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Parental Concern about Environmental Chemical Exposures and Children's Urinary Concentrations of Phthalates and Phenols

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Abstract

Objectives—To examine whether parents' concerns about environmental chemical exposures were associated with urinary phthalate and phenol concentrations in their school-age children.

Study design—In a prospective cohort of 218 mother-child pairs from Cincinnati, OH (2010–2014), we measured 11 phthalate metabolites and 5 phenols in urine samples when children were age 8 years and used questionnaire data from caregivers. We estimated the covariate-adjusted percent difference in phthalates and phenols among children of parents who expressed concern about environmental chemical exposures compared with children whose parents did not.

Results—Concentrations of four phthalates, bisphenol S (BPS), and bisphenol A (BPA) were lower among children whose parents expressed concern about environmental chemicals (n= 122) compared with those who did not (n=96). Di-2-ethylhexyl phthalate metabolites, BPS, and BPA concentrations were 23% (95% CI: -38, -5), 37% (95% CI: -49, -21), and 13% (95% CI: -26, 3) lower, respectively, among children whose parents expressed concern compared with those whose parents did not. Triclosan concentrations were 35% higher (95% CI: -2, 87) among children whose parents expressed concern compared with children whose parents did not.

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Conclusions—Parental concern about environmental chemicals was associated with lower childhood urine concentrations of several phthalates and phenols; unexpectedly, parental concern was associated with higher triclosan concentrations. These results suggest that parental concern may be an important factor in mitigating children's phthalate and phenol exposures.

Keywords

Children; endocrine disrupting chemicals; epidemiology

There is concern that early life exposure to environmental chemicals could adversely affect the development of the fetus, infant, or child to adversely impact brain development, growth, or immune function in infants and children (1-3). Children may be uniquely susceptible to environmental chemicals due to their immature metabolic pathways and rapidly growing vital organs (4). Moreover, compared with adults, children have higher exposure to some environmental chemicals, such as lead and persistent organic pollutants, due to differences in physiology, anatomy, and behaviors (5-7).

Among environmental chemicals of concern, phthalates and phenols have received considerable attention over the last decade because of their potential health effects on children (Table I; available at www.jpeds.com). Phthalates are multifunctional chemicals used in personal care products, medications, and plastics. Some phthalates have endocrine disrupting properties, and exposure has been associated with an increased risk of allergic disease, alterations in genital development, and neurobehavioral disorders (3, 8-11). Phenols are a broad class of chemicals that include bisphenol A (BPA), triclosan, triclocarban, and benzophenone. BPA is used in polycarbonate plastics and epoxy resins, whereas triclosan and triclocarban are used as antimicrobial agents in personal care products, textiles, and some household goods. Benzophenone is used as an ultraviolet light absorber and stabilizer in personal care products. Exposure to BPA and triclosan has been associated with adverse health outcomes including neurobehavioral problems, allergic disease, and reduced circulating thyroxine levels, respectively (3, 12, 13).

Several studies have demonstrated that targeted behavioral interventions such as changes in diet and personal care product use can decrease exposure to specific environmental chemicals in controlled settings (14-17). However, there has been little research to show whether individuals can successfully reduce their exposure to phthalates and phenols by actively changing their consumer habits (16). Clinically, this knowledge would encourage clinicians to educate unconcerned parents by counselling them on how to reduce their children's exposures. It may also motivate clinicians to discuss specific behavioral interventions with concerned parents. In the absence of clear evidence, it is up to clinicians to decide on the risks and benefits of educating patients on phthalate and phenol exposures and possible behavioral interventions.

The purpose of this study was to determine whether there is a relationship between parents' concerns about environmental chemicals and their children's exposure to phthalates and phenols using data from 218 parents and their children.

Methods

We used data from the Health Outcomes and Measures of the Environment (HOME) Study, a prospective pregnancy and birth cohort study designed to examine the health impacts of early-life exposure to prevalent environmental chemicals. We previously described eligibility criteria, enrollment, and follow-up (18). Briefly, we recruited 401 pregnant women from nine prenatal clinics associated with three hospitals in the Cincinnati, OH area from March 2003 through January 2006. After delivery, we conducted extensive longitudinal follow-up with parents or caregivers and their children at 1, 2, 3, 4, 5, and 8 years of age. For this study, we used data from 218 singleton children who completed follow-up at 8 years of age and had urinary biomarker and covariate data available.

All women provided written informed consent for themselves and their children after the study protocols had been explained. The institutional review boards (IRB) of Cincinnati Children's Hospital Medical Center, the Centers for Disease Control and Prevention (CDC), and the cooperating delivery hospitals approved this study. Brown University relinquished IRB authority to Cincinnati Children's Hospital Medical Center with an Interagency Agreement.

