

## SUPPLEMENTAL MATERIAL

### **Phthalate concentrations in house dust in relation to autism spectrum disorder and developmental delay in the CHildhood Autism Risks from Genetics and the Environment (CHARGE) Study.**

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#### **Table of contents**

Table 1: Aberrant Behavior Checklist hyperactivity subscale items used to compute the hyperactivity/impulsivity subdomain and the inattention subdomain .....	2
Table 2: MSEL, VABS and ABC scores according to diagnostic groups (CHARGE study, n = 145) .....	3
Table 3: Characteristics of the dust study population and comparison with the whole CHARGE case-control study enrolled before the end of the dust study (2003 – 2011). .....	4
Table 4: Phthalate concentrations in house dust ( $\mu\text{g/g}$ of dust, CHARGE study, n = 145).....	5
Table 5: Adjusted associations between dust phthalate concentrations and the MSEL and VABS scores among boys (CHARGE study, n = 115).....	6
Table 6: Comparison of phthalate concentrations measured in house dust in different studies .....	7
Figure 1: Dust phthalate concentrations ( $\mu\text{g/g}$ ) according to the date of dust collection .....	8

Table 1: Aberrant Behavior Checklist hyperactivity subscale items used to compute the hyperactivity/impulsivity subdomain and the inattention subdomain

<b>Subdomain</b>	<b>Subscale items used</b>
Hyperactivity/Impulsivity	Hyperactivity subscale items 1, 7, 13, 15, 21, 31, 38, 39, 48, and 54: 1. Excessively active at home, school, work, or elsewhere 7. Boisterous (inappropriately noisy and rough) 13. Impulsive (acts without thinking) 15. Restless, unable to sit still 21. Disturbs others 31. Disrupts group activities 38. Does not stay in seat (e.g., during lesson or training periods, meals, etc.) 39. Will not sit still for any length of time 48. Constantly jumps or runs around the room 54. Tends to be excessively active
Inattention	Hyperactivity subscale items 28,44,51 28. Does not pay attention to instructions 44. Easily distractible 51. Pays no attention when spoken to

Table 2: MSEL, VABS and ABC scores according to diagnostic groups (CHARGE study, n = 145)

	TD				DD				ASD			
	N	Percentiles			N	Percentiles			N	Percentiles		
		5	50	95		5	50	95		5	50	95
<b>Vineland Adaptive Behavior Scales (standard scores)</b>												
Communication	68	80	103	126	27	49	67	82	50	52	69	94
Daily living skills	68	72	93	117	27	51	64	86	50	54	68	93
Socialization	68	85	104	124	27	55	73	107	50	53	67	88
Motor skills	68	83	107	130	27	49	60	85	50	54	77	107
Adaptive behavior Composite score	68	83	98	127	27	47	61	87	50	53	65	88
<b>Mullen (DQ scores)</b>												
Visual Reception	68	88	114	150	27	27	60	103	50	40	70	120
Fine Motor	68	78	103	127	27	33	58	78	50	43	67	106
Receptive Language	68	80	112	142	27	18	56	81	50	25	52	109
Expressive Language	68	79	105	139	27	18	52	81	50	23	61	109
Composite score	68	88	112	131	27	26	60	83	50	37	61	102
<b>Aberrant Behavior Checklist (hyperactivity subscales)</b>												
Hyperactivity / impulsivity	64	0	1	7	22	0	4	20	48	0	7	20
Inattention	64	0	0	2	24	0	1	6	49	0	3	6

Abbreviation: ASD: autism spectrum disorder, CI: confidence interval, DD: developmental delay, TD: typically developing

Table 3: Characteristics of the dust study population and comparison with the whole CHARGE case-control study enrolled before the end of the dust study (2003 – 2011).

