
4	mono-isopropyl phthalate	mIPrP	4376–18–5	207>77	−25	MSM1_NEG	5.59
5	mono-n-propyl phthalate	mPrP	4376–19–6	207>77	−25	MSM1_NEG	5.77
6	mono-isobutyl phthalate	mIBP	30833–53–5	221>77	−25	MSM1_NEG	6.34
7	mono–butyl phthalate	mBP	131–70–4	221>77	−25	MSM1_NEG	6.40
8	mono-pentyl phthalate	mPeP	24539–56–8	235>77	−25	MSM1_NEG	6.95
9	mono-hexyl phthalate	mHxP	24539–57–9	249>77	−25	MSM1_NEG	7.40
10	mono-(3-carboxypropyl) phthalate	mCPP	66851–46–5	251>103	−25	MSM1_NEG	4.56
11	mono-benzyl phthalate	mBzP	2528–16–7	255>183	−16	MSM1_NEG	6.47
12	mono-2-heptyl phthalate	mHpP	129171–03–5	263>77	−25	MSM1_NEG	7.62
13	mono-octyl phthalate	mOP	5393–19–1	277>125	−20	MSM1_NEG	8.03
14	mono-(2-ethylhexyl) phthalate	mEHP	4376–20–9	277>134	−21	MSM1_NEG	7.89
15	mono-(2-ethyl-5-oxohexyl) phthalate	mEOHP	40321–98–0	291>121	−25	MSM1_NEG	6.29
16	mono-(2-ethyl-5-hydroxyhexyl) phthalate	mEHHP	40321–99–1	293>121	−26	MSM1_NEG	6.52
17	mono-isodecyl phthalate	mIDP	31047–64–0	305>155	−25	MSM1_NEG	8.39
18	mono-(2-ethyl-5-carboxypentyl) phthalate	mECPP	40809–41–4	307>159	−25	MSM1_NEG	6.39
19	mono-[2-(carboxymethyl)hexyl] phthalate	mCMHP	82975–93–7	307>159	−25	MSM1_NEG	7.00
20	mono-(7-carboxyheptyl) phthalate	mCHpP	856869–57–3	307>159	−25	MSM1_NEG	6.49
21	mono-carboxy-isooctyl phthalate	mCIOP	898544–09–7	321>173	−20	MSM1_NEG	6.77
22	mono-carboxy-isononyl phthalate	mCINP	1373125–93–9	335>187	−21	MSM1_NEG	7.16
23	2-(((9-hydroxydecyl)oxy)carbonyl) benzoic acid	mHiDP	not available	321>121	−35	MSM1_NEG	7.30
24	monohydroxy-isononyl phthalate	mHiNP	898544–10–0	307>121	−25	MSM1_NEG	6.95
25	cyclohexane-1,2-dicarboxylic acid-mono (hydroxy-isononyl) ester	mHNCH	1637562–52–7	313.3>153	−25	MSM1_NEG	7.40
26	cyclohexane-1,2-dicarboxylic acid-mono (oxo-isononyl) ester	mONCH	1588520–62–0	311.4>153	−25	MSM1_NEG	7.20
27	mono-2-(propyl-6-oxoheptyl)-phthalate	mPOHP	1373125–92–8	319.3>121.1	−22	MSM1_NEG	7.08
28	mono-2-(propyl-6-hydroxy-heptyl)-phthalate	mPHHP	1372605–11–2	321.2>121	−35	MSM1_NEG	7.31
29	cyclohexane-1,2-dicarboxylic acid- monocarboxy isooctyl ester	mCOCH	1637562–51–6	327.4>173.1	−22	MSM1_NEG	7.28
30	mono-2-(propyl-6-carboxy-hexyl)-phthalate	mPCHP	1412411–10–9	335.3>187.3	−15	MSM1_NEG	7.16
31	mono-ethyl terephthalate	mETP	713–57–5	192.9>119.9	−28	MSM1_NEG	6.29
32	mono–tert–butyl terephthalate	mTBTP	20576–82–3	221>119.8	−30	MSM1_NEG	7.18
33	mono-benzyl terephthalate	mBzTP	18520–63–3	255.3>119.9	−25	MSM1_NEG	7.38
34	triethyl phosphate	TEP	78–40–0	183>99.1	35	MSM2_POS	3.09
35–1	tri-n–butyl phosphate	TNBP	126–73–8	267.1>99	22	MSM2_POS	5.12
35–2	tri-isobutyl phosphate	TIBP	126–71–6	267.1>99	22	MSM2_POS	
37	tris(2-chloroethyl) phosphate	TCEP	115–96–8	284.9>63.1	40	MSM2_POS	3.42
38	tripropyl phosphate	TPP	513–08–6	225.1>99	35	MSM2_POS	3.93
39	triphenyl phosphate	TPhP	115–86–6	327.1>77.1	46	MSM2_POS	4.98
40	tris(2-butoxyethyl) phosphate	TBOEP	78–51–3	399.1>199	20	MSM2_POS	5.51
41–1	di-n–butyl phosphate	DNBP	107–66–4	209>78.9	−35	MSM1_NEG	6.92
41–2	di-isobutyl phosphate	DIBP	6303–30–6	209>78.9	−35	MSM1_NEG	
43	diphenyl phosphate	DPhP	838–85–7	248.9>93.1	−40	MSM1_NEG	6.28
44	bis(2-methylphenyl) phosphate	BMPP	35787–74–7	277>107	−40	MSM2_NEG	2.66
45	bis(1,3-dichloro-2-propyl) phosphate	BDCIPP	72236–72–7	316.9>35	−30	MSM2_NEG	1.74