Parents' Concern about Chemical Exposures

We administered surveys to parents, typically the mother (otherwise the primary caregiver), during face-to-face interviews in our study clinic when children were an average of 8.1 years of age (range: 7.5-10 years). We used responses from two questions to assess whether parents were concerned or unconcerned about the potential for environmental chemicals influencing their child's health. The first question asked, "Are you concerned that chemicals used in the products you buy might affect your child's health?" Among parents who responded "yes", we asked them to list as many chemicals as they could in response to the question, "What chemicals are you most concerned about?" Parents were allowed to list more than one specific chemical or exposure of concern. A priori we created categories that included arsenic, BPA, cadmium, flame retardants, lead, mercury, metals, non-stick compounds (e.g., perfluoroalkyl substances), pesticides, phthalates, plastics, and other.

Children's Urinary Chemical Biomarker Concentrations

At the study visit, we collected a single urine sample from the child in a polypropylene specimen cup. We refrigerated urine samples before processing and storing them at or below -20°C until chemical analysis. We shipped urine samples on dry ice to the CDC for phthalate and phenol analysis. We quantified the total concentration (free + conjugated) of eleven phthalate monoester metabolites and five phenols with analytic chemistry methods (Table I) (19, 20). The limits of detection ranged from 0.1-1.0 ng/mL. The coefficients of variation for low and high concentrations quality control samples for phthalates ranged from 5.0-12% and for phenols from 2.5-16%. We also quantified urinary creatinine concentrations to control for urine dilution.

Because we quantified four monoester metabolites of di-2-ethylhexyl phthalate (DEHP) that were highly correlated with each other (Pearson R's ranged from 0.71 to 0.98), we created a

weighted molar sum (ZDEHP) of mono(2-ethylhexyl) phthalate (MEHP), mono(2-ethyl-5-hydroxyhexyl) phthalate (MEHHP), mono(2-ethyl-5-oxohexyl) phthalate (MEOHP), and mono(2-ethyl-5-carboxypentyl) phthalate (MECPP). We expressed ZDEHP concentrations in Hg/L of MECPP by multiplying the molar sum of the individual metabolites by the molar mass of MECPP (308 g/mol).

Covariates

We considered adjusting for factors that might be associated with both parents' concern about environmental chemicals and children's urinary phthalate and phenol concentrations based on our prior studies in this cohort (21, 22). These variables included maternal education, maternal race/ethnicity, household income, child sex, and child age. Because of the small number of American Indian, Asian, or Multiracial mothers, we created two categories of maternal race: non-Hispanic Black and non-Hispanic White. To control for urine dilution, we adjusted for continuous log₁₀-transformed urinary creatinine concentrations in our models. Finally, because the phenol benzophenone-3 is used in sunscreens, and children may have higher levels during the summer, we also adjusted these models for season (May-August vs. September-April).

Statistical Analyses

We began our analysis by comparing the distribution of covariates among parents who did and did not express concern about environmental chemicals. Next, we described univariate statistics of urinary phthalate and phenol concentrations. Because phthalate and phenol concentrations were right-skewed, we log₁₀-transformed them to satisfy normality assumptions. We then used linear regression to calculate the unadjusted and covariate-adjusted geometric mean (GM) urinary phthalate and phenol concentrations among children of parents who did and did not express concern about environmental chemicals. We also calculated the percent differences in GM urinary phthalate and phenol concentrations among parents who expressed concern about environmental chemical exposures to those who did not.

We evaluated if parental concern specifically about phthalates, phenols, or plastics was associated with reductions in children's exposure to phthalates and phenols. Thus, we determined whether the children of parents who had specific concern about phthalates, phenols, or plastics had lower urinary phthalate or phenol concentrations compared with children whose parents had concern about chemicals, but not specifically phthalates, phenols, or plastics. We created a 3-level variable consisting of no concern (reference); concerned, but not about BPA, phthalates, or plastics; and concerned specifically about BPA, phthalates, or plastics. We also calculated adjusted GM phthalate and phenol concentrations for these three categories, as well as the percent difference in biomarker concentrations among those expressing concern compared with those without concern.

