Chapter 9
Results and Discussion

9.1 Overview

This chapter presents the results of the statistical analyses of the CTEPP study data. The presentation includes descriptive statistics and the outcome of statistical modeling efforts which were performed to address the following four statistical goals:

- **Goal 1:** To measure the environmental concentrations of pesticides and other persistent and non-persistent organic pollutants in multimedia at the homes and day care centers of a set of preschool children in several North Carolina (NC) and Ohio (OH) counties.
- **Goal 2:** To quantify the distribution of child characteristics, activities, and locations that are important for exposure.
- **Goal 3:** To estimate the exposures of the preschool children to these pollutants that they may encounter in their everyday environments.
- **Goal 4:** To apportion the exposures through the ingestion, inhalation, and dermal routes.

The results presented in this chapter characterize only those children who participated in the CTEPP study. The results should not be used to make inferences to larger populations of children, such as all children "in NC, OH, or in the United States," "in low-income and middle/high-income families," "in day care centers," etc. Neither can the study design permit results to be used to test hypotheses such as whether exposures differ significantly between all NC children and all OH children. The statistical analysis did not calculate sample weights assigned to the study participants that would represent larger populations of children.

Compound prevalence is reported for each pollutant by matrix for each state (section 9.2). Statistical analysis was conducted on the most frequently detected pollutants. The results of these analyses of the data that address the four specific goals of the study are presented in sections 9.3 through 9.6.

9.2 Method Quantifiable Limits and Compound Prevalence

The method quantifiable limits (MQLs) were based on instrumental performance alone and were estimated based on the lowest calibration standard that could be measured within 30% of the true value and had a signal-to-noise ratio that exceeded three to five. The method detection limit (MDL) was defined as the minimum concentration at which a pollutant can be detected in a sample and was estimated to be one-half of the MQL.

High and variable concentrations were observed in blank samples for several pollutants and matrices. These include:

- benzylbutylphthalate and di-*n*-butylphthalate in all sample media for both NC and OH,
- bisphenol-A in NC wipe blanks, and
- *cis*-permethrin and *trans*-permethrin in OH air blanks

For these pollutants and matrices, the MDL and MQL were calculated using the following equations:

$$MDL = [z_{0.95} * se(FMB)]/S$$

where z_α is the $\alpha*100^{th}$ percentile of the standard normal distribution ($z_{0.95} = 1.645$), se(FMB) is the standard error of the measurements associated with field blanks, and S corresponds to the sample volume, area, or weight, whichever is relevant for the given media type.

For each pollutant and metabolite, the MDL was initially reported in mass units (ng) for each collected multimedia sample and then converted to concentration units by dividing by the sample volume, weight, or area. Tables 9.2.1 and 9.2.2 give the median MDL values for neutral and acid pollutants, respectively, in the multimedia samples, while Table 9.2.3 provides the median MDL values for pollutants and metabolites measured in urine samples.

With some exceptions, median MDL values were the same or very similar across neutral pollutants for a given media type (Table 9.2.1). Median MDLs were somewhat higher for the two phthalates compared to other neutral pollutants, mainly due to the background corrections as described above. For bisphenol-A, nonylphenol, and cyfluthrin, the estimated instrumental detection limits were about ten times the detection levels of the other neutral pollutants due to their chromatographic properties and the relative abundances of the quantitation ions. For PCB congeners, the median MDL in transferable residue (PUF) samples was twice as large for OH than for NC due to differences in sample matrices. Among acid pollutants and metabolites measured in urine (Table 9.2.3), MDL values differed between the methylated pollutants/metabolites (2,4-D, hydroxy-PAHs, and PCP) and the silylated metabolites (3,5,6-TCP) due to the amounts of urine used for analysis (10 mL for the methylated pollutants/metabolites versus 1 mL for the silylated metabolites) and their different detection capabilities.

For each pollutant, percentages of collected samples with concentrations at or above the MDL are presented by media type in Tables 9.2.4 and 9.2.5 for NC and OH, respectively. Detection percentages associated with special samples collected from homes having recent pesticide applications (i.e., hard floor and food preparation surface wipes, PUF samples) are presented in Table 9.2.6 for NC and OH. Within these four tables, pollutants with detection percentages of at least 50% in a particular medium are shaded in gray. Similar tables

Table 9.2.1 Median MDL Values for Neutral Pollutants Measured in Multimedia Samples from North Carolina and Ohio

Pollutant [a]	Location	Median MDL Values Indoor Air (ng/m^3)	Outdoor Air (ng/m^3)	Soil (ng/g)	Dust (ng/g)	Dermal Wipe (ng/m^2)	Solid Food (ng/g)	Liquid Food (ng/mL)	Surface Wipe (ng/m^2)	PUF[d] (ng/m^2)
Benzylbutylphthalate	NC	57	57	12	50	6,400	52	27	1,400	4.4
	OH	35	35	5.6	22	8,000	5.7	18	1,700	4.4
Di-*n*-butylphthalate	NC	13	13	7.7	32	1,900	62	22	400	4.4
	OH	25	25	23	94	8,200	18	7.4	1,800	4.4
Bisphenol-A	NC	0.87	0.87	4.9	20	320	0.83	0.33	68	44
	OH	0.87	0.86	5.0	25	280	0.83	0.33	69	44
Nonylphenol	NC	0.87	0.87	4.9	20	320	0.83	0.33	69	44
	OH	0.87	0.87	5.0	20	280	0.83	0.33	69	44
Cyfluthrin	NC	0.87	0.87	4.9	20	320	0.83	0.33	69	44
	OH	0.87	0.87	5.0	20	250	0.83	0.33	69	44
cis-Permethrin	NC	0.09	0.09	0.49	2.0	32	0.08	0.03	6.9	4.4
	OH	0.39	0.38	0.50	2.0	32	0.08	0.03	6.9	4.4
trans-Permethrin	NC	0.09	0.09	0.49	2.0	32	0.08	0.03	6.9	4.4
	OH	0.33	0.33	0.50	2.3	32	0.08	0.03	6.9	4.4
PCB congeners	NC	0.04	0.04	0.49	2.0	32	0.08	0.03	6.9	4.4
	OH	0.04	0.04	0.50	2.0	32 [b]	0.08	– [c]	6.9	8.8
All other neutral pollutants [a]	NC	0.09	0.09	0.49	2.0	32	0.08	0.03	6.9	4.4
	OH	0.09	0.09	0.50	2.0	32 [b]	0.08	0.03	6.9	4.4

[a] Atrazine is not showed in this table as it was measured only in drinking water samples. It had a median MDL value of 0.01 ng/mL for both NC and OH.

[b] Across PCB congeners and all other neutral pollutants, median MDL values in Ohio ranged from 31 to 32 ng/m^2.

[c] Ohio liquid food samples were not analyzed for PCB congeners.

[d] There were no field blanks for PUF samples in NC and only one field blank for PUF samples in OH; the MDLs for the two phthalates in PUF were not corrected for the background levels.

