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## **Supplemental Material**

# **Polybrominated Diphenyl Ethers in Human Milk and Serum from the US EPA MAMA Study: Modeled Predictions of Infant Exposure and Considerations for Risk Assessment**

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**First Visit Questionnaire, U.S. EPA MAMA Study (Fenton 2004)**

**Title of Study: Methods Advancement for Milk Analysis (MAMA)**

**Sponsored by: U.S. Environmental Protection Agency**

**Study number: 03-EPA-207 Today's Month /Year: \_\_\_\_\_**

**Interviewer's Name: \_\_\_\_\_ Interview start time: \_\_\_\_\_**

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**Subject code:**

*Attach Consent code  
here once signed.*

*Attach Questionnaire  
code here and proceed  
with questions.*

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We would like you to answer the following questions for us so that we can obtain information about your lifestyle and surroundings. The subject matter should in no way alarm you, as this is just an information-gathering device to help us understand other information that is obtained from your samples. Some of the questions may have multiple answers. Please feel free to ask questions if you have any. We want you to be comfortable answering the following:

1. What is your month and year of birth? \_\_\_\_\_
2. What is your height? \_\_\_\_\_
3. What is your weight? \_\_\_\_\_
4. What is your child's age? (round to the nearest week) \_\_\_\_\_
5. How many children have you given birth to previously? \_\_\_\_\_
6. How many children have you previously breastfed? \_\_\_\_\_
7. If you have had previously breastfed a child(ren), about how long? \_\_\_\_\_
8. Were you informed at any time during your pregnancy that you had  
gestational diabetes                      Yes \_\_\_\_\_ No \_\_\_\_\_  
pre-eclampsia/toxemia                      Yes \_\_\_\_\_ No \_\_\_\_\_  
excessive weight gain                      Yes \_\_\_\_\_ No \_\_\_\_\_
9. How many times have you breast-fed your baby since midnight? \_\_\_\_\_
10. Is your baby being fed formula in addition to breast milk? (yes/no) \_\_\_\_\_  
*How many times in a 24-hour period are you breast-feeding?* \_\_\_\_\_  
*How many times in a 24-hour period is your baby drinking formula?* \_\_\_\_\_

Questionnaire (Cont'd)

***Title of Study: Methods Advancement for Milk Analysis (MAMA)***

11. Are you currently taking any prescription medication(s) on a regular basis?  
*If yes, please specify:* \_\_\_\_\_
12. Have you taken any non-prescription medications in the last 24 hours?  
*If yes, please specify:* \_\_\_\_\_
13. Do you have any cold/flu symptoms (sore throat, runny nose, fever, sore muscles) today?  
*Yes* \_\_\_\_\_ *No* \_\_\_\_\_
14. Are you currently experiencing any allergy symptoms?  
*Yes* \_\_\_\_\_ *No* \_\_\_\_\_
15. What county do you live in and how long have you lived in this county? \_\_\_\_\_  
\_\_\_\_\_
16. How long have you lived in North Carolina? \_\_\_\_\_ The United States? \_\_\_\_\_  
  
What is your race? (circle one) white, black or African American, Asian, Hispanic or Latino, Native American (Indian, Alaskan, Hawaiian), mixed.
17. What is your approximate household income? (circle one)  
Under \$29,999    \$30K to 50K    \$50K to 75K    \$75K to 100K    over \$100K
18. What is the highest grade of formal schooling completed? \_\_\_\_\_
19. How long have you lived in your present dwelling? \_\_\_\_\_
20. How old is your home or rental unit? \_\_\_\_\_
21. Does your home have an enclosed garage attached? \_\_\_\_\_
22. How old is the carpeting in your home? \_\_\_\_\_  
\_\_\_\_\_
23. How old are any of the upholstered pieces of living room furniture in your home? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
24. Do you have vinyl blinds on your windows that are over 5-6 years old?  
*Yes* \_\_\_\_\_ *No* \_\_\_\_\_ *How many?* \_\_\_\_\_
25. Do you have any lead-containing paint or asbestos in your home? (circle one)  
*Yes to both*    *No*    *Don't know*    *Probably*    *yes to one* \_\_\_\_\_