Because we previously reported biomarker results back to mothers about their and their child's phthalate and phenol exposure during pregnancy and early childhood (1-3 years), respectively, we conducted a sensitivity analysis where we adjusted for the mother and child's previous urinary phthalate and phenol concentrations. We were unable to do this for

bisphenol S (BPS), mono-n-butyl phthalate (MnBP), mono-iso-butyl phthalate (MiBP), mono-carboxynonyl phthalate (MCNP), or mono-carboxyoctyl phthalate (MCOP) either because these assays were not available when we analyzed these urine samples (BPS, MCNP, and MCOP) or because the children's urine samples were contaminated by the phthalate originating from the diapers or diaper inserts used to collect urine (MnBP and MiBP) (22). Finally, we investigated whether not adjusting for creatinine as a marker of urine dilution affected our results.

Results

Descriptive Statistics

As we previously reported, parents who completed follow-up at 8 years of age were similar to the original cohort in terms of sociodemographic features (Table II; available at www.jpeds.com) (18). In addition, mother's urinary phthalate metabolite and phenol concentrations during pregnancy were similar among those who completed follow-up and the original cohort (Table II).

A total of 122 of 218 parents (56%) expressed concern about the health effects environmental chemicals on their children. Among those who expressed concern, they provided 221 responses about specific chemicals of concern. The most frequently cited specific chemicals of concern were plastics (24%), pesticides (16%), and bisphenol A (19%). We classified almost two-thirds of responses (63%) about specific chemicals as other. The top three responses for other included cleaning products, personal care products, and food additives and preservatives (Table III; available at www.jpeds.com).

The children whose parents or caregivers expressed concern about environmental chemicals were more likely than those who did not express concern to live in higher income households (53% vs 28% had an income above \$80,000), have a mother who was white or other race (74% vs 53%), and have a mother with a bachelor's degree or greater (59% vs 32%) (Table IV). The distribution of child age and sex was similar among those parents with and without concerns about environmental chemicals.

Children's median urinary phthalate concentrations ranged from 4.1 ng/mL for mono-3-carboxypropyl phthalate to 47 ng/mL for Σ DEHP (Figure and Table V; Table V available at www.jpeds.com). Median urinary phenol concentrations ranged from 0.1 ng/mL for triclocarban to 24 ng/mL for benzophenone-3.

Phthalates

Before covariate adjustment, GM concentrations of Σ DEHP, monobenzyl phthalate (MBzP), MnBP, and MCNP were lower among children whose parents were concerned about chemical exposures compared with children whose parents were unconcerned (Figure and Table VI). Concentrations remained significantly lower after adjusting for covariates. For instance, geometric mean urinary Σ DEHP concentrations were 22% lower (95% CI: -34, -8) among parents expressing concern compared with parents not expressing concern (GM: 45 vs. 58 ng/mL). GM urinary concentrations of MEP, MiBP, MCP, and MCOP were not

significantly different among children whose parents did or did not have concern about chemicals.

Phenols

Before adjusting for confounders, the children of parents concerned about exposure to chemicals had significantly lower levels of BPA, BPS, and triclocarban in their urine compared with children of parents who were unconcerned (Figure and Table VI). After adjusting for covariates, geometric mean urinary BPS concentrations were 37% lower (95% CI: -49, -21) among parents expressing concern compared with parents not expressing concern (GM: 0.4 vs. 0.6 ng/mL). Urinary BPA concentrations showed a trend of being 13% lower (95% CI: -26, 3) among the children of parents concerned about exposure to chemicals compared with children of unconcerned parents (GM: 1.8 vs. 2.1 ng/mL), although the 95% CI of the difference included the null value. Children of parents who were concerned about chemical exposures had 35% *higher* (95% CI: -2, 87) urinary triclosan concentrations after adjustment for covariates (GM: 12 vs. 8.7ng/mL), although the 95% CI of this difference included the null value.

We did not observe that urinary phthalate or phenol concentrations were lower among children whose parents had specific concern about plastics, phthalates, or phenols compared with children of concerned parents without specific concern about those chemicals (Table VII; available at www.jpeds.com). In addition, adjusting for prenatal and early childhood urinary phthalate or phenol concentrations did not alter our results (results not shown). Not adjusting for urinary creatinine concentrations did not meaningfully change our results (Table VIII; available at www.jpeds.com).

Discussion

We evaluated whether urinary phthalate and phenol concentrations differed among 8-year old children based on expressed parental concern about the health effects of environmental chemical exposures. After adjusting for covariates, the children of concerned parents had lower levels of four phthalates, BPS, and BPA, but higher triclosan concentrations, compared with children of unconcerned parents.