Table 9.2.2 Median MDL Values for Acid Pollutants and Metabolites Measured in Multimedia Samples from North Carolina and Ohio

Pollutant/ Metabolite	Location	Median MDL Values								
		Indoor Air (ng/m^3)	Outdoor Air (ng/m^3)	Soil (ng/g)	Dust (ng/g)	Dermal Wipe (ng/m^2)	Solid Food (ng/g)	Liquid Food (ng/mL)	Surface Wipe (ng/m^2)	PUF[b] (ng/m^2)
Dicamba	NC	0.17	0.17	0.40	4.0	63	0.25	0.20	14	--[a]
	OH	0.17	0.17	0.40	4.0	61	0.25	0.20	14	4.4
2,4-D	NC	0.17	0.17	0.40	4.0	63	0.25	0.20	14	--
	OH	0.17	0.17	0.40	4.0	61	0.25	0.20	14	4.4
IMP	OH	0.09	0.09	0.20	2.0	30	0.12	0.10	6.9	4.4
Pentachlorophenol	NC	0.09	0.09	0.40	4.0	63	0.25	0.20	14	--
	OH	0.17	0.17	0.40	4.0	61	0.25	0.20	14	4.4
2,4,5-T	NC	0.17	0.17	0.40	4.0	63	0.25	0.20	14	--
	OH	0.17	0.17	0.40	4.0	61	0.25	0.20	14	4.4
3,5,6-TCP	NC	0.09	0.09	0.20	2.0	33	0.12	0.10	6.9	--
	OH	0.09	0.09	0.20	2.0	31	0.13	0.10	6.9	4.4

[a] A dash indicates that the pollutant was not measured in PUF samples.
[b] There were no field blanks for PUF samples in NC and only one field blank for PUF samples in OH.

Table 9.2.3 Median MDL Values for Pollutants and Metabolites Measured in Urine Samples from North Carolina and Ohio

Pollutant/Metabolite	Median MDL Values in Urine (ng/mL)	
	NC	OH
2,4-D	0.20	0.20
1-hydroxybenz[*a*]anthracene	0.20	0.20
3-hydroxybenz[*a*]anthracene	--[a]	0.20
3-hydroxybenz[*a*]pyrene	--	0.20
3-hydroxychrysene	0.20	0.20
6-hydroxychrysene	--	0.20
6-hydroxy indeno[1,2,3-*cd*]pyrene	--	0.20
1-hydroxypyrene	--	0.20
Pentachlorophenol	0.20	0.20
3-PBA	--	0.20
3,5,6-TCP	1.0	1.0

[a] A dash indicates that the pollutant was not measured in urine samples.

Table 9.2.4 Percentages of NC Samples With Detectable Pollutant and Metabolite Levels (At or Above the MDL) in Multimedia and Urine Samples [a]

Pollutant/Metabolite [b]	Percentage of Results At or Above the MDL in Multimedia and Urine Samples							
	INDOORS		OUTDOORS		PERSONAL			
	Indoor Air	Dust	Outdoor Air	Soil	Dermal Wipe	Solid Food	Liquid Food	Urine
OP Pesticides and Metabolite								
Chlorpyrifos	100	100	83	18	80	63	11	-- [c]
Diazinon	100	96	51	16	51	22	0.68	--
3,5,6-TCP	99	100	88	69	98	99	40	97
OC Pesticides								
Aldrin	41	16	8.6	0.0	3.1	2.6	0.0	--
alpha-Chlordane	99	96	54	31	59	16	5.4	--
gamma-Chlordane	100	97	64	31	61	18	0.0	--
p,p'-DDE	31	41	0.71	15	3.6	58	21	--
p,p'-DDT	34	38	12	20	6.7	3.9	2.0	--
Dieldrin	40	45	14	13	4.9	2.0	0.0	--
Endrin	34	18	41	4.2	2.2	0.65	0.0	--
Heptachlor	93	43	61	4.9	20	14	0.0	--
Lindane	14	15	11	6.3	3.1	7.2	2.0	--
Pentachloronitrobenzene	14	2.8	2.9	0.0	0.45	0.65	1.4	--
Pyrethroid Pesticides								
Cyfluthrin	4.7	47	0.0	11	23	5.9	0.0	--
cis-Permethrin	65	100	18	21	82	42	17	--
trans-Permethrin	64	100	18	21	82	43	16	--
Acid Herbicides								
Dicamba	0.68	21	7.9	5.0	0.44	14	0.0	--
2,4-D	48	67	22	17	7.4	52	2.6	78
2,4,5-T	6.8	0.71	8.6	0.72	0.0	1.1	0.0	--
PAHs								
Benz[*a*]anthracene	48	100	53	73	38	31	1.3	--
Benzo[*b*]fluoranthene	61	100	68	77	31	32	2.0	--
Benzo[*k*]fluoranthene	43	100	51	71	28	16	0.0	--
Benzo[*ghi*]perylene	63	100	64	74	43	1.3	0.0	--
Benzo[*a*]pyrene	50	100	54	74	25	16	0.0	--
Benzo[*e*]pyrene	49	100	56	75	30	24	3.3	--
Chrysene	61	100	69	75	43	33	3.3	--
Dibenz[*a,h*]anthracene	4.7	96	3.6	55	9.4	0.0	0.0	--
Indeno[1,2,3-*cd*]pyrene	51	100	58	71	27	0.66	0.0	--

Table 9.2.4. Percentages of NC Samples With Detectable Pollutant and Metabolite Levels (At or Above the MDL) in Multimedia and Urine Samples[a] (cont.)

Pollutant/Metabolite[b]	Percentage of Results At or Above the MDL in Multimedia and Urine Samples							
	INDOORS		OUTDOORS		PERSONAL			
	Indoor Air	Dust	Outdoor Air	Soil	Dermal Wipe	Solid Food	Liquid Food	Urine
Phthalates								
Benzylbutylphthalate	34	100	6.4	34	57	3.2	4.3	--
Di-*n*-butylphthalate	100	100	39	36	84	32	30	--
Phenols								
Bisphenol-A	65	29	31	2.9	94	88	79	--
Nonylphenol	9.5	4.5	2.1	1.9	1.3	2.6	4.6	--
Pentachlorophenol	97	93	95	32	31	7.8	1.5	75
PCBs								
PCB 44	48	20	24	1.4	1.8	1.3	0.0	--
PCB 52	91	36	65	4.2	6.7	7.2	0.0	--
PCB 70	47	22	18	1.4	1.8	0.0	0.0	--
PCB 77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--
PCB 95	75	38	44	2.8	8.5	2.6	0.0	--
PCB 101	53	38	26	3.5	11	0.0	0.0	--
PCB 105	6.8	5.7	0.71	2.1	0.89	0.0	0.0	--
PCB 110	42	42	19	7.1	12	0.0	0.0	--
PCB 118	24	26	8.6	5.6	8.0	0.0	0.0	--
PCB 138	13	20	2.9	9.9	2.2	0.0	0.0	--
PCB 153	21	30	2.9	9.2	3.6	0.0	0.0	--
PCB 180	4.7	12	0.71	7.7	0.89	0.0	0.0	--
PAH Metabolites Measured in Urine Only								
1-hydroxybenz[*a*]anthracene	--	--	--	--	--	--	--	11
3-hydroxychrysene	--	--	--	--	--	--	--	2.8

[a] The percentages were calculated using results from individual samples. Multiple samples for the same person or room were considered as individual samples. Cells corresponding to pollutants having at least 50% of samples detected in the specified matrix are shaded in gray.
[b] In addition to the pollutants represented in this table, atrazine was measured in drinking water samples. Thirty-eight percent of NC drinking water samples had atrazine levels at or above the MDL.
[c] A dash indicates that the pollutant was not measured in the specified matrix.