Questionnaire (Cont'd)

***Title of Study: Methods Advancement for Milk Analysis (MAMA)***

26. What are the average hours you spend in your home each day? \_\_\_\_\_
27. How many hours do you spend in your vehicle each day? \_\_\_\_\_  
Make and year: \_\_\_\_\_
28. Are you exposed to second-hand cigarette smoke in your workplace or at home?  
Yes \_\_\_\_\_ No \_\_\_\_\_  
*If yes, approximately how many hours/day are you exposed?* \_\_\_\_\_
29. Are you presently on maternity leave from your place of employment?  
Yes \_\_\_\_\_ No \_\_\_\_\_  
*If you work outside the home:*  
*How many hours a day are you away from your home?* \_\_\_\_\_  
*In which county do you work?* \_\_\_\_\_
30. Estimate how many hours a week you spend within 6 feet of a computer.  
\_\_\_\_\_
31. Estimate how many hours per day you spend within 6 feet of a television.  
\_\_\_\_\_
32. Do you pursue any of the following hobbies?  
Furniture upholstery/refinishing Yes \_\_\_ No \_\_\_  
Pillow making Yes \_\_\_ No \_\_\_  
Painting Yes \_\_\_ No \_\_\_  
Gardening Yes \_\_\_ No \_\_\_  
Computer repair Yes \_\_\_ No \_\_\_  
Hobbies that require the use of airplane glue or solvents Yes \_\_\_ No \_\_\_  
Talk on a cellular phone more than 1 hour per day Yes \_\_\_ No \_\_\_  
*Talk on a cellular phone more than 3 hours per day* Yes \_\_\_ No \_\_\_
33. How often do you: (1 = never, 2 = rarely, 3 = sometimes, 4 = often)
- |                               |  |
|-------------------------------|--|
| wear nail polish _____        | use hair styling products _____          |
| wear foundation _____         | consume/drink tofu or soy products _____ |
| color your hair _____         | eat processed meats _____                |
| take recreational drugs _____ | (sausages, hot dogs, bologna, etc)       |
| eat microwave popcorn _____   | take herbal remedies/supplements _____   |

Questionnaire (Cont'd)

***Title of Study: Methods Advancement for Milk Analysis (MAMA)***

34. In a usual week, how many hours do you spend in these occupations, activities, or establishments?

- Painting \_\_\_\_\_
- Dry cleaning \_\_\_\_\_
- Chemical Plant or Lab \_\_\_\_\_
- Plastics Fabrication \_\_\_\_\_
- Plastic or Computer Recycling \_\_\_\_\_
- Furniture Refinishing/Repair \_\_\_\_\_
- Firefighter/burn trash \_\_\_\_\_
- Carpet/insulation installation \_\_\_\_\_
- Carpet cleaning \_\_\_\_\_
- Clean houses \_\_\_\_\_
- Work with flame retardant chemicals \_\_\_\_\_
- Recycle electronic goods or plastic materials \_\_\_\_\_
- Repair computers or electronic equipment \_\_\_\_\_
- Make plastic parts \_\_\_\_\_
- Work with furniture parts, furniture coverings, or carpets \_\_\_\_\_
- Computers \_\_\_\_\_

35. Do you eat chicken? How often in each category (per week)?

- Grilled \_\_\_\_\_
- Baked \_\_\_\_\_
- Fried \_\_\_\_\_

36. How often do you:

- eat fish    Never \_\_\_\_\_    Less than once/week \_\_\_\_\_  
                  Once/week \_\_\_\_\_    Twice/week \_\_\_\_\_    > Twice/week \_\_\_\_\_

List all of the kinds of fish that you eat: \_\_\_\_\_  
\_\_\_\_\_

- eat beef    Never \_\_\_\_\_    Less than once/week \_\_\_\_\_  
                  Once/week \_\_\_\_\_    Twice/week \_\_\_\_\_    > Twice/week \_\_\_\_\_

List all of the ways that you prefer to cook your beef \_\_\_\_\_  
\_\_\_\_\_

Questionnaire (Cont'd)