Although we did not analyze mechanisms or interventions that influence exposure to phthalates and phenols, there are modifiable sources of phthalate and phenol exposures that include home furnishings, personal care products, diet, and medications (23, 24). Our results, as well as those of other studies, suggest that concerned parents may be making lifestyle choices that result in lower exposure to some phthalates and phenols. For phthalates, previous studies have shown that the presence of PVC flooring and wall coverings is associated with higher urinary concentrations of MBzP and MnBP in children and higher dust concentrations of DEHP in homes (25, 26). Many personal care products such as lotions, cosmetics, and perfumes contain phthalates, and studies have shown that increased use of these products correlates with an increase in urinary phthalate metabolite concentrations (27). BPA exposure occurs largely from dietary intake due to its use in food packaging materials, including the linings of food cans and plastic containers. Consuming

canned soup and water from BPA-containing packaging and bottles can cause increases in urinary BPA concentrations (28-30).

Despite the various sources of phenol and phthalate exposures, intervention studies suggest that these exposures could be mitigated by behavioral changes at the individual or family level. One study found that exposure to phthalates could be significantly reduced by short term changes in dietary behavior (17). A crossover study of five families showed that an intensive dietary intervention was successful in reducing BPA and DEHP exposures (14). Another intervention study found that modification of personal care product use reduced exposure to phthalates and parabens in adolescent girls (15). However, one study found that dietary interventions may not be effective at reducing phthalate and phenol exposures, and in some cases, there may be unsuspected sources of exposure that can dramatically elevate exposure (16).

We unexpectedly observed that children of concerned parents had elevated urinary concentrations of triclosan. Triclosan is a chemical with antimicrobial properties and is used in a variety of products, including hand sanitizers, household cleaners, toys, and fabrics (31). Its success in the marketplace has been aided by the public perception that antibacterial products protect and safeguard against potentially harmful bacteria. We speculate that the parents who expressed concern about chemicals may also have been choosing antimicrobial products because they were concerned about harmful microbes in their homes.

Several factors may influence parent's ability to reduce their children's phthalate or phenol exposure including: knowledge about phthalate or phenol exposures, knowledge about behavioral interventions to reduce exposure, or the ability for individuals to effectively control exposure (e.g., flooring or carpets in apartments). This may be why we observed that parental concern was associated with children's urinary BPA, BPS, triclosan, DEHP, MBzP, MnBP, and MCNP concentrations, but not other phenols or phthalates. Moreover, these factors may account for why urinary phthalate and phenol concentrations of children of parents who were specifically concerned with plastics, phthalates, or phenols were not lower than for children with concerned parents without specific concern for those chemicals. This reinforces the need for further research investigating what specific behaviors concerned parents engage in and whether these can reduce environmental chemical exposures.

The concerned parents in this study were more likely than unconcerned parents to be non-Hispanic white, educated, and have higher household income. The profile of a concerned parent we observed in this study has been anecdotally described, but there has been relatively little biomedical research on the correlates of parental concern about chemical exposures and the behaviors that parents engage in to mitigate or exacerbate chemical exposures. There have also been few studies documenting how and where parents receive information about environmental chemical exposures and risk mitigation (32). Given that children of concerned parents had lower urinary concentrations of some phthalates and phenols, but not triclosan, future research should consider how and where caregivers' are being educated about environmental chemical exposures, and what interventions caregivers are using. Findings from this line of research could also help inform patient education and knowledge translation in clinical settings. Additional research is necessary to determine how

parental concerns about chemical exposures translates into behavioral modification; this will be essential for designing effective behavioral interventions that can be implemented by families. Finally, it will be important to consider how to educate parents about new chemicals of concern that are introduced as replacements to current use chemicals. In some cases, replacement chemicals may have similar chemical structures or biological activity as the original chemicals of concern (33).

Currently, there is a gap in knowledge translation between what is known from epidemiological and interventional studies of chemical exposures and how to advise parents and patients in primary care settings about reducing their child's exposures. The health risks associated with these exposures can elicit anxiety for families, and it can be difficult for community health professionals to alleviate their patients' concerns. Specialists at the Pediatric Environmental Health Specialty Units in North America work to address this gap and provide information to both clinicians and parents (34, 35). However, more research remains to be done with regard to effective interventions and education in pediatric settings. For some chemicals of concern, there are not evidence-based guidelines for reducing exposure. In other cases (e.g., canned foods as a source of BPA exposure), there are evidence-based recommendations that could be made (28). However, clinicians in primary care settings should be encouraged to ask parents if they have concerns and what interventions they may be trying at home. Our results show that there are a sizable proportion of unconcerned parents in some populations who may benefit from additional knowledge about environmental chemical exposures and their potential health effects. These interactions may provide opportunities to provide evidence-based educational resources if parents do not have reliable sources for information. Asking about parental concern may also help to identify and relieve anxiety caregivers have about environmental chemical exposures. Finally, clinical interactions may also educate children about chemical exposures, so that they can make informed choices.