Table 9.2.5 Percentages of OH Samples With Detectable Pollutant and Metabolite Levels (At or Above the MDL) in Multimedia and Urine Samples [a]

Pollutant/Metabolite [b]	Percentage of Results At or Above the MDL in Multimedia and Urine Samples							
	INDOORS		OUTDOORS		PERSONAL			
	Indoor Air	Dust	Outdoor Air	Soil	Dermal Wipe	Solid Food	Liquid Food	Urine
OP Pesticides and Metabolites								
Chlorpyrifos	99	100	75	39	61	66	7.1	-- [c]
Diazinon	98	97	74	32	39	17	1.9	--
IMP	95	87	86	40	25	86	33	-- [d]
3,5,6-TCP	100	99	88	80	94	99	36	97
OC Pesticides								
Aldrin	2.7	3.5	1.4	2.1	0.45	0.65	0.65	--
alpha-Chlordane	93	86	56	55	29	7.1	0.0	--
gamma-Chlordane	97	85	59	51	29	5.8	0.0	--
p,p'-DDE	35	48	2.8	42	4.5	73	6.5	--
p,p'-DDT	22	39	2.1	29	3.6	5.2	1.9	--
Dieldrin	12	21	7.0	17	0.45	8.4	0.0	--
Endrin	12	7.0	19	2.8	2.7	1.3	0.0	--
Heptachlor	34	5.6	18	2.1	2.2	7.8	1.3	--
Lindane	4.1	11	3.5	0.70	1.8	3.2	1.3	--
Pentachloronitrobenzene	11	0.70	3.5	0.0	1.3	1.9	0.0	--
Pyrethroid Pesticides and Metabolite								
Cyfluthrin	2.7	74	0.71	18	6.7	2.6	0.65	--
cis-Permethrin	22	100	22	5.6	82	30	0.0	--
trans-Permethrin	19	100	18	5.8	82	30	0.0	--
3-PBA	--	--	--	--	--	--	--	60
Acid Herbicides								
Dicamba	0.69	48	2.9	4.2	2.7	13	0.36	--
2,4-D	44	96	32	39	43	42	5.4	92
2,4,5-T	0.0	2.8	0.74	3.5	0.45	0.0	0.36	–
PAHs								
Benz[*a*]anthracene	38	100	26	92	58	28	0.65	--
Benzo[*b*]fluoranthene	27	100	36	92	78	39	1.9	--
Benzo[*k*]fluoranthene	21	100	25	92	68	16	1.3	--
Benzo[*ghi*]perylene	27	100	23	91	71	3.8	0.0	--
Benzo[*a*]pyrene	18	100	15	91	64	17	0.0	--
Benzo[*e*]pyrene	22	100	26	91	76	19	0.65	--
Chrysene	42	100	50	93	75	36	0.65	--
Dibenz[*a,h*]anthracene	0.68	99	0.0	75	18	1.3	0.0	--
Indeno[1,2,3-*cd*]pyrene	20	100	17	91	67	3.2	0.65	--

Table 9.2.5 Percentages of OH Samples With Detectable Pollutant and Metabolite Levels (At or Above the MDL) in Multimedia and Urine Samples [a] (cont.)

Pollutant/Metabolite [b]	Percentage of Results At or Above the MDL in Multimedia and Urine Samples							
	INDOORS		OUTDOORS		PERSONAL			
	Indoor Air	Dust	Outdoor Air	Soil	Dermal Wipe	Solid Food	Liquid Food	Urine
Phthalates								
Benzylbutylphthalate	33	100	11	37	46	58	6.6	--
Di-*n*-butylphthalate	97	100	49	58	45	25	3.3	--
Phenols								
Bisphenol-A	65	51	35	2.1	98	100	71	--
Nonylphenol	0.68	3.6	0.0	2.4	1.3	1.3	0.0	--
Pentachlorophenol	88	94	60	50	47	22	4.3	92
PCBs								
PCB 44	31	24	15	15	7.6	0.0	--	--
PCB 52	88	50	66	20	19	5.8	--	--
PCB 70	36	25	14	19	14	0.0	--	--
PCB 77	0.0	0.0	0.0	0.70	0.0	0.0	--	--
PCB 95	63	42	36	23	7.6	0.65	--	--
PCB 101	55	45	25	25	11	0.65	--	--
PCB 105	5.4	14	2.8	20	2.7	0.0	--	--
PCB 110	44	48	21	31	12	0.65	--	--
PCB 118	23	41	8.5	30	8.5	1.3	--	--
PCB 138	9.5	28	2.8	31	1.3	0.65	--	--
PCB 153	17	41	1.4	34	2.7	1.3	--	--
PCB 180	2.7	16	0.0	22	0.45	0.0	--	--
PAH Metabolites Measured in Urine Only								
1-hydroxybenz[*a*]anthracene	--	--	--	--	--	--	--	12
3-hydroxybenz[*a*]anthracene	--	--	--	--	--	--	--	1.1
3-hydroxybenz[*a*]pyrene	--	--	--	--	--	--	--	0.0
3-hydroxychrysene	--	--	--	--	--	--	--	0.67
6-hydroxychrysene	--	--	--	--	--	--	--	0.90
6-hydroxyindeno[1,2,3-*cd*]pyrene	--	--	--	--	--	--	--	0.0
1-hydroxypyrene	--	--	--	--	--	--	--	62

[a] The percentages were calculated using results from individual samples. Multiple samples for the same person or room were considered as individual samples. Cells corresponding to pollutants having at least 50% of samples detected in the specified matrix are shaded in gray.
[b] In addition to the pollutants represented in this table, atrazine was measured in drinking water samples. Fifty-nine percent of OH drinking water samples had atrazine levels at or above the MDL.
[c] A dash indicates that the pollutant was not measured in the specified matrix.
[d] Low recovery (<10%) of IMP was observed in matrix spikes, and therefore, IMP was not quantifiable in urine samples.

Table 9.2.6 Percentages of NC and OH Samples With Detectable Pollutant and Metabolite Levels (At or Above the MDL) in Surface Samples [a]

Pollutant/Metabolite	Percentage of Results At or Above the MDL in Samples Collected From Homes After Recent Pesticide Applications					
	North Carolina			Ohio		
	Hard Floor Surface Wipe	Food Prep. Surface Wipe	Trans. Residue (PUF)	Hard Floor Surface Wipe	Food Prep. Surface Wipe	Trans. Residue (PUF)
OP Pesticides and Metabolites						
Chlorpyrifos	91	89	94	73	62	85
Diazinon	69	61	67	31	31	54
IMP	--[b]	--	--	33	0.0	0.0
3,5,6-TCP	100	--	--	92	67	33
OC Pesticides						
Aldrin	13	5.6	11	3.8	0.0	0.0
alpha-Chlordane	59	56	44	23	15	23
gamma-Chlordane	66	56	44	23	15	23
p,p'-DDE	16	11	28	12	0.0	0.0
p,p'-DDT	19	17	28	19	7.7	0.0
Dieldrin	25	17	22	3.8	0.0	23
Endrin	13	28	11	0.0	0.0	7.7
Heptachlor	38	33	28	3.8	0.0	0.0
Lindane	9.4	0.0	28	0.0	0.0	0.0
Pentachloronitrobenzene	0.0	0.0	0.0	0.0	0.0	0.0
Pyrethroid Pesticides						
Cyfluthrin	6.3	0.0	78	7.7	0.0	0.0
cis-Permethrin	94	83	83	69	38	69
trans-Permethrin	94	83	83	69	38	69
Acid Herbicides						
Dicamba	0.0	--	--	0.0	0.0	0.0
2,4-D	7.1	--	--	42	0.0	33
2,4,5-T	0.0	--	--	0.0	0.0	0.0
PAHs						
Benz[*a*]anthracene	78	33	94	96	31	62
Benzo[*b*]fluoranthene	78	33	67	96	46	92
Benzo[*k*]fluoranthene	75	28	67	92	38	85
Benzo[*ghi*]perylene	88	17	67	92	31	85
Benzo[*a*]pyrene	81	17	61	88	31	85
Benzo[*e*]pyrene	88	17	67	96	38	92
Chrysene	88	50	83	96	46	85
Dibenz[*a,h*]anthracene	34	5.6	22	62	7.7	15
Indeno[1,2,3-*cd*]pyrene	84	22	67	96	31	69

Table 9.2.6 Percentages of NC and OH Samples With Detectable Pollutant and Metabolite Levels (At or Above the MDL) in Surface Samples [a] (cont.)