*Title of Study: Methods Advancement for Milk Analysis (MAMA )*

36. How often do you: (con't.)

eat dairy products Never \_\_\_\_\_ Two times or less/week \_\_\_\_\_  
Two times/week but not daily \_\_\_\_\_ Everyday \_\_\_\_\_

drink cow's milk Never \_\_\_\_\_ Two times or less/week \_\_\_\_\_  
Two times/week but not daily \_\_\_\_\_ Everyday \_\_\_\_\_

37. What kind of milk do you typically drink?

Skim \_\_\_\_\_ 2% or less fat \_\_\_\_\_ whole milk \_\_\_\_\_

38. Have you had any alcoholic drinks since you have been breast-feeding \_\_\_\_\_

*If yes, how many drinks/week do you have?* \_\_\_\_\_

39. What is the primary source of your drinking water? (city, well, bottled water)

\_\_\_\_\_

40. How much water do you drink each day (e.g. 4 large glasses, 6 small cups)

\_\_\_\_\_

Thank you very much for your time. Do you have any questions for me?

Time interview **ended:** \_\_\_\_\_

**Table S1.** Spearman correlation between maternal age and BFR concentrations.

Variable	Serum		Milk	
	$r_s$	$p$ -value	$r_s$	$p$ -value
BB-153	0.47	<0.001	0.35	<0.01
BDE-28	-0.33	<0.01	n.d.	--
BDE-47	-0.27	<0.05	-0.25	0.05
BDE-85	-0.19	0.14	-0.22	0.09
BDE-99	-0.26	<0.05	-0.21	0.10
BDE-100	-0.40	<0.001	-0.33	<0.01
BDE-153	-0.27	<0.05	-0.26	<0.05
BDE-154	-0.27	<0.05	-0.19	0.135
$\Sigma$ PBDEs	-0.34	<0.01	-0.28	<0.05

n.d., not determined.

Median maternal age = 31 yr (range, 21-39 yr).

n = 63-64 individual samples.

**Table S2.** Spearman correlation between vehicle age and BFR concentrations.

Variable	Serum		Milk	
	$r_s$	$p$ -value	$r_s$	$p$ -value
BB-153	0.17	0.21	-0.30	<0.02
BDE-47	0.40	<0.01	0.43	<0.01
BDE-28	0.32	<0.02	n.d.	--
BDE-85	0.33	<0.02	0.29	<0.05
BDE-99	0.31	<0.02	0.33	<0.02
BDE-100	0.39	<0.01	0.45	<0.001
BDE-153	0.26	0.05	0.29	<0.05
BDE-154	0.37	<0.01	-0.06	0.62
$\Sigma$ PBDEs	0.24	0.07	0.35	<0.01

n.d., not determined.

Median vehicle age = 5 yr (range, 0.1-11 yr).

n = 63-64 individual samples.



**Table S3.** Spearman correlation between home age and BFR concentrations.

Variable	Serum		Milk	
	$r_s$	$p$ -value	$r_s$	$p$ -value
BB-153	0.25	0.05	0.10	0.42
BDE-28	-0.35	<0.01	n.d.	--
BDE-47	-0.30	<0.05	-0.30	<0.05
BDE-99	-0.25	<0.05	-0.26	<0.05
BDE-100	-0.36	<0.01	-0.36	<0.01
BDE-153	-0.14	0.28	-0.12	0.35
BDE-154	-0.19	0.14	-0.06	0.66
$\Sigma$ PBDEs	-0.25	0.05	-0.24	0.06

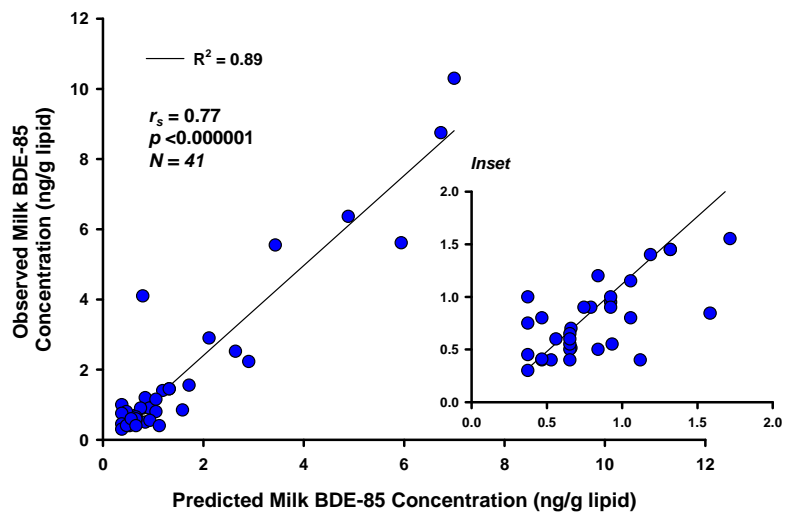
n.d., not determined.