These findings have implications for studies of environmental chemicals and children's health. First, parental concern about chemical exposure is an important variable to consider when conducting interventions designed to reduce chemical exposures, because it might modify their effect. For instance, families without concern might benefit more from exposure-reducing interventions than families who are actively trying to reduce their exposure. Second, etiological studies quantifying the health effects of childhood environmental chemical exposures may need adjust for parental concern as it is a potential determinant of children's exposures and correlate of risk factors for various childhood diseases (e.g., socioeconomic status).

A limitation of our study is the inability to assess whether a concerned parent made any specific behavioral changes to reduce their child's risk of exposure. Concern is not necessarily indicative of a change in behavior. Despite this limitation, we were able to identify associations between parental concern and sensitive and specific biomarkers of phthalate and phenol exposures in children. However, there is potential for misclassification of phthalate and phenol exposure given the known variability of urinary phthalate and phenol metabolites among children in this cohort (21, 22). If this misclassification is non-differential with respect to parental concern, then our findings would likely be biased

towards the null. In addition, selection bias could influence our results because those women who participated in the HOME Study or subsequent follow-up visits may have greater interest in and concern about the health effects of chemical exposures and be more likely to engage in behaviors that reduce their chemical exposures. Although we were able to adjust for many confounders, there is the potential for other factors, such as neighborhood, diet, or drinking water source to be correlated with determinants of chemical exposure and parental concern. For instance, socioeconomic factors may be associated with both parental concern and access to foods or products that are free of phthalates or phenols. Finally, our findings may not be generalizable to all populations. However, median urinary concentrations of phthalate metabolites and phenols in HOME Study children were similar to median concentrations in children age 6-11 years in the National Health Nutrition Examination Surveys 2009-10 and 2011-12 (36). This suggests that these results may be generalizable to populations of children with similar phthalate and phenol exposures.

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Abbreviations

and Acronyms	BPA, Bisphenol A
BPS	Bisphenol S
CDC	Centers for Disease Control and Prevention
DEHP	Di-2-ethylhexyl Phthalate
GM	Geometric Mean
MBzP	Mono-benzyl Phthalate
MCNP	Mono-carboxynonyl Phthalate
MCOP	Mono-carboxyoctyl Phthalate
MEHP	Mono(2-ethylhexyl) Phthalate
MECPP	Mono(2-ethyl-5-carboxypentyl) Phthalate
MEHHP	Mono(2-ethyl-5-hydroxyhexyl) Phthalate
MEOHP	Mono(2-ethyl-5-oxohexyl) Phthalate
MiBP	Mono-iso-butyl Phthalate
MnBP	Mono-n-butyl Phthalate

Figure 1.
Box-and-whisker plots of urinary phthalate and phenol concentrations among HOME Study children at age 8 years.

Table 1

Parent compounds, urinary metabolites, and commercial/industrial uses of phthalates and phenols.

Parent Compound (Abbreviation)	Urine Metabolite(s) (Abbreviation)	Uses in Commerce or Industry
Di-2-ethylhexyl phthalate (DEHP)	Mono-2-ethylhexyl (MEHP), mono-2-ethyl-5-carboxypentyl (MECPP), mono-2-ethyl-5-hydroxyhexyl (MEHHP), and mono-2-ethyl-5-oxohexyl (MEOHP) phthalate	PVC plastics, food packaging, and plastic medical tubing and bags.
Butylbenzyl phthalate (BBzP)	Monobenzyl phthalate (MBzP)	Vinyl flooring, adhesives, food packaging, synthetic leather, and toys.
Diethyl phthalate (DEP)	Monoethyl phthalate (MEP)	Scent retainer in personal care products and medication excipient.
Di-n/i-butyl phthalate (DnBP and DiBP)	M-n/i-butyl phthalates (MnBP and MiBP)	Scent retainer in personal care products, medication excipients, cellulose plastics, & adhesives.
D-n-octyl phthalate (DnOP)	Mono(3-carboxypropyl) phthalate (MCP)	Storage bags, wire and cables, carpet back coating, floor tile, adhesives, medical tubing, blood storage bags, cosmetics and pesticides.
Di-isodecyl phthalate (DiDP)	Monocarboxynonyl phthalate (MCNP)	Flooring, roofing, footwear, food wrap, packaging materials and sealants, exercise balls, adhesives, pool lining, clothing, and toys.
Di-isononyl phthalate (DiNP)	Monocarboxyoctyl phthalate (MCOP)	PVC sheeting, waterproofing materials, flooring, footwear, clothing, inks, hosing, paints, sealings, lamination, tarpaulins, toys, exercise and play balls, adhesives, paints, toys and plastic books, changing mats, pacifiers, soap.
Bisphenol A (BPA)	BPA	Polycarbonate plastics, resins, thermal receipts, food cans, dental fillings, and medical equipment.
Bisphenol S (BPS)	BPS	Polycarbonate plastics, resins, food packaging, thermal receipts.
Triclosan	Triclosan	Antimicrobial soaps, personal care products, toothpaste, kitchen utensils, clothes, and cleaning products.
Triclocarban	Triclocarban	Soaps, deodorants, toothpaste, personal cleansers, toys, plastic utensils.
Benzophenone-3	Benzophenone-3	Ink toner, sunscreens, paints, personal care products, photographic supplies and film .