Characteristics	CHARGE participant enrolled in the dust study (n = 145)		CHARGE participant enrolled until the end of the dust study (n = 1092)		P-values <sup>a</sup>
	N	%	N	%	
<b>Child diagnosis</b>					0.001
TD	68	47	304	32	
DD	27	19	188	20	
ASD	50	34	455	48	
<b>Child gender</b>					0.61
Male	115	79	768	81	
Female	30	21	179	19	
<b>Child race</b>					0.09
White, Non-Hispanic	85	59	461	49	
Hispanic (any)	40	28	307	32	
other	20	14	175	18	
missing	0	0	4	0	
<b>Maternal education</b>					0.002
High school diploma and lower, < 1 year college, technical vocational school	21	14	265	28	
> 1 year college, associate degree	43	30	285	30	
Bachelor degree	56	38	280	30	
Graduate school	25	17	116	12	
missing	0	0	1	0	
<b>Delivery payer</b>					0.02
Government program / no Insurance	19	13	202	21	
Private insurance	126	87	743	78	
Missing	0	0	2	0	
<b>Own their home</b>					0.002
Yes	111	76	590	62	
No	27	19	290	31	
missing	7	5	67	7	
<b>Regional center catchment area at enrollment</b>					0.03
Alta, Far Northern, and Redwood Coast	85	59	459	48	
North Bay	25	17	143	15	
East Bay, San Andreas, and Golden Gate	15	10	121	13	
Valley Mt, Central Valley, and Kern	20	14	224	24	
	<b>Mean</b>	<b>SD</b>	<b>Mean</b>	<b>SD</b>	
<b>Paternal age</b>	35	6	33	7	<0.001
<b>Maternal age</b>	33	6	30	6	<0.001
<b>Birth weight</b>	3344	674	3407	687	0.25
<b>Gestational duration</b>	39	2	39	2	0.21

<sup>a</sup>Chi-square test for categorical variables and Mann-Whitney test for continuous variables.

Table 4: Phthalate concentrations in house dust ( $\mu\text{g/g}$  of dust, CHARGE study, n = 145)

	% >	Percentiles				
	LOD	5	25	50	75	95
Dimethyl phthalate	63	< LOD	<LOD	0.07	0.14	0.53
Diethyl phthalate	92	< LOD	0.41	1.01	1.75	6.67
Dibutyl phthalate	99	2.71	5.91	10.3	17.9	36.8
Butylbenzyl phthalate	99	1.07	5.24	13.4	34.1	200
Di(2-ethylhexyl) phthalate	99	40.4	103	187	301	656

Table 5: Adjusted associations between dust phthalate concentrations and the MSEL and VABS scores among boys (CHARGE study, n = 115)

