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Gestational and childhood urinary triclosan concentrations and academic achievement among 8-year-old children.

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Abstract

Background: Early life exposure to triclosan, an antimicrobial chemical and suspected endocrine disruptor, may adversely affect neurodevelopment. No studies have examined gestational and early childhood exposure to triclosan and children's academic achievement.

Methods: Using data from 193 mother-child pairs from the HOME Study, we quantified triclosan in maternal and child urine samples up to nine times between the second trimester of gestation (16-weeks) and age 8 years. At age 8 years, we administered the reading and math components of the Wide Range Achievement Test-4 (WRAT-4) to children. Using multiple informants models, we estimated covariate-adjusted associations of triclosan concentrations during each time period with WRAT-4 scores. We also tested whether associations differed by exposure period and child sex.

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Declaration of interests

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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Results: There was evidence that timing of exposure modified the associations between triclosan and reading composite scores (triclosan-exposure period interaction p-value=0.20), but not math scores (interaction p-value=0.72). Each 10-fold increase in triclosan concentrations at delivery was associated with lower reading composite scores (β : -2.6; 95% CI: -5.0, -0.1). Additionally, we observed weaker and less precise inverse association of math scores with triclosan concentrations at delivery (β : -1.9; 95% CI: -4.6, 0.8) and at age 1 year (β : -2.0; 95% CI: -6.0, 2.1). There was not strong evidence that child sex modified the pattern of associations between repeated triclosan measures and WRAT-4 reading composite or math scores (sex-triclosan-exposure period interaction p-values>0.20).

Conclusion: Urinary triclosan concentrations at delivery and at age 1 year, but not other times during gestation or childhood, were associated with lower reading composite and to a lesser extent math test scores at age 8 years in this cohort of U.S. children.

1. Introduction

Triclosan is a synthetic antimicrobial chemical found in some soaps, toothpaste, and personal care products (Food and Drug Administration, 2016; Rodricks et al., 2010). The addition of triclosan to consumer products has led to widespread exposure in the U.S., including among pregnant women and children (Calafat et al., 2008; Stacy et al., 2017). Although the Food and Drug Administration banned using triclosan in over the counter hand washing soaps in 2016 (Food and Drug Administration, 2016), recent reports indicate that triclosan exposure still occurs in the US population (CDC, 2019).

Triclosan may interfere with thyroid hormone metabolism and homeostasis (Braun et al., 2018; Dann and Hontela, 2011; Johnson et al., 2016; Paul et al., 2012). Given that thyroid hormones play a critical role in neurodevelopment during gestation and early childhood, triclosan-induced alterations in thyroid hormone homeostasis may adversely affect cognition and behavior in children (Álvarez-Pedrerol et al., 2007; Gilbert et al., 2012; Haddow et al., 1999; Heyer and Meredith, 2017; Korevaar et al., 2016; Lazarus et al., 2014). Two previous studies reported that increasing urinary triclosan concentrations during gestation or at delivery were associated with decreased maternal or neonatal thyroid hormone concentrations (Braun et al. 2017b; Wang et al. 2017).

A number of epidemiologic studies have examined the association of gestational or childhood urinary triclosan concentrations with cognitive and behavioral outcomes in children (Braun et al., 2017; Etzel et al., 2018; Jackson-Browne et al., 2019, 2018; Nakiwala et al., 2018; Philippat et al., 2017). We previously reported inverse associations between maternal urinary triclosan concentrations and intelligence quotient (IQ) and adverse behavioral outcomes in children at age 8 years (Jackson-Browne et al., 2019, 2018). However, other studies reported no associations of urinary triclosan concentrations during pregnancy with children's IQ scores (Etzel et al., 2018; Nakiwala et al., 2018) or other cognitive outcomes such as visual spatial abilities (Braun et al., 2017). Given the inconclusive results related to triclosan and IQ, we extended our prior findings by examining the potential impact of triclosan exposure on academic achievement. Academic achievement is correlated with measures of cognitive abilities (Kaya et al., 2015) and an important

predictor of later life career success, health, and wellbeing (Fiscella and Kitzman, 2009; Lê-Scherban et al., 2014).

Using the HOME Study we sought to identify periods of susceptibility to the potential impact of triclosan exposure using repeated measures of gestational and childhood urinary triclosan concentrations and academic achievement test scores in children. Our objective was to determine if the pattern of associations of repeated urinary triclosan concentrations with academic achievement scores were similar to our previously observed associations between repeated urinary triclosan measurements and child IQ scores at age 8 years.