Information for this table was retrieved from the Agency for Toxic Substances and Disease Registry (<https://www.atsdr.cdc.gov/>), Centers for Disease Control and Prevention (<https://www.cdc.gov/biomonitoring>) Environmental Protection Agency (<https://www.epa.gov/>), National Institutes of Environmental Health Sciences (<https://www.niehs.nih.gov/health/topics/agents/>), and PubChem Project (<https://pubchem.ncbi.nlm.nih.gov/>) websites.

Table 2
Sociodemographic characteristics and geometric mean prenatal urinary phthalate and phenol biomarker concentrations (ng/mL) in participating moms at baseline (n=389) and the 8 year follow-up (n=218)

Characteristic or Prenatal Phthalate/Phenol Concentration	Baseline (%)	8-Year Follow-Up (%)
Maternal Race		
White or Other	263 (67.6)	142 (65.1)
Black	121 (31.1)	76 (34.9)
Household Income		
>\$80K	103 (26.5)	56 (25.7)
\$40-80K	128 (32.9)	69 (31.7)
\$20-40K	65 (16.7)	33 (15.1)
<\$20K	88 (22.6)	60 (27.5)
Maternal Education		
Bachelor's/Graduate/Professional	191 (49.1)	100 (45.9)
Tech school/Some College	98 (25.2)	62 (28.4)
High School or Less	95 (24.4)	56 (25.7)
Missing		
Child Sex		
Girls	208 (53.5)	120 (54.8)
Boys	181 (46.5)	99 (45.2)
Maternal ΣDEHP	88	83
Maternal MEP	137	140
Maternal MBzP	9.4	9.5
Maternal MnBP	25	25
Maternal MiBP	4.7	4.8
Maternal MCPP	2.2	2.2
Maternal Bisphenol A	1.9	2.0
Maternal Triclosan	26	25
Maternal Benzophenone	44	39

* Average of mother's log₁₀-transformed creatinine-standardized standardized phthalate metabolite or phenol concentration at 16 and 26 weeks of pregnancy.

Table 3
Specific responses parents provided for “other” chemicals of concern

Category	N
Cleaning Products	27
Personal Care Products	15
Food Additives and Preservative	15
Chemicals (general)	12
Dyes	9
Growth Hormones	7
Artificial Sweeteners	5
Pesticides or Herbicides	4
Carcinogens	3
GMO	3
Cans	3
Aluminum	2
Sulfates	2
Pink Slime	2
Antibiotics	2
Formaldehyde	2
Glue, ink	2
BPA Replacements	1
Phosphates	1
Petroleum	1

* Parents could be included in more than one category.

Table 4
Sociodemographic characteristics of mother-child pairs in the HOME Study according to maternal concern about environmental chemicals (n= 218)^a

Characteristic	N Maternal Concern (%)	N No Maternal Concern (%)
All	122 (55.7)	96 (44.0)
Maternal Race		
White or Other	92 (75.4)	50 (52.1)
Black	30 (24.6)	46 (47.9)
Household Income		
>\$80K	66 (54.1)	26 (27.1)
\$40-80K	24 (19.7)	24 (25.0)
\$20-40K	15 (12.3)	20 (20.8)
<\$20K	17 (13.9)	26 (27.1)
Maternal Education		
Bachelor's/Graduate/Professional	64 (61.5)	52 (54.2)
Tech school/Some College	30 (28.8)	44 (45.8)
High School or Less	10 (9.6)	8.1 (0.6)
Child Sex		
Girls	68 (55.7)	96 (44.0)
Boys	54 (44.3)	50 (52.1)
Mean Child Age [SD]	8.1 (0.6)	46 (47.9)

^aDefined by the response to the question, “Are you concerned that chemicals used in the products you buy might affect your child 's health?”