Median home age = 13 yr (range, 0.5-100 yr).

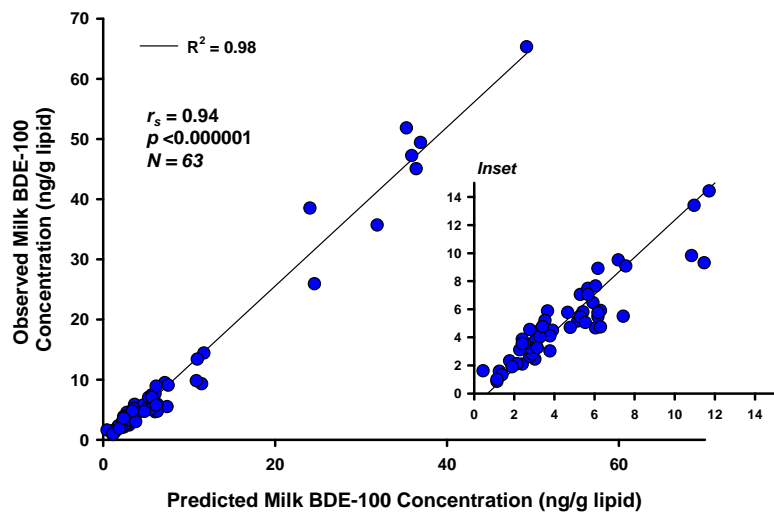
n = 63-64 individual samples.

Figure S1

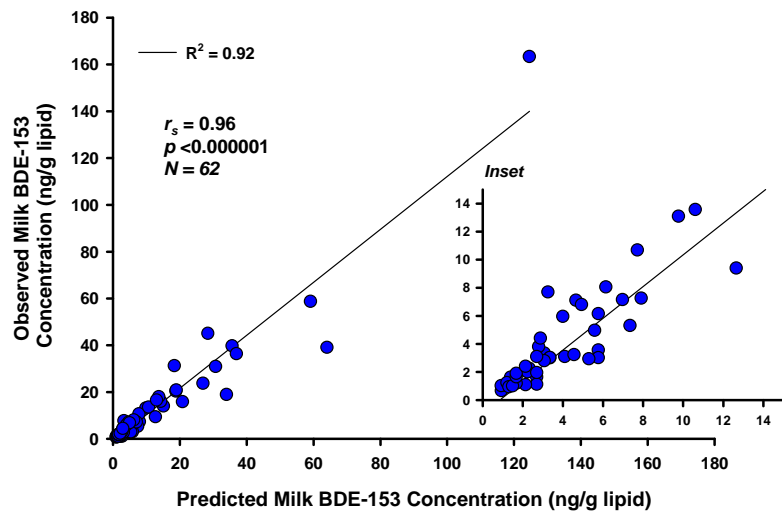
A.



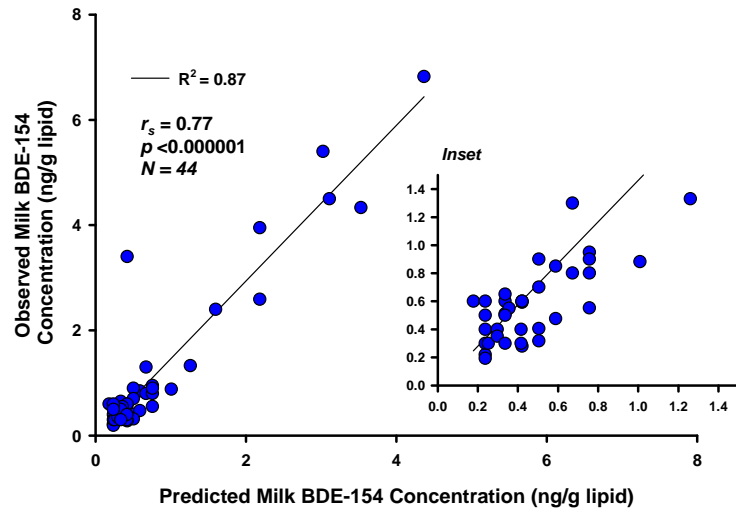
B.