2. Materials and Methods

2.1. Study Participants

We used data from a prospective pregnancy and birth cohort in Cincinnati, Ohio, the Health Outcomes and Measures of the Environment (HOME) study, previously described (Braun et al., 2016). Inclusion and eligibility criteria has been previously reported (Braun et al., 2016; Jackson-Browne et al., 2019, 2018). Briefly, women age 18 or older whom were in their second trimester of pregnancy living in Cincinnati, OH and planned on delivering at a HOME study participating hospital were eligible. Of the 389 eligible women, 193 mother-child pairs had at least one triclosan measurement, academic achievement test scores, and all covariates. The institutional review boards (IRBs) at Cincinnati Children's Hospital Medical Center (CCHMC) and participating delivery hospitals approved this study. The Centers for Disease Control and Prevention (CDC) and Brown University deferred to the CCHMC IRB as the IRB of record. All women provided written informed consent for themselves and their children.

2.2. Quantification of triclosan urinary concentrations

We assessed triclosan exposure in mothers and children using urinary triclosan concentrations. For urine collection, storage, and analysis, we followed previously described protocols to minimize potential external contamination (Jackson-Browne et al., 2018; Stacy et al., 2017; Ye et al., 2013). Women provided up to two spot urine samples around 16-and 26-weeks of pregnancy and another within 48 hours of delivery. Childhood samples were collected annually from ages 1–5 years, and again at age 8 years. Collection and storage of urine samples were previously described (Jackson-Browne et al., 2018; Stacy et al., 2017). Triclosan concentrations were quantified using online solid phase extraction-high performance liquid chromatography isotope-dilution tandem mass spectrometry methods (Kuklennyik et al., 2005; Zhou et al., 2014). The limit of detection (LOD) was 2.3 ng/ml for all samples except for the 8-year visit which was 1.0 ng/ml. LOD/ 2 was assigned for concentrations below the LOD (Hornung and Reed, 1990). Urinary creatinine was quantified and used in regression models to account for urine dilution (Larsen, 1972).

2.3. Child Academic Achievement.

Trained research assistants, who were blinded to women and children's urinary triclosan concentrations, administered the math and reading subtests of the Wide Range Achievement Test-4 (WRAT-4) to children at age 8 years (Wilkinson and Robertson, 2006). The WRAT-4

is an achievement test that measures foundational academic skills including word reading, sentence comprehension, and math. The reading composite is made up of word reading and sentence comprehension subtests. These scores are normalized to a mean of 100 and standard deviation of 15. Lower scores on the WRAT-4 are indicative of poorer performance on this test. We analyzed all scores as continuous variables.

2.4. Covariates.

We adjusted for variables associated with urinary triclosan concentrations and child academic achievement or shown in previous studies to confound other environmental chemicals similar to triclosan and neurodevelopmental outcomes similar to academic achievement (Figure S1) (Braun et al., 2011; Jackson-Browne et al., 2018; Stacy et al., 2017, 2016; Textor et al., 2016). We included children's sex, race/ethnicity, maternal education, household income, marital status, maternal IQ, urine creatinine, and serum cotinine in all models. Serum cotinine was measured from samples collected during pregnancy or at birth (Braun et al., 2010). We assessed the quality and quantity of the caregiving environment (Caldwell and Bradley, 1984) at the 1-year visit. Child and maternal IQ were assessed using the Wechsler Intelligence Scale for Children-IV (WISC-IV) and Wechsler Abbreviated Scale of Intelligence (WASI), respectively (Wechsler, 2003, 1999). Lower scores on the WISC-IV and WASI are indicative of poorer performance. The WRAT-4 test was administered after the WISC-IV during the 8-year study visit.