Table 5
Univariate characteristics of urinary phenol and phthalate concentrations (ng/mL) in HOME Study children at 8 years of age

	Minimum	5 th	10 th	25 th	Median	75 th	90 th	95 th	Maximum
Bisphenol A	0.07	0.5	0.7	1.0	1.6	3.6	5.6	10	72
Bisphenol S	0.07	0.07	0.1	0.2	0.4	0.7	2.0	3.7	50
Triclosan	1.0	1.0	1.5	3.8	9.8	35	118	200	1610
Triclocarban	0.07	0.07	0.07	0.07	0.1	0.4	1.3	11	71
Benzophenone	0.1	2.1	3.1	6.7	24	133	631	1360	13010
ΣΣDEHP _a	4.5	10	16	30	47	86	172	272	1275
MEP	1.3	5.4	6.7	11	23	54	121	195	745
MBzP	0.2	1.1	2.2	4.7	8.6	24	58	95	1800
MnBP	0.3	3.3	4.7	9.0	17	30	56	66	254
MtBP	0.5	2.4	3.3	5.8	11	20	33	48	275
MCPP	0.2	0.9	1.3	2.4	4.1	7.8	17	25	213
MCOP	2.3	5.4	8.2	14	28	71	149	204	843
MCNP	0.5	1.5	2.0	2.8	4.7	8.6	14	18	55

^aThis is the weighted molar sum of the DEHP metabolites MEHP, MEHHP, MEOHP, and MECPP, expressed in units of ng/mL of MECPP (308 g/mol).

Table 6
Unadjusted and adjusted geometric mean (ng/mL) and percent difference in child urine chemical concentrations at 8 years of age according to maternal concern about environmental chemicals^{a,b}

Chemical	G/M	Unadjusted % Difference	(95% CI)	GM	Adjusted % Difference	(95% CI)	P-value for Adjusted Difference
ΣDEHP^c							
No Concern	59		Ref	58		Ref	
Concerned	47		-21 (-31, -9)	45		-22 (-34, -8)	<0.001
MEP							
No Concern	28		Ref	29		Ref	
Concerned	25		-10 (-24, 8)	33		15 (-4, 38)	0.16
MBzP							
No Concern	14		Ref	14		Ref	
Concerned	8.5		-37 (-48, -23)	11		-23 (-38, -5)	<0.01
MnBP							
No Concern	17		Ref	16		Ref	
Concerned	15		-13 (-24, -1)	14		-16 (-28, -2)	0.02
MIBP							
No Concern	11		Ref	10		Ref	
Concerned	11		1 (-12, 16)	9.6		-6 (-20, 11)	0.47
MCPP							
No Concern	4.2		Ref	3.9		Ref	
Concerned	4.6		9 (-8, 29)	3.7		-6 (-22, 14)	0.54
MCOP							
No Concern	32		Ref	40		Ref	
Concerned	32		0.3 (-17, 21)	26		-13 (-29, 8)	0.18
MCNP							
No Concern	5.4		Ref	5.4		Ref	
Concerned	4.6		-16 (-26, -4)	4.3		-21 (-32, -8)	<0.001
Bisphenol A							
No Concern	2.2		Ref	2.1		Ref	
Concerned	1.7		-17 (-28, -4)	1.8		-13 (-26, 3)	0.10

Chemical	GM	Unadjusted % Difference	% Difference (95% CI)	GM	Adjusted % Difference	% Difference (95% CI)	P-value for Adjusted Difference
Bisphenol S							
No Concern	0.6		Ref	0.6		Ref	
Concerned	0.4		-38 (-49, -25)	0.3		-37 (-49, -21)	<0.001
Triclosan							
No Concern	9.3		Ref	8.7		Ref	
Concerned	1.5		62 (22, 115)	12		35 (-2, 87)	0.12
Triclocarban							
No Concern	0.3		Ref	0.3		Ref	
Concerned	0.3		-28 (-44, -6)	0.3		4 (-21, 35)	0.80
Benzophenone							
No Concern	22		Ref	21		Ref	
Concerned	45		101 (40, 188)	23		9 (-19, 47)	0.58

^aModels are adjusted for maternal race, household income, maternal education, child sex, maternal race, child age, and child urinary creatinine concentrations. The benzophenone models are additionally adjusted for season.

^b122 (56%) were concerned and 97 (44%) were not concerned.

^cWeighted molar sum of the DEHP metabolites MEHP, MEHHP, MEOHP, and MECPP, expressed in units of ng/mL of MECPP (308 g/mol).