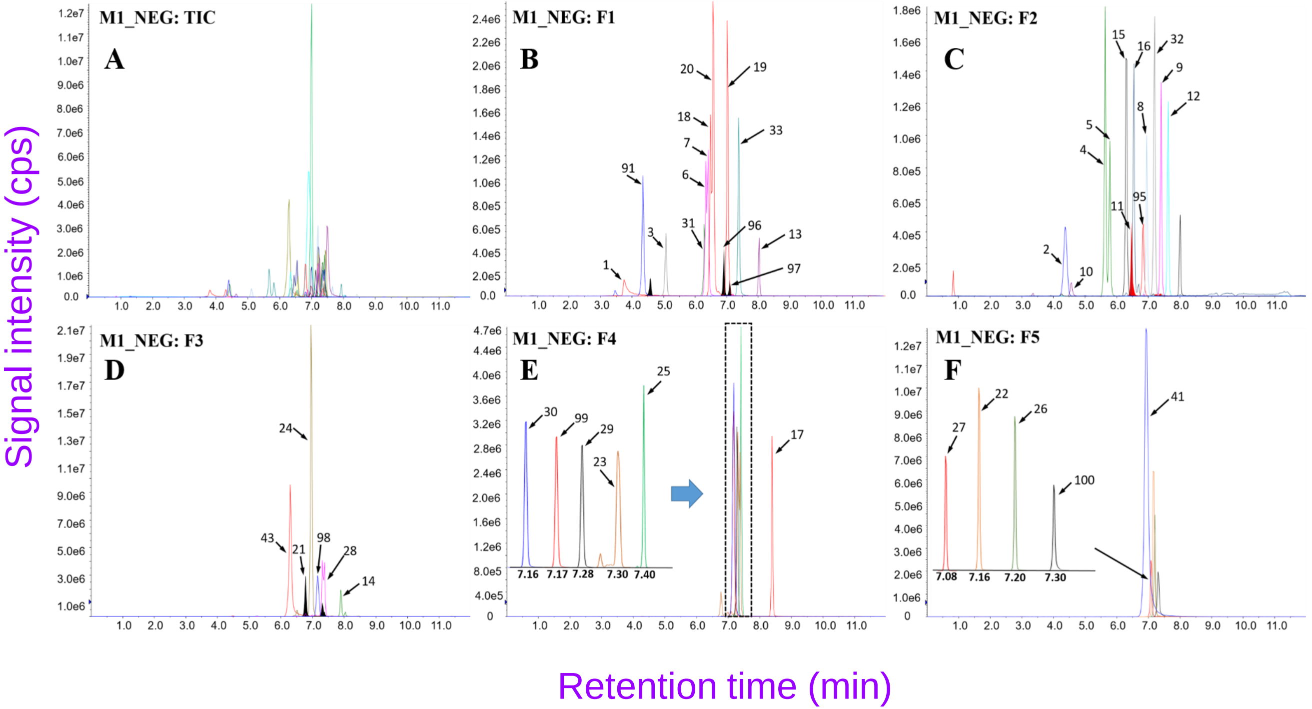
HPLC method

Two separate LC columns – Ultra AQ C18; Betasil C18
2 mass spec methods.