2.5. Statistical Analysis.

We described the distribution of urinary triclosan concentrations across exposure periods. We calculated geometric mean urinary triclosan concentrations and mean child reading composite and math scores according to covariates. We used a multiple informants model to examine the associations between repeated urinary triclosan concentrations and academic achievement test scores (Sánchez et al., 2011). This approach uses generalized estimating equations (GEE) to jointly estimate triclosan-academic achievement associations across all nine exposure periods and determine if these associations also differed by exposure window. We examined the associations between repeated urinary \log_{10} -transformed creatinine-standardized triclosan concentrations and reading composite and math scores while adjusting for \log_{10} -transformed serum cotinine concentrations (continuous), child sex (male vs. female), child race/ethnicity (White-non-Hispanic, Black-non, Hispanic, and other), caregiving environment scores (continuous), household income (continuous), and maternal marital status (married vs. unmarried), education (less than high school, high school graduate, and college graduate or more), and IQ (continuous). We examined the interaction term between triclosan concentrations and time period to assess heterogeneity in the exposure-outcome association across the nine time periods. Given the low power of the interaction test (Greenland et al., 2016), we set a p-value ≤ 0.20 significance threshold as indication that associations differed by exposure period. Given that we previously observed sex-specific association between triclosan and child behavior (Jackson-Browne et al., 2019), we examined whether child sex modified the associations between repeated urinary triclosan concentration across exposure periods and WRAT-4 scores.

2.5.1. Secondary and Sensitivity Analyses.—We set an p-value threshold of $p = 0.20$ as evidence that associations were modified by sex. Additionally, we estimated the variation in WRAT-4 scores explained by child IQ using Pearson's correlation coefficients given the strong linear relations between IQ and academic achievement (Kaya et al., 2015). Furthermore, we characterized the relation between urinary triclosan concentration at delivery and WRAT-4 scores using natural splines and quartiles of urinary triclosan concentrations, controlling for the same covariates used in the multiple informant analyses. We used analysis of variance to determine whether the regression model fit better with triclosan concentrations characterized as a linear term or with natural splines.

We performed sensitivity analyses using the word reading and sentence comprehension subscales of the reading composite test to determine if one of these subscales were more strongly associated with triclosan than the other. We also performed sensitivity analyses to assess whether our results differed when adjusting for or standardizing by urinary creatinine concentrations but not both. We previously found triclosan concentrations at delivery to be associated with IQ (Jackson-Browne et al., 2018). Complications during labor and delivery, as well as mode of delivery, may be associated with both increased triclosan exposure and poorer neurodevelopment outcomes. Therefore, we further adjusted regression models for child admission to the neonatal intensive care unit (NICU) and the mode (vaginal vs. caesarean) of delivery. Maternal age at delivery and pre-pregnancy BMI may be associated with both adverse neurodevelopment and academic achievement, as well as pregnancy complications and medical interventions, which in turn could potentially increase triclosan exposure at delivery (Marchi et al., 2015; Pugh et al., 2016). Therefore, we performed further sensitivity analyses adjusting for maternal pre-pregnancy BMI and age at delivery.

3. Results

Baseline characteristics of the study participants included in this analysis were similar to those of the full cohort (Table S1). Among children included in this analysis, 56% were female, 62% were White, non-Hispanic, 77% of the mothers had at least a high school education, and 64% of the mothers were married. Although 60% of study participant had a household income above \$40,000 per year, approximately 24% lived in households reported incomes below \$20,000 per year (Table 1).

Median gestational urinary triclosan concentrations between 16-and 26-weeks decreased from 17 to 12 ng/mL and remained at 12 ng/mL at delivery (Table S2). Geometric mean gestational urinary triclosan concentrations were higher than mean childhood urinary triclosan concentrations (17 vs. 11 ng/mL, Table 1). Gestational urinary triclosan concentrations were higher in males but similar across race/ethnicity and maternal education categories. Gestational urinary triclosan concentrations were lowest among children living in households with an income below \$20,000 level (Table 1). Gestational urinary triclosan concentrations increased with increasing caregiving environment scores (Table 1).

Median child urinary triclosan concentrations increased from 3.8 to 17 ng/mL between ages 1 to 4 years and then decreased to 10 ng/mL at age 8 years (Table S2). Childhood urinary triclosan concentrations were similar across sex and race/ethnicity (Table 1). Childhood

urinary triclosan concentrations were lower in children with mothers who had less than a high school diploma (7.1 ng/mL) compared to mothers with a high school diploma or greater (13 ng/mL) and lower in children with unmarried (9.1 ng/mL) compared to married (13 ng/mL, Table 1) mothers. Childhood urinary triclosan mothers increased monotonically with increasing household income and caregiving environment scores (Table 1).

Mean reading composite and math scores at age 8-years were similar among males and females, but scores were lower in non-Hispanic Black children compared with other race/ethnicities and scores decreased monotonically with lower maternal education, income, IQ, and caregiving environment scores (Table 1).