Table 7
Adjusted geometric mean (ng/mL) and percent difference in child urinary chemical concentrations at 8 years of age according to maternal concern about environmental chemicals^a

Chemical	GM	% Difference (95% CI)
Bisphenol A		
No concern	2.1	Ref
Concerned, but not about plastics	1.8	-15 (-31, 3.0)
Concerned, and about plastics	1.9	-10 (-32, 19)
SDEHP^b		
No concern	61	Ref
Concerned, but not about plastics	45	-27 (-39, -12)
Concerned, and about plastics	55	-11 (-32, 16)
MEP		
No concern	27	Ref
Concerned, but not about plastics	33	24 (0.6, 54)
Concerned, and about plastics	27	0.5 (-26, 36)
MBzP		
No concern	13	Ref
Concerned, but not about plastics	9.6	-26 (-43, -4.0)
Concerned, and about plastics	9.3	-28 (-50, 3.6)
MnBP		
No concern	20	Ref
Concerned, but not about plastics	17	-14 (-36, 15)
Concerned, and about plastics	20	-0.7 (-42, 70)
MiBP		
No concern	11	Ref
Concerned, but not about plastics	10	-2.3 (-19, 18)
Concerned, and about plastics	10	-8.2 (-29, 19)
MCP		
No concern	4.2	Ref
Concerned, but not about plastics	3.9	-7.7 (-26, 15)
Concerned, and about plastics	4.0	-5.1 (-30, 29)
MCOP		
No concern	32	Ref
Concerned, but not about plastics	26	-21 (-38, 0.7)
Concerned, and about plastics	34	3.9 (-26, 46)
MCNP		
No concern	5.5	Ref
Concerned, but not about plastics	4.2	-22 (-35, -8.0)
Concerned, and about plastics	4.4	-20 (-37, 1.4)

^a Models are adjusted for maternal race, household income, maternal education, child sex, child age, and child urinary creatinine concentrations.

^bThis is the weighted molar sum of the DEHP metabolites MEHP, MEHHP, MEOHP, and MECPP, expressed in units of ng/mL of MECPP (308 g/mol).

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Table 8
Adjusted percent difference in child urine chemical concentrations at 8 years of age
according to maternal concern about environmental chemicals: With and without
adjustment for urinary creatinine^{a,b}

Chemical	No Creatinine Adjustment % Difference (95% CI)	Creatinine Adjusted % Difference (95% CI)
ΣDEHP^c		
No Concern	Ref	Ref
Concerned	-32 (-44, -17)	-22 (-34, -8)
MEP		
No Concern	Ref	Ref
Concerned	0.5 (-19, 24)	15 (-4, 38)
MBzP		
No Concern	Ref	Ref
Concerned	-36 (-50, -17)	-23 (-38, -5)
MnBP		
No Concern	Ref	Ref
Concerned	-29 (-42, -12)	-16 (-28, -2)
MiBP		
No Concern	Ref	Ref
Concerned	-18 (-33, -0.3)	-6 (-20, 11)
MCP		
No Concern	Ref	Ref
Concerned	-17 (-33, 3)	-6 (-22, 14)
MCOP		
No Concern	Ref	Ref
Concerned	-22 (-38, -2)	-13 (-29, 8)
MCNP		
No Concern	Ref	Ref
Concerned	-27 (-38, -14)	-21 (-32, -8)
Bisphenol A		
No Concern	Ref	Ref
Concerned	-24 (-37, -6)	-13 (-26, 3)
Bisphenol S		
No Concern	Ref	Ref
Concerned	-43 (-55, -27)	-37 (-49, -21)
Triclosan		
No Concern	Ref	Ref
Concerned	19 (-15, 67)	35 (-2, 87)
Triclocarban		
No Concern	Ref	Ref
Concerned	-1 (-24, 29)	4 (-21, 35)
Benzophenone		

Chemical	No Creatinine Adjustment % Difference (95% CI)	Creatinine Adjusted % Difference (95% CI)
No Concern	Ref	Ref
Concerned	-5 (-30, 31)	9 (-19, 47)

^aBoth models are adjusted for maternal race, household income, maternal education, child sex, maternal race, and child age. The benzophenone models are additionally adjusted for season. The first set of results is not adjusted for urinary creatinine concentrations, while the second set is.

^b122 (56%) were concerned and 97 (44%) were not concerned.

^cWeighted molar sum of the DEHP metabolites MEHP, MEHHP, MEOHP, and MECPP, expressed in units of ng/mL of MECPP (308 g/mol).