An example total ion chromatogram (TIC; A) and extracted ion chromatograms (B–F) of 43 target compounds at concentration of 10 ng/mL measured in method 1 under negative mode (M1_NEG).

For the sake of distinction individual compounds, ion chromatograms were extracted and divided into five fractions (i.e., F1-F5) depending on their retention times and signal intensities. Peak numbers correspond to compounds in Table 1

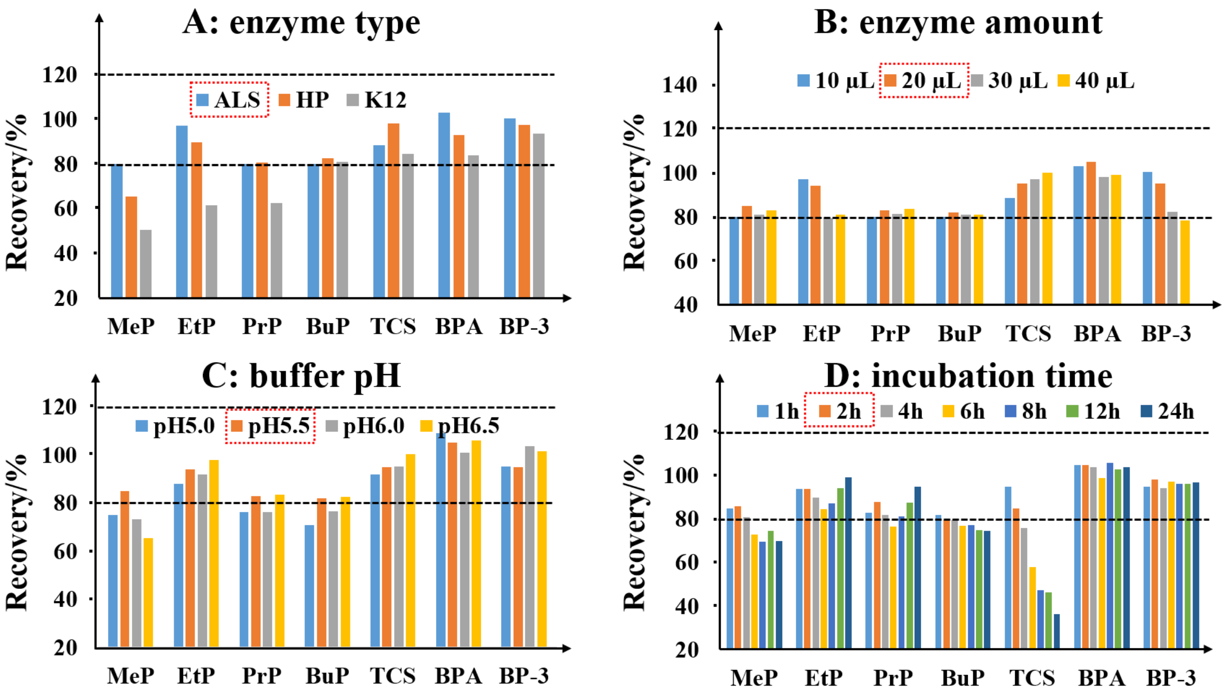
50 picogram standard



Further details of additional peaks and chromatograms can be found in: JCA 1646 (2021), 462146.

Extraction method

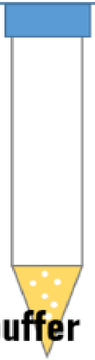
Recoveries of seven phenolic compounds certified in standard reference material 3672 (SRM 3672) with different enzymatic deconjugation conditions including enzyme type (A), enzyme amount (B), buffer pH (C), and incubation time (D).