3.1. Regression Analyses.

We found evidence that associations of urinary triclosan concentrations and reading composite scores varied by the timing of exposure (triclosan \times exposure period interaction p-values = 0.20) but did not with math scores (triclosan \times exposure period interaction p-value = 0.72, Figures 1–2). Associations between triclosan concentrations and WRAT-4 scores appeared more heterogeneous for gestational or delivery triclosan measures compared to childhood triclosan measures (Figures 1–2). After adjusting for covariates, associations between triclosan and reading composite scores were strongest at delivery compared to other exposure periods, which were generally null. Specifically, for every 10-fold increase in maternal urinary triclosan concentration at delivery, reading composite score decreased by 2.6 (95% CI: -5.0, -0.1) points (Figure 1).

Generally, we observed weaker associations of maternal urinary triclosan concentrations during gestational or childhood periods with math scores, except for associations at delivery and age 1 years (Figure 2). Specifically, each 10-fold increase in triclosan concentrations at delivery age 1 years was associated with a 1.9-point (95% CI: -4.6, 0.8) and 2.0-point (95% CI: -6.0, 2.1) decrease in math scores at age 8 years, respectively.

3.2. Secondary and Sensitivity Analyses.

Child sex did not modify the associations between repeated urinary triclosan concentrations and WRAT-4 scores (triclosan \times exposure period \times sex p-values > 0.20). However, in sex-stratified analyses we observed that urinary triclosan concentrations were generally inversely associated with WRAT-4 scores in males, whereas associations were mostly positive in females (Table S3). Child full scale IQ scores were strongly correlated with reading composite ($r = 0.75$) and math ($r = 0.76$) scores (Figure S2). In addition, verbal IQ subscale scores were strongly correlated with reading composite ($r = 0.71$) and math ($r = 0.60$) scores (Figure S2). After adjusting for covariates, increasing urinary triclosan concentrations at delivery were associated with increasing mean reading composite scores and we did not observe evidence that the association was non-linear (non-linearity p-value = 0.55, Figure S3). Reading composite scores were lower among children born to mothers with urinary triclosan concentrations at delivery in the second (β : -5.3; 95% CI: -12.0, 1.0), third (β : -3.7; 95% CI: -10, 2.8), and fourth quartiles (β : -3.7; 95% CI: -10, 2.7) compared with children born to women with urinary triclosan concentrations in the first quartile (Figure S4).

The association of triclosan at delivery with reading composite scores did not change after further adjustment for maternal age at delivery and pre-pregnancy BMI (Table S4). Additional adjustment for NICU admission and mode of delivery also did not substantially change the association between maternal urinary triclosan concentrations at delivery and WRAT-4 scores. There were no appreciable differences between creatinine-adjusted and creatinine-standardized model results (Table S5). The associations of triclosan concentrations with the word reading and sentence comprehension subtests were similar to reading composite results (Figures S5–S6).

4. Discussion

In this prospective cohort study, urinary triclosan concentrations at delivery and age 1 year, but not other periods, were inversely associated with both reading composite and math scores on the WRAT-4. These results are consistent with our prior findings from this cohort showing that triclosan concentrations at delivery were inversely associated with child IQ and suggest that triclosan exposure near delivery could be a period of heightened neurodevelopmental susceptibility (Jackson-Browne et al., 2018).

While the underlying biological mechanisms by which triclosan could affect neurodevelopment or academic achievement are not well understood, experimental studies in animals report reductions in thyroid hormone concentrations during pregnancy, infancy, and adulthood associated with triclosan exposure (Johnson et al., 2016; Louis et al., 2017). Lower triiodothyronine (T_3) and thyroxine (T_4) hormone concentrations during pregnancy and infancy have consistently been associated with poorer neurodevelopmental outcomes (Klein et al., 2001; Lazarus, 1999; Murphy et al., 2015). Additionally, children with congenital hypothyroidism also have poorer neurodevelopmental outcomes (Klein et al., 2001; Lazarus, 1999; Murphy et al., 2015). Gestational triclosan concentrations were also inversely associated with maternal serum free T_3 (Aker et al., 2018; Skarha et al., 2019; Wang et al., 2017), maternal free T_4 (Berger et al., 2018; Wang et al., 2017), and cord serum total T_4 (Braun et al., 2018) in human studies. Thus, we speculate that observed associations may relate to the ability of triclosan to affect thyroid hormone homeostasis during late gestation and early infancy.