Pollutant/Metabolite	Percentage of Results At or Above the MDL in Samples Collected From Homes After Recent Pesticide Applications					
	North Carolina			Ohio		
	Hard Floor Surface Wipe	Food Prep. Surface Wipe	Trans. Residue (PUF)	Hard Floor Surface Wipe	Food Prep. Surface Wipe	Trans. Residue (PUF)
Phthalates						
Benzylbutylphthalate	97	56	100	77	54	100
Di-*n*-butylphthalate	100	72	100	65	85	100
Phenols						
Bisphenol-A	81	89	100	96	85	71
Nonylphenol	0.0	0.0	6.3	0.0	0.0	8.3
Pentachlorophenol	43	--	--	33	0.0	33
PCBs						
PCB 44	9.4	22	11	12	7.7	15
PCB 52	22	22	6.3	38	7.7	50
PCB 70	13	17	17	50	15	23
PCB 77	0.0	0.0	0.0	0.0	0.0	0.0
PCB 95	13	22	13	3.8	0.0	31
PCB 101	6.3	17	20	7.7	0.0	46
PCB 105	0.0	0.0	22	12	0.0	7.7
PCB 110	19	28	10	38	0.0	46
PCB 118	9.4	17	33	15	0.0	23
PCB 138	3.1	0.0	0.0	0.0	0.0	7.7
PCB 153	3.1	11	17	3.8	0.0	23
PCB 180	3.1	0.0	5.6	0.0	0.0	0.0

[a] The percentages were calculated using results from individual samples. Multiple samples for the same person or room were considered as individual samples. Cells corresponding to pollutants having at least 50% of samples detected in the specified matrix are shaded in gray.
[b] A dash indicates that the pollutant was not measured in the specified matrix.

documenting the percentages of samples with concentrations at or above the MQL are presented by media type in Appendix H for NC and OH. These percentages take into account all samples collected in the study within the given state for which a valid measurement for the pollutant was available.

For NC, pollutants and metabolites that were most commonly detected in the sampled environmental and personal media were the following:

- The OP pesticides, chlorpyrifos and diazinon, were frequently detected in indoor air (100%), floor dust ($96%), transferable residue ($67%), surface wipe ($61%), outdoor air ($51%), and dermal wipe ($51%) samples. The metabolite of chlorpyrifos, 3,5,6-

TCP, had high detection rates in floor dust and hard floor surface wipes (100%), indoor air and solid food (99%), dermal wipe (98%), urine (97%), outdoor air (88%), and soil (69%) samples.

- Two OC pesticides, *alpha*- and *gamma*-chlordane, were both frequently detected in indoor air ($99%), floor dust ($96%), dermal wipe ($59%), surface wipe ($56%), and outdoor air ($54%) samples.

- Two pyrethroid pesticides, *cis*- and *trans*-permethrin, were both frequently detected in floor dust (100%), surface wipe ($83%), transferable residue (83%), dermal wipe (82%), and indoor air ($64%) samples.

- The acid herbicide, 2,4-D, had the highest detection percentages in urine (78%), floor dust (67%), and solid food (52%) samples.

- All nine PAHs were frequently detected above 50% in dust, soil, and floor surface wipe samples, except for dibenz[*a,h*]anthracene in floor surface wipes (34%). These PAHs were frequently detected above 50% in outdoor air and transferable residue samples, except for dibenz[*a,h*]anthracene. Five of these PAHs (benzo[*b*]fluoranthene, benzo[*ghi*]perylene, benzo[*a*]pyrene, chrysene, and indeno[1,2,3-*cd*]pyrene) were detected in at least 50% of indoor air samples, while two other PAHs (benzo[a]anthracene and benzo[e]pyrene) were detected in slightly below 50% of the indoor air samples.

- The two phthalates, benzylbutylphthalate and di-*n*-butylphthalate, were frequently detected in floor dust (100%), transferable residue (100%), floor surface wipe ($97%), dermal wipe ($57%), and food preparation surface wipe ($56%) samples. In addition, di-*n*-butylphthalate was detected in 100% of indoor air samples.

- Among the phenols, bisphenol-A was detected most frequently in transferable residue (100%), dermal wipe (94%), solid food (88%), surface wipe ($81%), and liquid food (79%) samples. Pentachlorophenol was detected most frequently in indoor air (97%), outdoor air (95%), floor dust (93%), and urine (75%) samples.

For OH, pollutants and metabolites that were most commonly detected in the environmental and personal media were the following:

- The OP pesticides, chlorpyrifos and diazinon, were both frequently detected in indoor air ($98%), floor dust ($97%), and outdoor air ($74%) samples. The two OP metabolites, IMP and 3,5,6-TCP, were also frequently detected in indoor air ($95%), floor dust ($87%), and outdoor air ($86%) samples. In addition, 3,5,6-TCP was detected frequently in solid food (99%), urine (97%), dermal wipe (94%), floor surface wipe (92%), and soil (80%) samples.

- Two OC pesticides, *alpha*- and *gamma*-chlordane, were both frequently detected in indoor air ($93%) and floor dust ($85%) samples, while detection percentages for outdoor air ($56%) and soil ($51%) samples were somewhat lower but still above 50%.

- Two pyrethroid pesticides, *cis*- and *trans*-permethrin, were both frequently detected in floor dust (100%), dermal wipe (82%), hard floor surface wipe (69%), and transferable residue (69%) samples. Cyfluthrin was detected in 74% of the floor dust samples. A urinary metabolite of *cis*- and *trans*-permethrin, 3-PBA, was found in 60% of urine samples.

- The acid herbicide, 2,4-D, was frequently detected in floor dust (96%) and urine (92%) samples.

- The PAHs were frequently detected in floor dust ($99%), soil ($75%), floor surface wipe ($62%), transferable residue ($62% for all but dibenz[*a,h*]anthracene), and dermal wipe ($58% for all but dibenz[*a,h*]anthracene) samples.

- The two phthalates, benzylbutylphthalate and di-*n*-butylphthalate, were both detected most frequently in floor dust (100%), transferable residues (100%), and floor surface wipes ($65%). In addition, di-*n*-butylphthalate was detected in 97% of indoor air samples and 85% of food preparation surface wipe samples.

- Among the phenols, bisphenol-A was detected most frequently in solid food (100%), dermal wipe (98%), surface wipe ($85%), liquid food (71%), and transferable residue (71%) samples. Pentachlorophenol was detected most frequently in floor dust (94%), urine (92%), and indoor air (88%) samples.

For each state, the detection percentages in Tables 9.2.4 through 9.2.6 were used to classify the pollutants and metabolites measured in multimedia samples into the following three groups:

- Frequently Detected - pollutants detected in 50% or more of samples in 4 or more different media types.
- Sometimes Detected - pollutants detected in 50% or more of samples in 1, 2, or 3 media types.
- Rarely Detected: pollutants detected in less than 50% of the samples in all media types.