	Dimethyl phthalate		Diethyl phthalate		Dibutyl phthalate		Butylbenzyl phthalate		Di(2-ethylhexyl) phthalate	
	$\beta$	95%CI	$\beta$	95%CI	$\beta$	95%CI	$\beta$	95%CI	$\beta$	95%CI
<b>ASD and DD children (n = 57)</b>										
<b>Mullen (DQ scores)</b>										
Composite score	-0.89	[-5.2 ; 3.4]	-0.77	[-6.1 ; 4.5]	1.10	[-7.0 ; 9.2]	-1.07	[-5.7 ; 3.6]	2.00	[-5.8 ; 9.8]
Expressive language	-1.67	[-6.8 ; 3.5]	0.80	[-5.6 ; 7.2]	1.20	[-8.5 ; 10.9]	-0.87	[-6.5 ; 4.7]	-0.46	[-9.8 ; 8.9]
Fine motor	-0.57	[-4.3 ; 3.1]	-3.08	[-7.7 ; 1.5]	-3.02	[-10.1 ; 4.0]	-1.86	[-5.9 ; 2.2]	1.78	[-5.0 ; 8.6]
Receptive language	0.86	[-4.3 ; 6.1]	0.68	[-5.7 ; 7.1]	2.48	[-7.2 ; 12.2]	0.28	[-5.3 ; 5.9]	3.46	[-5.9 ; 12.8]
Visual reception	-2.17	[-7.7 ; 3.3]	-1.49	[-8.4 ; 5.4]	3.75	[-6.7 ; 14.2]	-1.85	[-7.9 ; 4.2]	3.22	[-6.9 ; 13.3]
<b>Vineland (standard scores)</b>										
Composite score	0.00	[-2.4 ; 2.4]	-1.49	[-4.5 ; 1.5]	-0.78	[-5.3 ; 3.8]	-0.19	[-2.8 ; 2.5]	-2.34	[-6.7 ; 2.0]
Communication	-0.87	[-3.5 ; 1.8]	-1.82	[-5.1 ; 1.4]	-1.74	[-6.7 ; 3.3]	0.28	[-2.6 ; 3.2]	-2.30	[-7.1 ; 2.5]
Composite score	0.00	[-2.4 ; 2.4]	-1.49	[-4.5 ; 1.5]	-0.78	[-5.3 ; 3.8]	-0.19	[-2.8 ; 2.5]	-2.34	[-6.7 ; 2.0]
Daily living skills	1.09	[-1.0 ; 3.2]	-0.41	[-3.1 ; 2.3]	-0.35	[-4.5 ; 3.8]	0.15	[-2.2 ; 2.5]	-0.98	[-5.0 ; 3.0]
Motor skills	0.69	[-2.7 ; 4.1]	-0.89	[-5.2 ; 3.4]	-1.65	[-8.2 ; 4.9]	-1.62	[-5.4 ; 2.1]	-3.28	[-9.6 ; 3.0]
Socialization	-0.48	[-3.5 ; 2.5]	-1.34	[-5.1 ; 2.4]	0.68	[-5.0 ; 6.4]	0.20	[-3.1 ; 3.5]	-0.90	[-6.4 ; 4.6]
<b>TD children (n =58)</b>										
<b>Mullen (DQ scores)</b>										
Composite score	0.21	[-3.2 ; 3.6]	-1.54	[-5.1 ; 2.0]	0.20	[-3.6 ; 4.0]	1.23	[-1.6 ; 4.0]	1.29	[-3.1 ; 5.6]
Expressive language	-0.57	[-5.0 ; 3.8]	-1.83	[-6.7 ; 3.0]	0.32	[-5.0 ; 5.6]	1.08	[-2.8 ; 5.0]	0.75	[-5.3 ; 6.7]
Fine motor	1.00	[-2.4 ; 4.4]	0.78	[-2.8 ; 4.4]	2.10	[-1.8 ; 6.0]	0.09	[-2.8 ; 3.0]	2.31	[-2.1 ; 6.7]
Receptive language	-0.24	[-4.6 ; 4.2]	-1.92	[-6.7 ; 2.8]	0.03	[-5.1 ; 5.2]	1.36	[-2.4 ; 5.1]	0.83	[-5.0 ; 6.7]
Visual reception	0.65	[-4.3 ; 5.7]	-3.17	[-8.3 ; 1.9]	-1.66	[-7.2 ; 3.9]	2.37	[-1.7 ; 6.4]	1.25	[-5.1 ; 7.6]
<b>Vineland (standard scores)</b>										
Composite score	1.28	[-2.7 ; 5.3]	-4.30	[-8.1 ; -0.5]	-3.39	[-7.6 ; 0.8]	0.98	[-2.1 ; 4.1]	-0.80	[-5.7 ; 4.0]
Communication	0.87	[-2.6 ; 4.3]	-3.66	[-7.1 ; -0.3]	-4.05	[-7.7 ; -0.4]	0.45	[-2.4 ; 3.3]	-1.38	[-5.7 ; 3.0]
Composite score	1.28	[-2.7 ; 5.3]	-4.30	[-8.1 ; -0.5]	-3.39	[-7.6 ; 0.8]	0.98	[-2.1 ; 4.1]	-0.80	[-5.7 ; 4.0]
Daily living skills	1.13	[-2.4 ; 4.6]	-3.56	[-7.2 ; 0.1]	-3.01	[-7.0 ; 0.9]	0.68	[-2.3 ; 3.6]	-1.98	[-6.5 ; 2.6]
Motor skills	1.51	[-2.0 ; 5.0]	-2.15	[-5.7 ; 1.4]	-1.46	[-5.3 ; 2.4]	0.98	[-1.8 ; 3.8]	1.08	[-3.3 ; 5.5]
Socialization	0.28	[-3.0 ; 3.6]	-2.90	[-6.2 ; 0.4]	-1.15	[-4.8 ; 2.5]	1.21	[-1.5 ; 3.9]	0.38	[-3.8 ; 4.5]