Studies examining the relations between intelligence and academic achievement suggest that intelligence test scores explain much, but not all of the variation, in academic achievement scores in children (Gustafsson and Undheim, 1996; Jencks, 1979; Jensen and Rushton, 1998; Lubinski et al., 2001). This may explain differences in the magnitude of associations of triclosan concentrations at delivery between WRAT reading composite (β : -2.6 ; 95% CI: $-5.0, -0.1$) compared to IQ scores (β : -4.5 ; 95% CI: $-7.0, -2.0$) at age 8-years (Jackson-Browne et al., 2018).

While we are unaware of any studies examining the association between triclosan exposure and academic achievement, two other studies examined associations between early life triclosan exposure and IQ in children (Etzel et al., 2018; Nakiwala et al., 2018). We previously reported that increasing urinary triclosan concentrations measured near delivery were inversely associated with IQ at age 8 years in the HOME Study, but in the Canadian

MIREC and French EDEN cohorts, maternal triclosan concentrations during pregnancy were not associated with child IQ at ages 3–4 and 5 years, respectively (Etzel et al., 2018; Nakiwala et al., 2018). However, these studies did not assess triclosan exposure near the time of delivery. Additionally, the MIREC and EDEN studies both only had a single gestational triclosan measurement compared to multiple gestational measurements in the HOME Study, and the EDEN cohort only included mother-son pairs (Braun et al., 2016; Nakiwala et al., 2018). These differences in the study design, specifically the timing of exposure assessment, may explain the divergent results observed among these studies.

We can only speculate as to why neurodevelopmental processes near the time of delivery may be more sensitive to triclosan than exposure at other times. One possible explanation is that triclosan disrupts the neonatal microbiome at the time of delivery, which is a crucial period for microbiota development (DiGiulio et al., 2015; Ribado et al., 2017). Future work could explore the role triclosan plays in differences in microbiota diversity in the mother and newborn at delivery.

Our study has several strengths. First, the prospective study design enabled us to examine associations between child academic achievement test scores and triclosan exposure during nine separate gestational and childhood developmental periods. Second, we capitalized on these repeated exposure measures to formally examine differences in associations of academic achievement with triclosan concentrations measured at different exposure time periods. The use of a well-validated measure of academic abilities was another strength of our study (Wilkinson and Robertson, 2006). An additional strength was the adjustment for sociodemographic, maternal, and child factors that may confound the association between triclosan concentrations and WRAT-4 scores. Moreover, adjustment for these factors resulted in negative confounding of the association of triclosan at delivery and WRAT-4 scores, and the standard errors for the adjusted associations were more precise than the unadjusted. Finally, mean WRAT-4 scores in this cohort were similar to other children living in the US (Wilkinson and Robertson, 2006) and median urinary triclosan concentrations among pregnant women and children in this cohort were also similar to concentrations observed in the U.S. general population (Calafat et al., 2008).

There are some limitations of this study. First, we relied on a single urine sample during each exposure period to assess exposure to triclosan, however exposure assessment at more frequent intervals was not economical. Exposure to non-persistent chemicals, like triclosan, varies within individuals because exposure is episodic and triclosan has a relatively short biological half-life (~21 hours) (Calafat et al., 2008; Jackson-Browne et al., 2018; Sandborgh-Englund et al., 2006; Stacy et al., 2017). We previously reported that maternal urinary triclosan concentrations in this cohort had an intraclass correlation coefficient (ICC) of 0.5 compared to a lower ICC (< 0.4) during childhood (Stacy et al., 2017). Assuming non-differential exposure measurement error, we expect this misclassification would likely bias associations toward the null (Perrier et al., 2016). Second, although we did not observe differences between the characteristics of this study sample and the original cohort, attrition due to loss to follow-up in our cohort resulted in limited sample size for assessing sex-specific effects, and the modest sample size may have limited our ability to identify periods of susceptibility. We acknowledge that our modest sample size may have also been

insufficient to meet positivity assumptions of our statistical models and this might be reflected by the differences in the magnitude and precision between our unadjusted and adjusted estimates.