C.



D.



**Figure S1.** Predicted milk BFR concentrations vs. observed MAMA Study milk concentrations for BDE-85 (A), BDE-100 (B), BDE-153 (C), and BDE-154 (D). Milk concentrations were predicted by applying exposure models for these BDEs (Marchitti et al., 2013) to serum BDE concentrations from MAMA study participants. Solid lines are the least-squares fit of predicted and observed milk concentrations ( $R^2$  0.87-0.98). Spearman correlation coefficients ( $r_s$ ) and related p values are given for each evaluation of the relationship between predicted and observed milk concentration values ( $r_s = 0.77$ -0.96).

Additional Information for Models Previously Developed in Marchitti et al. 2013b.

Exposure models for predicting milk PBDE concentrations from serum concentrations have been previously developed (Marchitti et al. 2013b). Three U.S. studies met our study criteria (LaKind et al. 2009; Schechter et al. 2006, 2010) and only participants for whom lipid-adjusted (ng/g lipid) milk and serum PBDE concentrations where both > LOD were included. Data for seven PBDE congeners were available: BDE-28, BDE-47, BDE-85, BDE-99, BDE-100, BDE-153, and BDE-154.

Individual PBDE milk:serum partitioning ratios were calculated for each congener by dividing the milk concentration (ng/g lipid) by the serum concentration (ng/g lipid). Minimal interindividual variability was observed among participants, thus, we combined data from the three studies into one dataset. Pearson's  $r$  correlation coefficients and least-squares linear regression [SigmaPlot Systat Software, version 12.3 (2011)] were used to determine if serum and milk PBDE concentrations for each congener were significantly correlated and yielded model equations:

$$(1) y_i' = \beta_1 x_i$$

where  $y_i$  is the breast milk PBDE concentration of the participant ( $i$ ),  $\beta_1$  is the slope of the regression line, and  $x_i$  is the serum PBDE concentration of the participant.  $\beta_1$  provides an estimate of the congener's milk:serum partitioning ratio. The predictive power of each model was determined by  $k$ -fold cross-validation followed by the quantification of its predictive ability ( $Q^2$ ) (Eriksson et al. 2003). Regression models for the seven PBDE congeners exhibited high predictive abilities ( $Q^2 \geq 0.90$ ).

## Supplemental References

Eriksson L, Jaworska J, Worth AP, Cronin MT, McDowell RM, Gramatica P. 2003. Methods for reliability and uncertainty assessment and for applicability evaluations of classification- and regression-based QSARs. *Environ Health Perspect* 111(10): 1361-1375.

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LaKind JS, Berlin CM, Jr., Sjödin A, Turner W, Wang RY, Needham LL, et al. 2009. Do human milk concentrations of persistent organic chemicals really decline during lactation? Chemical concentrations during lactation and milk/serum partitioning. *Environ Health Perspect* 117:1625-1631.

Marchitti SA, LaKind JS, Naiman DQ, Berlin CM, Kenneke JF. 2013b. Improving infant exposure and health risk estimates: Using serum data to predict polybrominated diphenyl ether concentrations in breast milk. *Environ Sci Technol* 47:4787-4795.

Schechter A, Colacino J, Sjödin A, Needham L, Birnbaum L. 2010. Partitioning of polybrominated diphenyl ethers (PBDEs) in serum and milk from the same mothers. *Chemosphere* 78:1279-1284.

Schechter AJ, Papke O, Harris TR, Tung KC. 2006a. Partitioning of polybrominated diphenyl ether (PBDE) congeners in human blood and milk. *Toxicol Environ Chem* 88:319-324.