Multi-class analytical method capable to capturing 121 analytes in a single extraction

Sample Preparation

Enzymatic hydrolysis



0.5 mL of urine

2.5 ng each of IS

20 µL of ALS enzyme

0.5 mL of 1 M NH_4Ac buffer (pH 5.5)

Incubation 2 h at 37°C

Solid Phase Extraction

Agilent Bond Elut C18 (60 mg, 3 mL)

Conditioning
1.5 mL of ACN
+ 1.5 mL of phosphate buffer (pH 2.0)

Sample Percolation
Incubated urine mixed with
1 mL of phosphate buffer (pH 2.0)

Washing
1.5 mL of 0.1 M FA in H_2O
+ 1.5 mL of 5% MeOH in H_2O

Eluting
1.2 mL of ACN
+ 1.2 mL of EtAc
+ 1.2 mL of MeOH:DCM (1:1, v/v)

Concentrated with N_2 stream and reconstituted with 250 µL of ACN:H_2O (2:8, v/v)

Instrumental Analysis

UPLC-MS/MS (API 5500+)

1st injection:

MS/MS mode: ESI-negative
Column: Ultra AQ C18 column
(3 µm, 100 × 2.1 mm^2, Restek)
MA: 0.1% v/v HAc in H_2O
MB: 0.1% v/v HAc in MeOH
Injection volume: 5.0 µl
Flow rate: 0.38 mL/min

45 compounds (mostly PMs)

2nd injection:

MS/MS mode: ESI-negative & positive
Column: BetaSil™ C18 column
(5 µm, 100 × 2.1 mm^2, TFS)
MA: H_2O MB: ACN
Injection volume: 5.0 µl
Flow rate: 0.35 mL/min

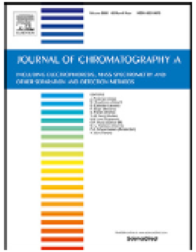
45 EPs (-ve)
31 Pes (+ve)

Journal of Chromatography A 1646 (2021) 462146

Contents lists available at ScienceDirect

Journal of Chromatography A

journal homepage: www.elsevier.com/locate/chroma



A method for the analysis of 121 multi-class environmental chemicals in urine by high-performance liquid chromatography-tandem mass spectrometry

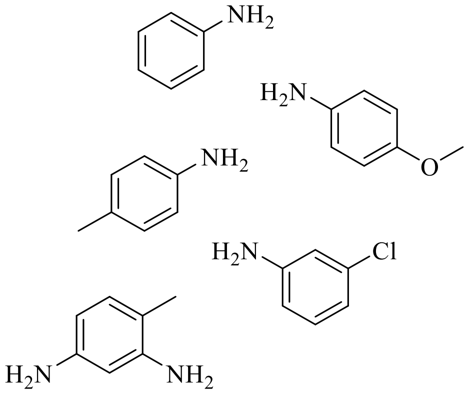
Hongkai Zhu, Sridhar Chinthakindi, Kurunthachalam Kannan*

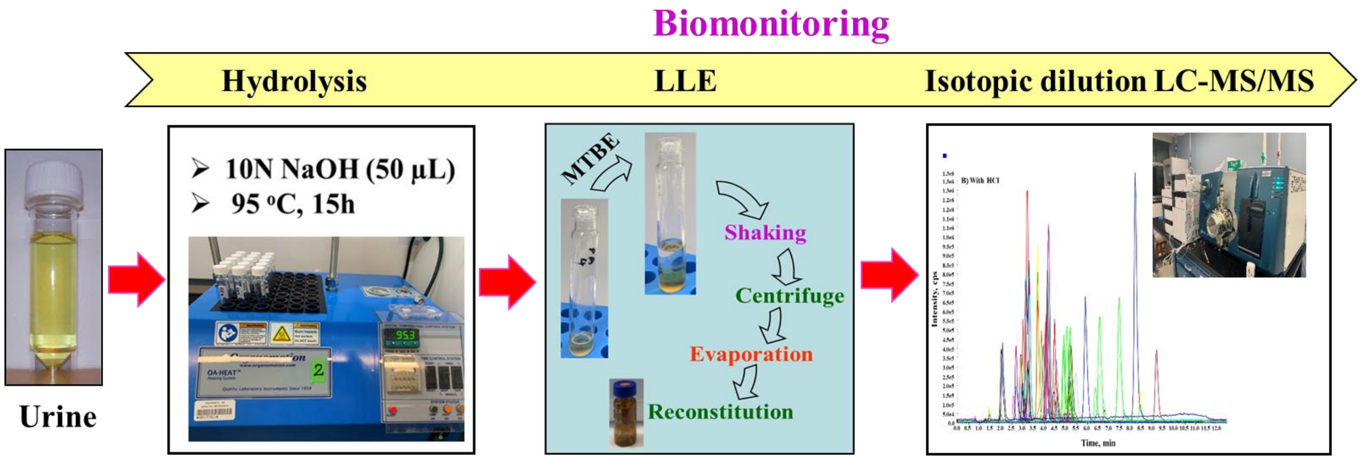
Department of Pediatrics and Department of Environmental Medicine, New York University School of Medicine, MSB 6-698, 550 1st Avenue, New York, NY 10016, United States