Third, it is still possible that there were unmeasured factors associated with higher triclosan concentrations at delivery and lower academic test scores at age 8 years. However, we only observed inverse associations between triclosan at delivery and WRAT-4 scores after adjusting for covariates, suggesting that there was negative confounding of this association (Mehio-Sibai et al., 2005). One alternative explanation for our findings is that complications during labor and delivery may increase the risk for medical interventions which in turn are associated with both increased triclosan exposure and adverse neurodevelopmental risks; however, adjusting for mode of delivery and NICU admission did not materially change the association between triclosan concentrations at delivery and academic achievement scores. Finally, a decrease of 2 points in academic achievement scores may not translate into a meaningful change in an individual child's classroom performance. However, on a population level, a 2-point reduction in academic achievement scores can result in a larger proportion of children with poorer scholastic performance at the population level (Bellinger, 2004; Braun et al., 2016a).

5. Conclusions

In this cohort of children, we observed inverse associations of urinary triclosan concentrations measured at delivery and age 1 year with reading and math achievement test scores at age 8 years, but not at other time periods. These results are consistent with our prior findings from this same cohort of associations between triclosan exposure at delivery with reduced cognitive abilities at age 8 years. Taken together, this study and previous investigations in this cohort suggest that triclosan exposures near delivery may influence intelligence and subsequently, academic performance in children.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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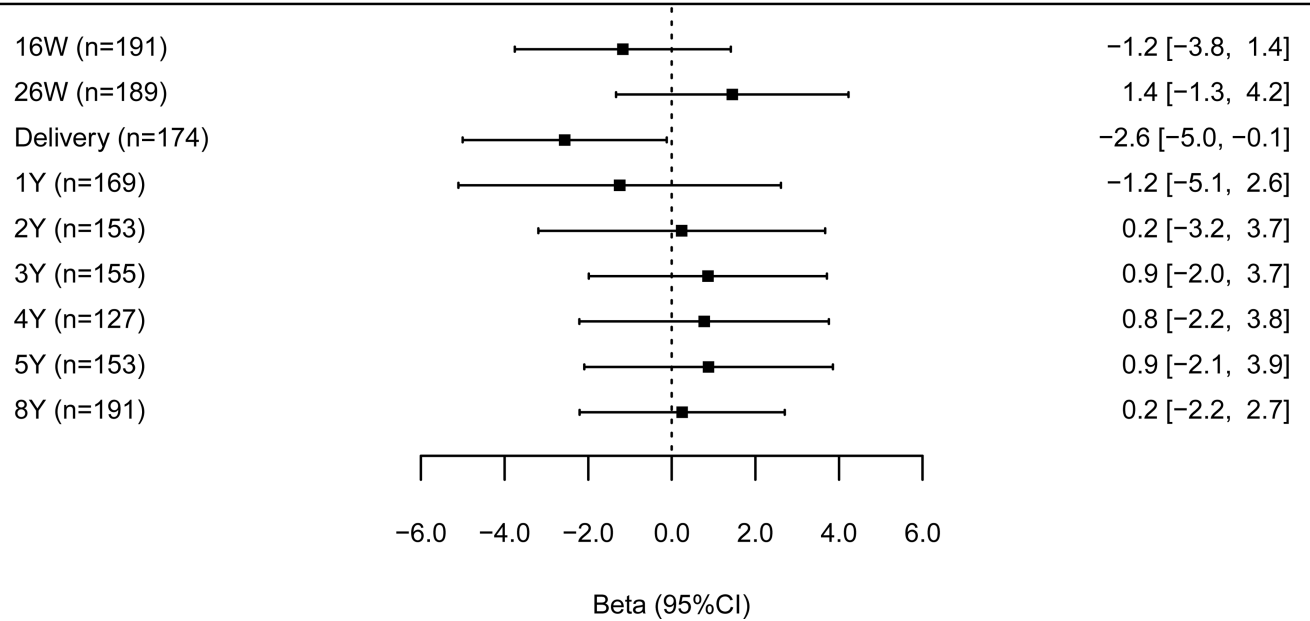
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Highlights

- We measured urinary triclosan concentrations in women up to twice during pregnancy, at delivery, and up to 6 times in children from ages 1–8-years.
- We measured children’s academic achievement at age 8 years using the Wide Range Achievement Test (WRAT-4).
- We used a multiple informant regression to estimate covariate-adjusted triclosan-reading composite and triclosan-math WRAT-4 test score associations at each visit and tested if triclosan-WRAT-4 associations at each visit differed from one another.
- Timing of exposure modified the associations between triclosan and reading composite but not math test scores.
- Increasing maternal and childhood triclosan concentrations at delivery and at age 1 year were inversely associated with reading and math scores at age 8 years.