Results of this classification for each state are presented in Table 9.2.7.

Table 9.2.7 Pollutants Were Classified Into Three Groups, By State, Based On Their Level of Detection in the Multimedia Samples

North Carolina	Ohio
Frequently Detected	
<u>OP pesticides/metabolites</u> Chlorpyrifos, Diazinon, 3,5,6-TCP	<u>OP pesticides/metabolites</u> Chlorpyrifos, Diazinon, IMP, 3,5,6-TCP
<u>OC pesticides</u> *alpha*-Chlordane, *gamma*-Chlordane	<u>OC pesticides</u> *alpha*-Chlordane, *gamma*-Chlordane
<u>Pyrethroid pesticides</u> *cis*-Permethrin, *trans*-Permethrin	<u>Pyrethroid pesticides</u> *cis*-Permethrin, *trans*-Permethrin
<u>PAHs</u> Benz[*a*]anthracene, Benzo[*b*]fluoranthene, Benzo[*k*]fluoranthene, Benzo[*ghi*]perylene, Benzo[*a*]pyrene, Benzo[*e*]pyrene, Chrysene, Indeno[1,2,3-*cd*]pyrene,	<u>PAHs</u> Benz[*a*]anthracene, Benzo[*b*]fluoranthene, Benzo[*k*]fluoranthene, Benzo[*ghi*]perylene, Benzo[*a*]pyrene, Benzo[*e*]pyrene, Chrysene, Indeno[1,2,3-*cd*]pyrene
<u>Phthalates</u> Benzylbutylphthalate, Di-*n*-butylphthalate	<u>Phthalates</u> Benzylbutylphthalate, Di-*n*-butylphthalate
<u>Phenols</u> Bisphenol-A, Pentachlorophenol	<u>Phenols</u> Bisphenol-A, Pentachlorophenol
<u>PCBs</u> None	<u>PCBs</u> Congener 52
Sometimes Detected	
<u>OC pesticides</u> *p,p'*-DDE, Heptachlor	<u>OC pesticides</u> *p,p'*-DDE
<u>Pyrethroid pesticides</u> Cyfluthrin	<u>Pyrethroid pesticides</u> Cyfluthrin
<u>Acid Herbicides</u> 2,4-D	<u>Acid Herbicides</u> 2,4-D
<u>PAHs</u> Dibenzo[*a,h*]anthracene	<u>PAHs</u> Dibenz[*a,h*]anthracene
<u>PCBs</u> Congeners 52, 95, 101	<u>PCBs</u> Congeners 70, 95, 101

Table 9.2.7 Pollutants Were Classified Into Three Groups, By State, Based On Their Level of Detection in the Multimedia Samples (cont.)

North Carolina	Ohio
Rarely Detected	
<u>OC Pesticides</u> Aldrin, *p,p'*-DDT, Dieldrin, Endrin, Lindane, Pentachloronitrobenzene	<u>OC Pesticides</u> Aldrin, *p,p'*-DDT, Dieldrin, Endrin, Heptachlor, Lindane, Pentachloronitrobenzene
<u>Acid Herbicides</u> Dicamba, 2,4,5-T	<u>Acid Herbicides</u> Dicamba, 2,4,5-T
<u>Phenols</u> Nonylphenol	<u>Phenols</u> Nonylphenol
<u>PCBs</u> Congeners 44, 70, 77, 105, 110, 118, 138, 153, 180	<u>PCBs</u> Congeners 44, 77, 105, 110, 118, 138, 153, 180

The pollutants and metabolites that are classified as "frequently" or "sometimes" detected in Table 9.2.7 were among those considered for calculating potential exposure level and potential absorbed dose of these pollutants in the study participants. Although IMP was classified as "frequently" detected in OH multimedia samples, it was not measured in NC multimedia samples.

For the study participants, aggregate exposure level and aggregate potential absorbed dose were calculated for bisphenol-A (BPA), chlorpyrifos (CPS), diazinon (DZN), di-*n*-butylphthalate (DBP), 2,4-D, *cis*- and *trans*- permethrin (*cis- and trans*-P), and the metabolite 3,5,6-TCP (TCP). These eight pollutants/metabolites were detected in a majority of samples across multiple media, including urine, and some were commonly found in consumer products used by the participating households and day care centers.

9.3 <u>Goal 1</u>: To Measure the Environmental Concentrations of Pesticides and Other Persistent and Non-Persistent Organic Pollutants in Multimedia (Environmental and Personal Samples) at Participating Homes and Day Care Centers.

Goal 1 focused on quantifying the concentration of each pollutant by medium and determining whether these concentrations differed significantly between microenvironments (i.e., urbanicity, income level, home versus day care environments).

9.3.1 ***Sub-goal 1.1: To Quantify the Distribution of Target Pollutants in Multimedia at Participating Home and Day Care Centers***

Descriptive statistics for pollutant and metabolite concentrations in multimedia samples are given in Appendix I for NC and Appendix J for OH. These appendices display the descriptive statistics (number of samples, percentage of samples with detected results, arithmetic mean, standard deviation, geometric mean, log standard deviation, selected percentiles [25^{th}, 50^{th}, 75^{th}, and 95^{th}], and range) within two tables for each measured pollutant. For a given sample type, descriptive statistics are presented separately for samples collected at the homes of study participants and for samples collected at participating day care centers. In addition, for the home environment, descriptive statistics are presented separately for the homes of day care children and the homes of stay-at-home children. In these tables, the arithmetic and geometric means, as well as the standard deviations for both untransformed and log-transformed measurements, are specified only when more than 50% of the data entering into their calculation exceeded the MDL. In addition, percentiles of the observed data distribution are reported when the data values at the percentile exceeded the MDL, otherwise "<MDL" is displayed.

Overall median levels of the 27 target pollutants in NC multimedia samples are presented by sample type in Table 9.3.1 and Table 9.3.2 for home and day care center environments, respectively. Similarly, Table 9.3.3 and Table 9.3.4 contain median levels of the 26 target pollutants in OH multimedia samples for home and day care center environments, respectively. The pollutants are grouped by pollutant class, and medians are presented only when a pollutant achieved greater than a 50% detection rate in the given medium.

For the eight pollutants for which estimated aggregate potential exposures and potential absorbed doses were calculated, the distributions of valid measurements are presented as boxplots in Figures 9.3.1 through 9.3.5. The sample types and measurements represented within each figure are as follows:

- Figure 9.3.1: concentrations in indoor and outdoor air samples (both NC and OH), expressed in units of ng/m^3.
- Figure 9.3.2: concentrations in floor dust and soil samples (both NC and OH), expressed in units of ng/g.
- Figure 9.3.3 (NC) and Figure 9.3.4 (OH): loadings in floor dust samples, hard floor surface wipes, food preparation surface wipes, transferable residues, and dermal wipes (children and adults), expressed in units of ng/m^2.
- Figure 9.3.5: concentrations in solid food samples (children and adults, for both NC and OH), expressed in units of ng/g. Adult solid food sample data were available only for 2,4-D and 3,5,6-TCP.