>95% analytes recovery 80-120% (accuracy); Variances : 0.4-11% (RSD; precision);
LOD : <0.1 ng/mL for 101 analytes, 0.1-1 ng/mL for 18 analytes (sensitivity)
Method requires only 0.5 mL urine
Time and Cost reduced by 1/3

Aromatic amines

- A method was developed for the analysis of 44 aromatic amine in urine (manuscript submitted for publication)
- Many are known carcinogens
- Tattoos, hair dyes, printing inks, textile dyes
- Tobacco smoke
- Used in the production of polyurethane, rubber, pesticides, and pharmaceuticals





A Liquid Chromatography –Tandem Mass Spectrometry Method for the Analysis of 44 Primary Aromatic Amines in Human Urine

Sridhar Chinthakindi and Kurunthachalam Kannan*

Department of Pediatrics and Department of Environmental Medicine, New York University School of Medicine, New York, NY 10016, United States

Submitted to: Journal of Chromatography B

ECHO
Environmental influences on Child Health Outcomes
A program supported by the NIH

Assessing exposures to novel chemicals among pregnant women in ECHO: a pilot to inform studies of associations with child health outcomes

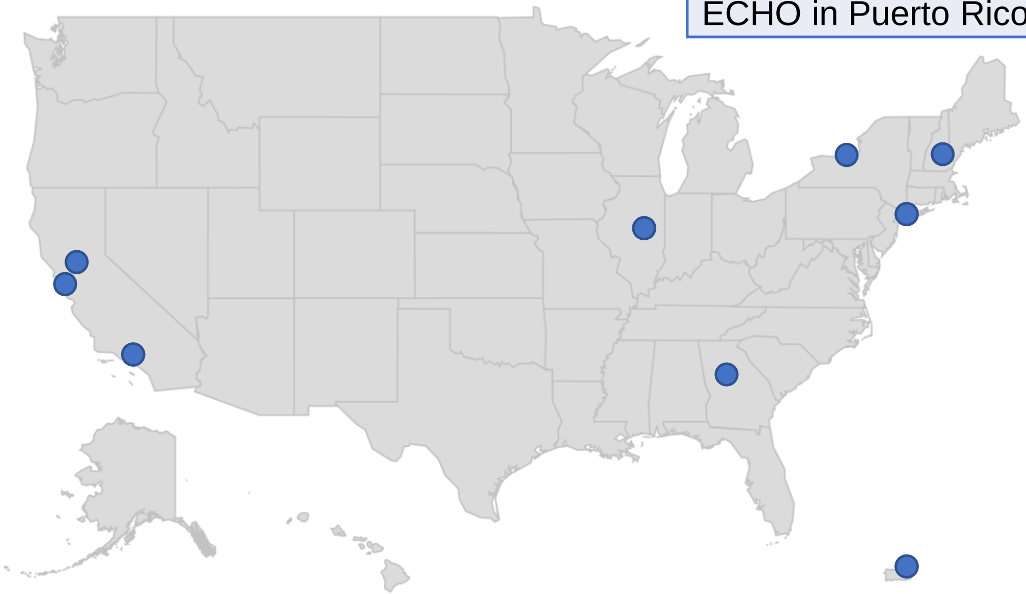
Jessie Buckley, PhD, MPH
Associate Professor, Environmental Health and Engineering & Epidemiology
Johns Hopkins University Bloomberg School of Public Health