Exposure Period**Difference in Score****Figure 1.**

Adjusted differences in WRAT-4 reading composite scores at age 8 years per 10-fold increase in gestational and childhood urinary triclosan concentrations.

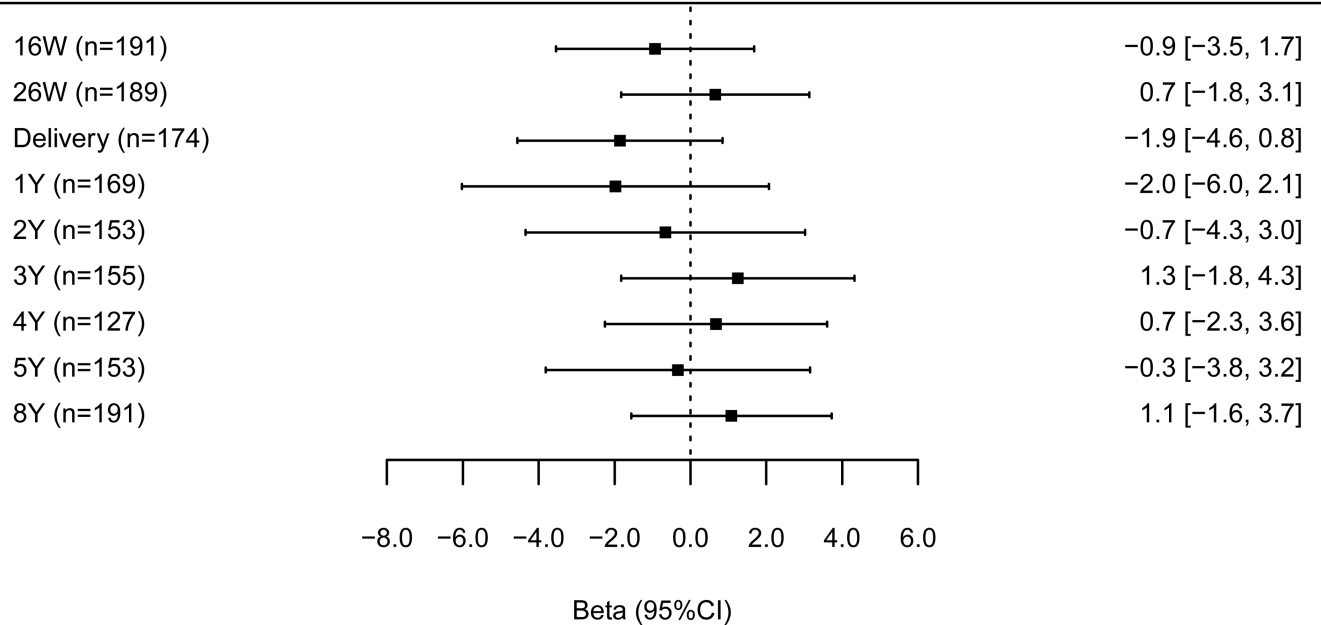
Betas and 95% CI derived from a multiple informants model.

Abbreviations: W: weeks of gestation, Y: age in years, CI: confidence interval, WRAT-4: Wide Range Achievement Test-4.

Multiple Informant regression model adjusted for \log_{10} -transformed serum cotinine concentrations (continuous), child sex (male vs. female), child race/ethnicity (White-non-Hispanic, Black-non, Hispanic, and other), household income (continuous), marital status (married vs. unmarried), maternal education (less than high school, high school graduate, and college graduate or more), caregiving environment scores (continuous), and maternal IQ (continuous).

Error bars are 95% CI.

Urinary triclosan concentration by exposure window interaction p-value = 0.20.

Exposure Period**Difference in Score****Figure 2.**

Adjusted differences in child WRAT-4 math scores at 8 years of age per 10-fold increase in gestational and childhood urinary triclosan concentrations.

Betas and 95% CI derived from a multiple informants model.

Abbreviations: W: weeks of gestation, Y: age in years, CI: confidence interval, WRAT-4: Wide Range Achievement Test-4.

Multiple Informant regression model adjusted for \log_{10} -transformed serum cotinine concentrations (continuous), child sex (male vs. female), child race/ethnicity (White-non-Hispanic, Black-non, Hispanic, and other), household income (continuous), marital status (married vs. unmarried), maternal education (less than high school, high school graduate, and college graduate or more), caregiving environment scores (continuous), and maternal IQ (continuous).