Table 9.3.1 Median Levels of 27 Target Pollutants in NC Multimedia Samples Collected from Home Environments[a]

Pollutant/Metabolite	Median Values											
	INDOORS						OUTDOORS		PERSONAL			
	Indoor Air (ng/m³)	Dust (ng/g)	Dust (ng/m²)	Hard Floor Wipe (ng/m²)	Food Prep. Wipe (ng/m²)	Trans. Residue (PUF) (ng/m²)	Outdoor Air (ng/m³)	Soil (ng/g)	Dermal Wipe (ng/m²)	Solid Food (ng/g)	Liquid Food (ng/mL)	Urine (ng/mL)
OP Pesticides and Metabolite												
Chlorpyrifos	6.2	140	94	68	69	35	0.27	<[b]	200	0.19	<	–[c]
Diazinon	2.0	18	16	11	16	33	0.090	<	<	<	<	--
3,5,6-TCP	1.9	96	83	50	--	--	0.23	0.57	190	2.3	<	4.5
OC Pesticides												
alpha-Chlordane	0.88	22	26	9.4	11	<	0.080	<	39	<	<	--
gamma-Chlordane	1.5	31	35	11	14	<	0.12	<	57	<	<	--
p,p'-DDE	<	<	<	<	<	<	<	<	<	0.16	<	--
Heptachlor	6.8	<	<	<	<	<	0.29	<	<	<	<	--
Pyrethroid Pesticides												
Cyfluthrin	<	<	<	<	<	1,000	<	<	<	<	<	--
cis-Permethrin	0.58	800	1,000	460	600	230	<	<	620	<	<	--
trans-Permethrin	0.36	630	850	360	260	210	<	<	490	<	<	--
Acid Herbicides												
2,4-D	<	32	36	<	--	--	<	<	<	0.35	<	0.43
PAHs												
Benz[*a*]anthracene	<	120	140	15	<	110	0.090	1.4	<	<	<	--
Benzo[*b*]fluoranthene	0.13	300	400	47	<	23	0.19	3.0	<	<	<	--
Benzo[*k*]fluoranthene	<	110	120	13	<	11	0.090	1	<	<	<	--
Benzo[*ghi*]perylene	0.13	180	210	19	<	16	0.14	1.3	<	<	<	--
Benzo[*a*]pyrene	0.080	180	210	20	<	9.5	0.090	1.9	<	<	<	--
Benzo[*e*]pyrene	<	180	190	18	<	15	0.11	1.5	<	<	<	--
Chrysene	0.10	170	190	23	<	18	0.12	1.7	<	<	<	--
Dibenz[*a,h*]anthracene	<	40	46	<	<	<	<	0.61	<	<	<	--
Indeno[1,2,3-*cd*]pyrene	0.090	160	200	17	<	8.8	0.10	1.2	<	<	<	--
Phthalates												
Benzylbutylphthalate	<	17,000	19,000	27,000	2,100	28,000	<	<	12,000	<	<	--
Di-*n*-butylphthalate	230	5,600	5,400	5,000	3,400	5,100	<	<	10,000	<	<	--
Phenols												
Bisphenol-A	1.8	<	<	250	260	410	<	<	6,900	4.3	0.45	--
Pentachlorophenol	1.5	60	73	<	--	--	0.91	<	<	<	<	0.36
PCBs												
PCB 52	0.53	<	<	<	<	<	0.090	<	<	<	<	--
PCB 95	0.090	<	<	<	<	<	<	<	<	<	<	--
PCB 101	0.060	<	<	<	<	<	<	<	<	<	<	--

[a] For urine, the median was based on data for NC children who were classified as "stay-at-home" children.
[b] "<" indicates that the median value falls below the MDL for the pollutant within the specified sample medium.
[c] Dashes indicate that no data were available for the pollutant within the specified sample medium.

Table 9.3.2 Median Levels of 27 Target Pollutants in NC Multimedia Samples Collected from Day Care Center Environments[a]

Pollutant/Metabolite	Median Values											
	INDOORS						OUTDOORS		PERSONAL			
	Indoor Air (ng/m^3)	Dust (ng/g)	Dust (ng/m^2)	Hard Floor Wipe (ng/m^2)	Food Prep. Wipe (ng/m^2)	Trans. Residue (PUF) (ng/m^2)	Outdoor Air (ng/m^3)	Soil (ng/g)	Dermal Wipe (ng/m^2)	Solid Food (ng/g)	Liquid Food (ng/mL)	Urine (ng/mL)
OP Pesticides and Metabolite												
Chlorpyrifos	3.0	140	570	130	–[c]	--	0.34	<[b]	170	0.10	<	--
Diazinon	2.3	65	180	33	--	--	0.12	<	65	<	<	--
3,5,6-TCP	0.93	66	200	53	--	--	0.13	<	100	2.9	0.10	5.1
OC Pesticides												
alpha-Chlordane	0.51	43	190	<	--	--	0.15	<	48	<	<	--
gamma-Chlordane	0.78	67	270	9.9	--	--	0.28	<	64	<	<	--
p,p'-DDE	<	<	<	<	--	--	<	<	<	0.16	<	--
Heptachlor	5.4	19	89	<	--	--	0.54	<	<	<	<	--
Pyrethroid Pesticides												
Cyfluthrin	<	<	<	<	--	--	<	<	<	<	<	--
cis-Permethrin	0.11	810	6,900	940	--	--	<	<	730	<	<	--
trans-Permethrin	<	860	4,100	730	--	--	<	<	360	<	<	--
Acid Herbicides												
2,4-D	0.33	23	56	<	--	--	<	<	<	<	<	0.66
PAHs												
Benz[*a*]anthracene	<	200	980	7.2	--	--	0.060	3.6	<	<	<	--
Benzo[*b*]fluoranthene	0.11	500	2,300	35	--	--	0.11	9.4	<	<	<	--
Benzo[*k*]fluoranthene	<	180	770	8.1	--	--	<	3.7	<	<	<	--
Benzo[*ghi*]perylene	0.10	280	1,200	12	--	--	0.10	4.8	60	<	<	--
Benzo[*a*]pyrene	<	270	1,300	7.9	--	--	0.070	5.9	<	<	<	--
Benzo[*e*]pyrene	<	280	1,200	15	--	--	0.070	5.0	<	<	<	--
Chrysene	0.090	220	1,100	53	--	--	0.090	5.3	<	<	<	--
Dibenz[*a,h*]anthracene	<	64	290	<	--	--	<	1.5	<	<	<	--
Indeno[1,2,3-*cd*]pyrene	<	230	1,100	12	--	--	0.064	4.4	<	<	<	--
Phthalates												
Benzylbutylphthalate	<	58,000	140,000	160,000	--	--	<	<	<	<	<	--
Di-*n*-butylphthalate	380	14,000	66,000	18,000	--	--	15	13	12,000	<	<	--
Phenols												
Bisphenol-A	<	31	120	<	--	--	<	<	28,000	3.6	0.79	--
Pentachlorophenol	1.2	81	430	<	--	--	0.77	<	<	<	<	0.43
PCBs												
PCB 52	0.50	8.2	47	<	--	--	0.080	<	<	<	<	--
PCB 95	0.11	<	<	<	--	--	0.050	<	<	<	<	--
PCB 101	0.080	4.3	16	<	--	--	0.050	<	<	<	<	--

[a] For urine, the median was based on data for NC children who were classified as "day care" children.
[b] "<" indicates that the median value falls below the MDL for the pollutant within the specified sample medium.
[c] Dashes indicate that no data were available for the pollutant within the specified sample medium.