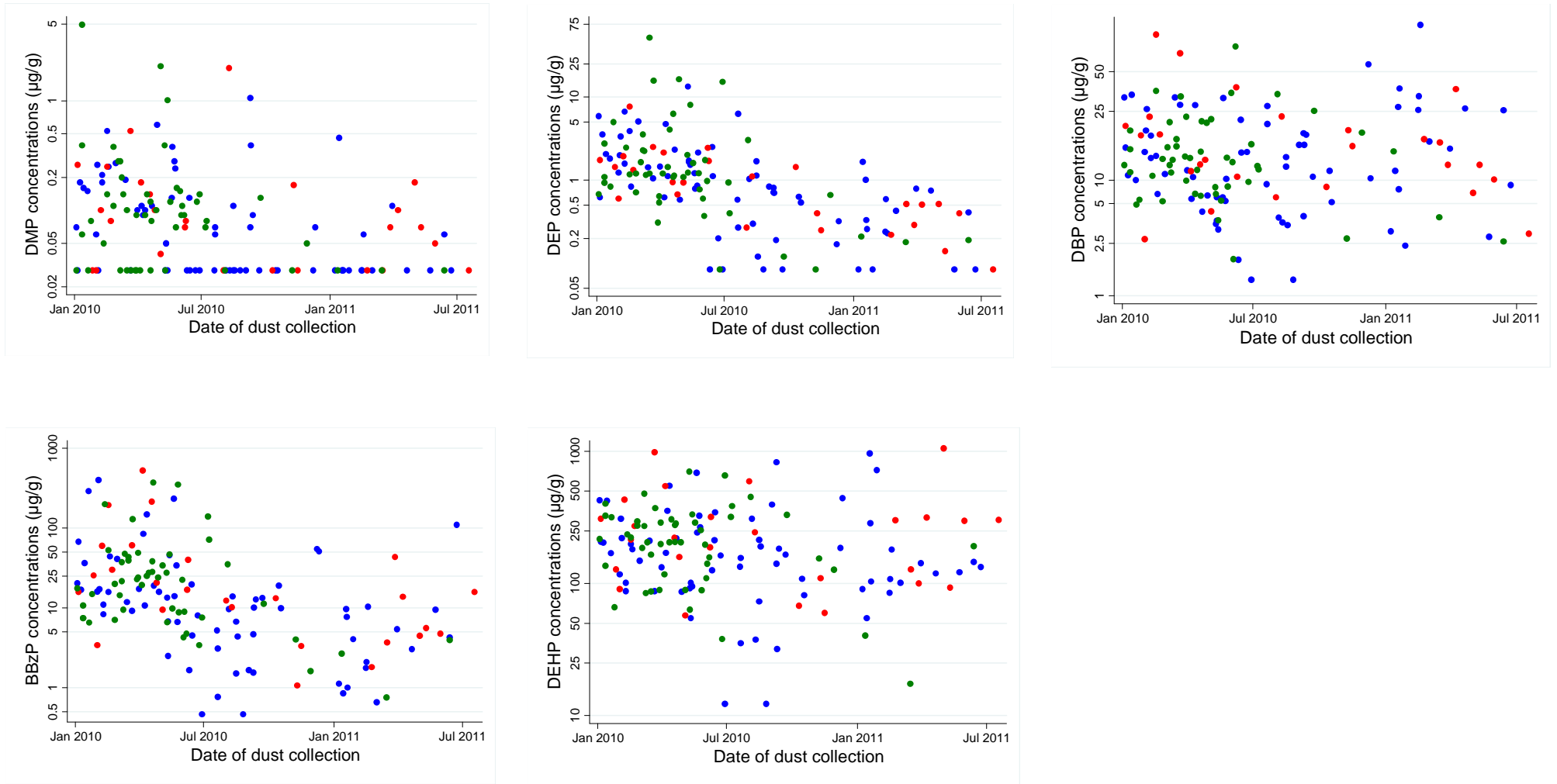
Analyses adjusted for child age at assessment, child race, maternal education and date of dust collection.

Abbreviation: ASD: autism spectrum disorder, DD: developmental delay, TD: typically developing

Table 6: Comparison of phthalate concentrations measured in house dust in different studies

<b>Country and year of dust collection</b>	<b>Concentrations measured in dust (median, ug/g)</b>				
	<b>DMP</b>	<b>DEP</b>	<b>DBP</b>	<b>BBzP</b>	<b>DEHP</b>
USA (CA), 2011-2010 (present study)	0.07	1	10	13	187
Japan, 2009 and 2010 [1]	< LOD	< LOD	16.6	2	1110
USA (NY), 2007-2008, 2010 [2]	0.08	2	13.1	21.1	304
China, 2007-2008, 2010 [2]	0.2	0.4	20.1	0.2	228
Denmark, 2008 [3]	/	1.7	15	3.7	210
USA (CA), 2004 [4]	/	/	/	/	386
Sweden, 2001-2002 [5]	/	0	45	135	770
Germany, 2000-2001 [6]	1.5	6.1	47	29.7	703
USA (MA), 1999-2001 [7]	/	4.98	20.1	45.4	340
Germany [8]	/	/	87.4	15.2	480

Figure 1: Dust phthalate concentrations ( $\mu\text{g/g}$ ) according to the date of dust collection



Blue circles represent TD children, red circles DD children and green circles ASD children.

Abbreviations: BBzP: Butylbenzyl phthalate, DBP: Dibutyl phthalate, DEP: Diethyl phthalate, DMP: Dimethyl phthalate, DEHP: Di(2-ethylhexyl) phthalate



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