Error bars are 95% CI.

Urinary triclosan concentration by exposure window interaction p-value = 0.72

Table 1.

Geometric mean gestational and childhood urinary triclosan concentrations (ng/mL) and mean age 8-year WRAT-4 reading composite and math scores according to sociodemographic, caregiving, and maternal factors among mother-child pairs in the HOME Study.

Characteristics	Gestational Triclosan ^a		Childhood Triclosan ^b		Reading Composite	Math
	N (%)	GM (GSD)	GM (GSD)	Mean (SD)	Mean (SD)	
Total	193	17 (3.6)	11 (2.7)	109 (16)	109 (12)	
Child Sex						
Female	108 (56)	15 (2.8)	12 (2.8)	108 (17)	109 (13)	
Male	85 (44)	19 (4.0)	11 (2.6)	109 (14)	109 (11)	
Child Race						
White, non-Hispanic	120 (62)	17 (3.8)	12 (2.5)	114 (13)	112 (10)	
Black, non-Hispanic	63 (33)	17 (3.2)	10 (3.1)	98 (16)	102 (14)	
Other	10 (5)	18 (3.9)	9 (2.1)	113 (14)	111 (12)	
Maternal Education						
< High School Diploma	45 (23)	16 (2.7)	7.1 (2.5)	98 (16)	101 (13)	
High School Diploma	56 (29)	17 (3.6)	13 (2.4)	104 (14)	107 (12)	
College +	92 (48)	18 (4.0)	13 (2.8)	116 (12)	114 (9.8)	
Income (\$/year)						
<20k	47 (24)	14 (2.8)	7.9 (2.5)	96 (16)	100 (13)	
20–40k	31 (16)	18 (3.5)	9.9 (2.7)	108 (12)	109 (11)	
>40–80k	62 (32)	17 (4.1)	13 (2.5)	113 (13)	111 (11)	
>80k	53 (28)	19 (3.8)	15 (2.9)	116 (13)	115 (10)	
Marital Status						
Not Married	70 (36)	15 (2.7)	9.1 (2.7)	99 (15)	103 (13)	
Married	123 (64)	18 (4.1)	13 (2.6)	114 (13)	113 (11)	
Caregiving Score						
<35	39 (20)	15 (3.0)	9.2 (3.4)	95 (15)	100 (13)	
35–40	53 (27)	17 (3.4)	11 (2.4)	108 (15)	109 (12)	
>40	101 (52)	18 (3.9)	13 (2.6)	114 (13)	112 (10)	
Maternal IQ						
<96	55 (28)	15 (2.7)	8.2 (2.6)	99 (15)	102 (13)	
96–110	51 (26)	17 (3.3)	12 (2.9)	107 (15)	108 (13)	
>110–117	36 (19)	21 (4.8)	17 (2.3)	111 (13)	111 (9.9)	
>117	51 (26)	17 (4.0)	12 (2.6)	119 (11)	116 (9.5)	
Serum Cotinine						
Unexposed (<0.015 ng/ml)	86 (45)	17 (3.4)	12 (2.7)	111 (15)	110 (12)	
SHS (0.15 <3.0 ng/ml)	90 (47)	18 (3.8)	11 (2.8)	106 (17)	107 (13)	
Active (3.0 ng/ml)	17 (8)	13 (3.1)	12 (2.5)	114 (11)	113 (9.6)	
NICU Admission						
No	182 (94)	17 (3.5)	12 (2.7)	110 (15)	110 (12)	

Characteristics	Gestational Triclosan ^a	Childhood Triclosan ^b	Reading Composite	Math
	N (%)	GM (GSD)	GM (GSD)	Mean (SD)
Yes	11 (6)	24 (4.8)	6.8 (1.8)	96 (20)
Delivery Method				
Caesarean	53 (27)	17 (4.4)	13 (3.2)	111 (14)
Vaginal	140 (73)	17 (3.3)	11 (2.5)	108 (16)

Abbreviations: GM: geometric mean, GSD: Geometric Standard Deviation, WRAT-4: Wide Range Achievement Test-4, SHS: secondhand smoke.

^aMean gestational triclosan concentrations included up to 3 triclosan measurements from maternal urine samples collected during 16-and 26-weeks gestation, and within 48 hours of delivery.

^bMean childhood triclosan concentrations included up to 6 triclosan measurements from child urine samples collected annually from ages 1–5 and at 8-years.