Table 9.3.3 Median Levels of 26 Target Pollutants in OH Multimedia Samples Collected from Home Environments[a]

Pollutant/Metabolite	Median Values											
	INDOORS						OUTDOORS		PERSONAL			
	Indoor Air (ng/m^3)	Dust (ng/g)	Dust (ng/m^2)	Hard Floor Wipe (ng/m^2)	Food Prep. Wipe (ng/m^2)	Trans. Residue (PUF) (ng/m^2)	Outdoor Air (ng/m^3)	Soil (ng/g)	Dermal Wipe (ng/m^2)	Solid Food (ng/g)	Liquid Food (ng/mL)	Urine (ng/mL)
OP Pesticides and Metabolite												
Chlorpyrifos	1.7	52	64	24	12	20	0.20	<[b]	110	0.19	<	–[c]
Diazinon	0.97	20	22	<	<	7.3	0.17	<	<	<	<	--
3,5,6-TCP	0.63	41	38	9.0	7.6	<	0.23	0.70	120	1.9	<	5.3
OC Pesticides												
alpha-Chlordane	0.26	11	11	<	<	<	0.10	0.76	<	<	<	--
gamma-Chlordane	0.36	12	12	<	<	<	0.11	0.62	<	<	<	--
p,p'-DDE	<	<	<	<	<	<	<	<	<	0.19	<	--
Pyrethroid Pesticides												
Cyfluthrin	<	200	180	<	<	<	<	<	<	<	<	--
cis-Permethrin	<	470	450	89	<	37	<	<	330	<	<	--
trans-Permethrin	<	340	300	94	<	31	<	<	270	<	<	--
Acid Herbicides												
2,4-D	<	120	120	18	<	<	<	<	<	<	<	1.2
PAHs												
Benz[*a*]anthracene	<	570	620	23	<	8.4	<	15	43	<	<	--
Benzo[b]fluoranthene	<	1,500	1,800	54	<	25	<	33	120	<	<	--
Benzo[*k*]fluoranthene	<	520	590	22	<	9.3	<	12	64	<	<	--
Benzo[*ghi*]perylene	<	770	920	28	<	19	<	16	93	<	<	--
Benzo[*a*]pyrene	<	720	900	32	<	15	<	18	72	<	<	--
Benzo[*e*]pyrene	<	830	920	35	<	17	<	16	100	<	<	--
Chrysene	<	780	910	43	<	16	<	19	89	<	<	--
Dibenz[*a,h*]anthracene	<	170	190	8.1	<	<	<	4.2	<	<	<	--
Indeno[1,2,3-*cd*]pyrene	<	780	950	31	<	13	<	15	80	<	<	--
Phthalates												
Benzylbutylphthalate	<	17,000	16,000	4,800	2,000	5,400	<	<	<	11	<	--
Di-*n*-butylphthalate	250	5,200	5,700	6,800	5,500	7,500	<	46	<	<	<	--
Phenols												
Bisphenol-A	0.98	<	<	680	500	260	<	<	5,600	3.6	0.47	--
Pentachlorophenol	2.1	60	75	<	<	<	0.43	0.73	<	<	<	1.0
PCBs												
PCB 52	0.42	<	<	<	<	<	0.11	<	<	<	--	--
PCB 95	0.11	<	<	<	<	<	<	<	<	<	--	--
PCB 101	0.090	<	<	<	<	<	<	<	<	<	--	--

[a] For urine, the median was based on data for OH children who were classified as "stay-at-home" children.
[b] "<" indicates that the median value falls below the MDL for the pollutant within the specified sample medium.
[c] Dashes indicate that no data were available for the pollutant within the specified sample medium.

Table 9.3.4 Median Levels of 26 Target Pollutants in OH Multimedia Samples Collected from Day Care Center Environments[a]

	Median Values											
	INDOORS						OUTDOORS		PERSONAL			
Pollutant/Metabolite	Indoor Air (ng/m^3)	Dust (ng/g)	Dust (ng/m^2)	Hard Floor Wipe (ng/m^2)	Food Prep. Wipe (ng/m^2)	Trans. Residue (PUF) (ng/m^2)	Outdoor Air (ng/m^3)	Soil (ng/g)	Dermal Wipe (ng/m^2)	Solid Food (ng/g)	Liquid Food (ng/mL)	Urine (ng/mL)
OP Pesticides and Metabolite												
Chlorpyrifos	2.0	170	450	<[b]	–[c]	--	0.11	<	98	0.14	<	--
Diazinon	0.96	40	220	<	--	--	0.080	<	<	<	<	--
3,5,6-TCP	0.71	58	170	8.8	--	--	0.17	0.63	110	1.5	0.11	4.3
OC Pesticides												
alpha-Chlordane	0.18	11	41	<	--	--	0.064	<	<	<	<	--
gamma-Chlordane	0.26	13	53	<	--	--	0.070	<	<	<	<	--
p,p'-DDE	<	<	<	<	--	--	<	<	<	0.11	<	--
Pyrethroid Pesticides												
Cyfluthrin	<	340	1,400	<	--	--	<	<	<	<	<	--
cis-Permethrin	<	1,000	2,700	59	--	--	<	<	350	<	<	--
trans-Permethrin	<	550	2,600	45	--	--	<	<	280	<	<	--
Acid Herbicides												
2,4-D	<	140	640	<	--	--	<	<	<	<	<	0.87
PAHs												
Benz[*a*]anthracene	<	1,800	6,200	7.9	--	--	<	20	41	<	<	--
Benzo[b]fluoranthene	<	4,200	13,000	83	--	--	<	35	100	<	<	--
Benzo[*k*]fluoranthene	<	1,500	4,500	17	--	--	<	15	49	<	<	--
Benzo[*ghi*]perylene	<	2,300	7,100	15	--	--	<	19	78	<	<	--
Benzo[*a*]pyrene	<	2,100	7,800	15	--	--	<	20	65	<	<	--
Benzo[*e*]pyrene	<	2,200	7,000	34	--	--	<	19	67	<	<	--
Chrysene	0.072	2,400	7,800	120	--	--	0.090	20	91	<	<	--
Dibenz[*a,h*]anthracene	<	470	1,500	<	--	--	<	4.8	<	<	<	--
Indeno[1,2,3-*cd*]pyrene	<	2,200	7,300	15	--	--	<	20	70	<	<	--
Phthalates												
Benzylbutylphthalate	<	29,000	94,000	210,000	--	--	<	<	<	9.0	<	--
Di-*n*-butylphthalate	320	15,000	53,000	99,000	--	--	21	<	14,000	<	<	--
Phenols												
Bisphenol-A	0.92	28	160	410	--	--	<	<	3,000	3.5	0.51	--
Pentachlorophenol	1.3	36	00	<	--	--	0.22	<	<	<	<	0.81
PCBs												
PCB 52	0.49	7.2	26	<	--	--	0.10	<	<	<	--	--
PCB 95	0.10	6.0	16	<	--	--	<	<	<	<	--	--
PCB 101	0.10	6.1	16	<	--	--	<	<	<	<	--	--

[a] For urine, the median was based on data for OH children who were classified as “day care” children.
[b] “<” indicates that the median value falls below the MDL for the pollutant within the specified sample medium.
[c] Dashes indicate that no data were available for the pollutant within the specified sample medium.