Tracey Woodruff, PhD, MPH
Professor & Director, Program on Reproductive Health and the Environment
University of California San Francisco

Writing Team
Jordan Kuiper
Emily Barrett
Tracy Bastain
Deborah Bennett
Carrie Breton
Sridhar Chinthakindi
Anne Dunlop
Shohreh Farzan
Julie Herbstman
Margaret Karagas
Carmen Marsit
John Meeker
Rachel Morello-Frosch
Tom O’Connor
Megan Romano
Sue Schantz
Rebecca Schmidt
Edo Pellizzari
Deborah Watkins
Hongkai Zhu
Kurunthachalam Kannan

Pilot study to measure novel chemicals among 171 pregnant women from 9 ECHO cohorts

Cohort	Location	Enrollment
Chemicals in our Bodies (CIOB)	CA	2014-present
MARBLES	CA	2006-present
MADRES	CA	2016-present
Illinois Kids Development Study (IKIDS)	IL	2013-present
Atlanta ECHO Cohort of Emory	GA	2014-present
UPSIDE	NY	2016-present
Fair Start	NY	2013-present
New Hampshire Birth Cohort Study (NHBCS)	NH	2009-present
ECHO in Puerto Rico (PROTECT)	PR	2011-present



Includes women from across the U.S. to capture geographic, temporal, and sociodemographic diversity

Next steps

Characterize exposure patterns

- Compare concentrations by geographic location, calendar year, demographic variables, and urine sample collection characteristics
- Determine correlations among chemicals

Full-scale study of prenatal novel chemical exposures and pre-, peri-, and postnatal outcomes

Quantify novel chemical exposures for 6,330 pregnant women from 21 ECHO cohorts using the HHEAR assay

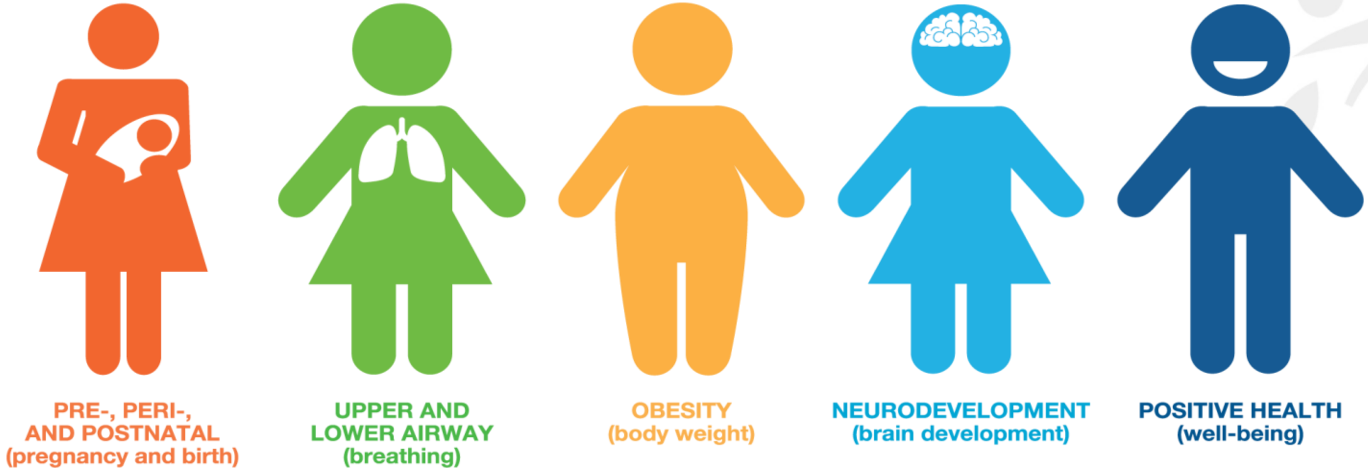
Investigate associations with perinatal outcomes: low birth weight, preterm birth, small for gestational age

Conduct a substudy with repeated samples during pregnancy to understand within-person variability

Leverage biomonitoring resource to study all priority child health outcomes in ECHO

ECHO's Mission

To enhance the health of children for generations to come



Thank you

ECHO

Environmental influences on Child Health Outcomes

A program supported by the NIH