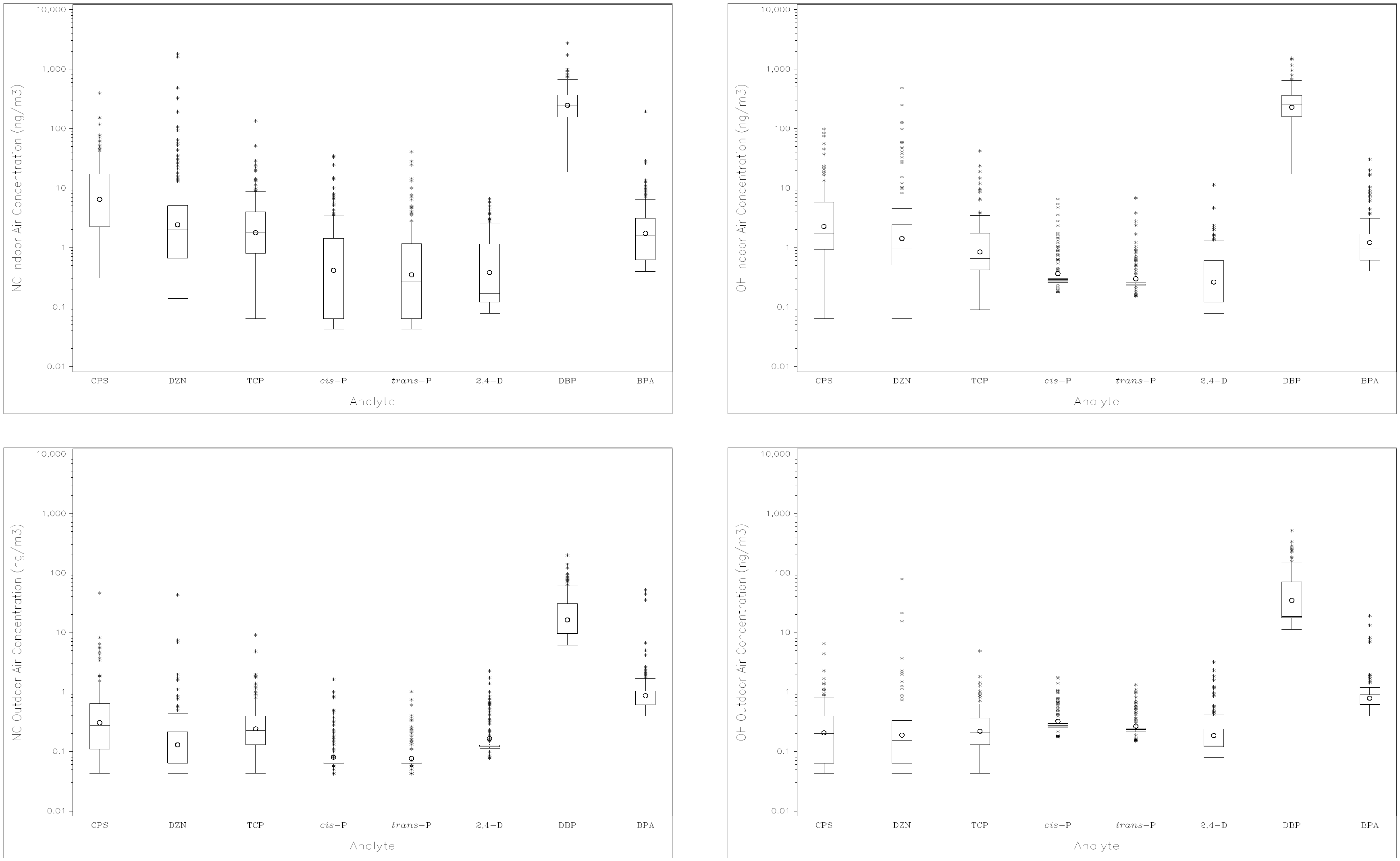

Figure 9.3.1 Boxplots of Pollutant Concentrations in <u>Indoor Air and Outdoor Air</u> <u>Samples</u> Collected at the Homes and Day Care Centers of Participating NC and OH Children, for Eight Pollutants

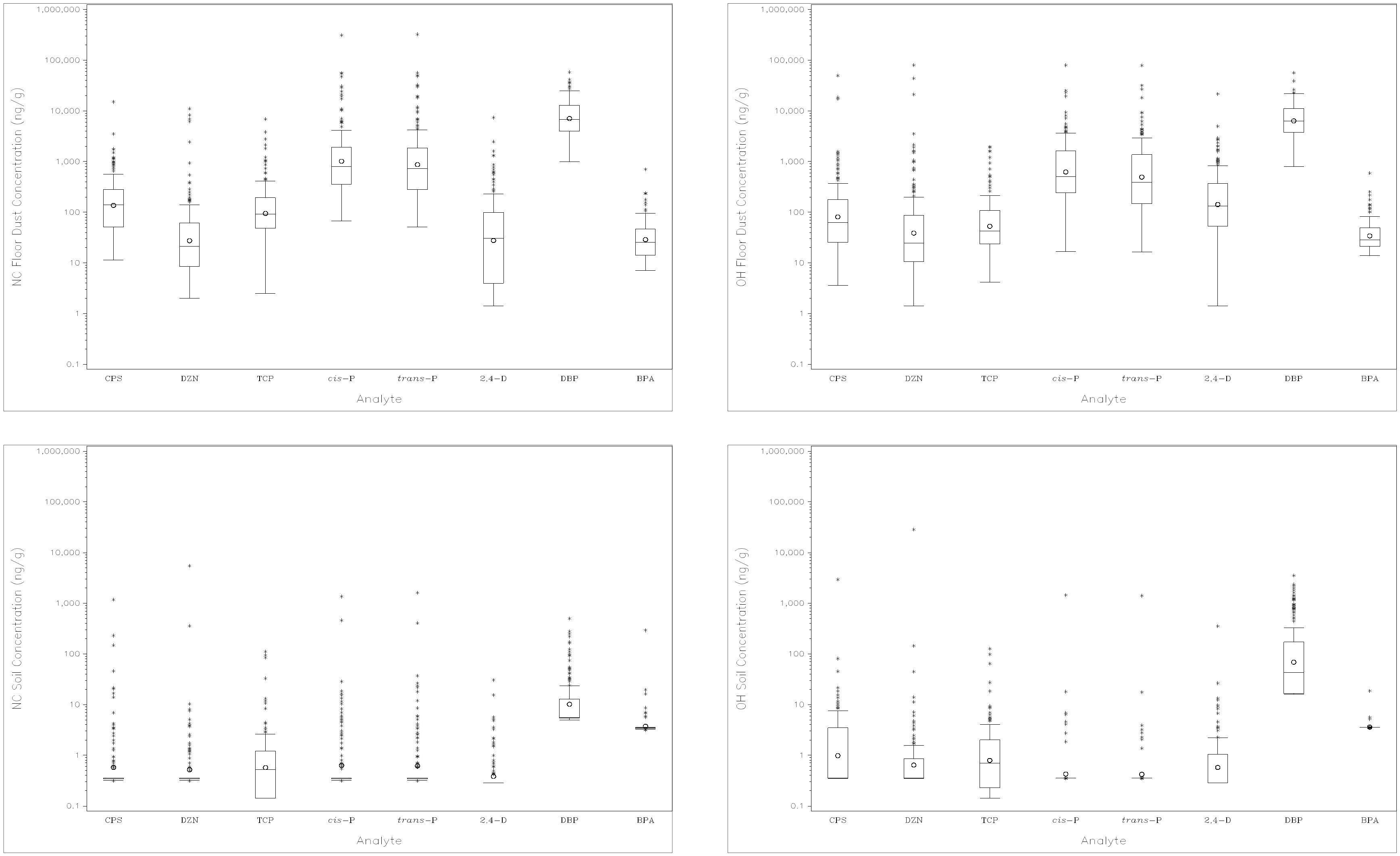

Figure 9.3.2 Boxplots of Pollutant Concentrations in Dust and Soil Samples Collected at the Homes and Day Care Centers of Participating NC and OH Children, for Eight Pollutants

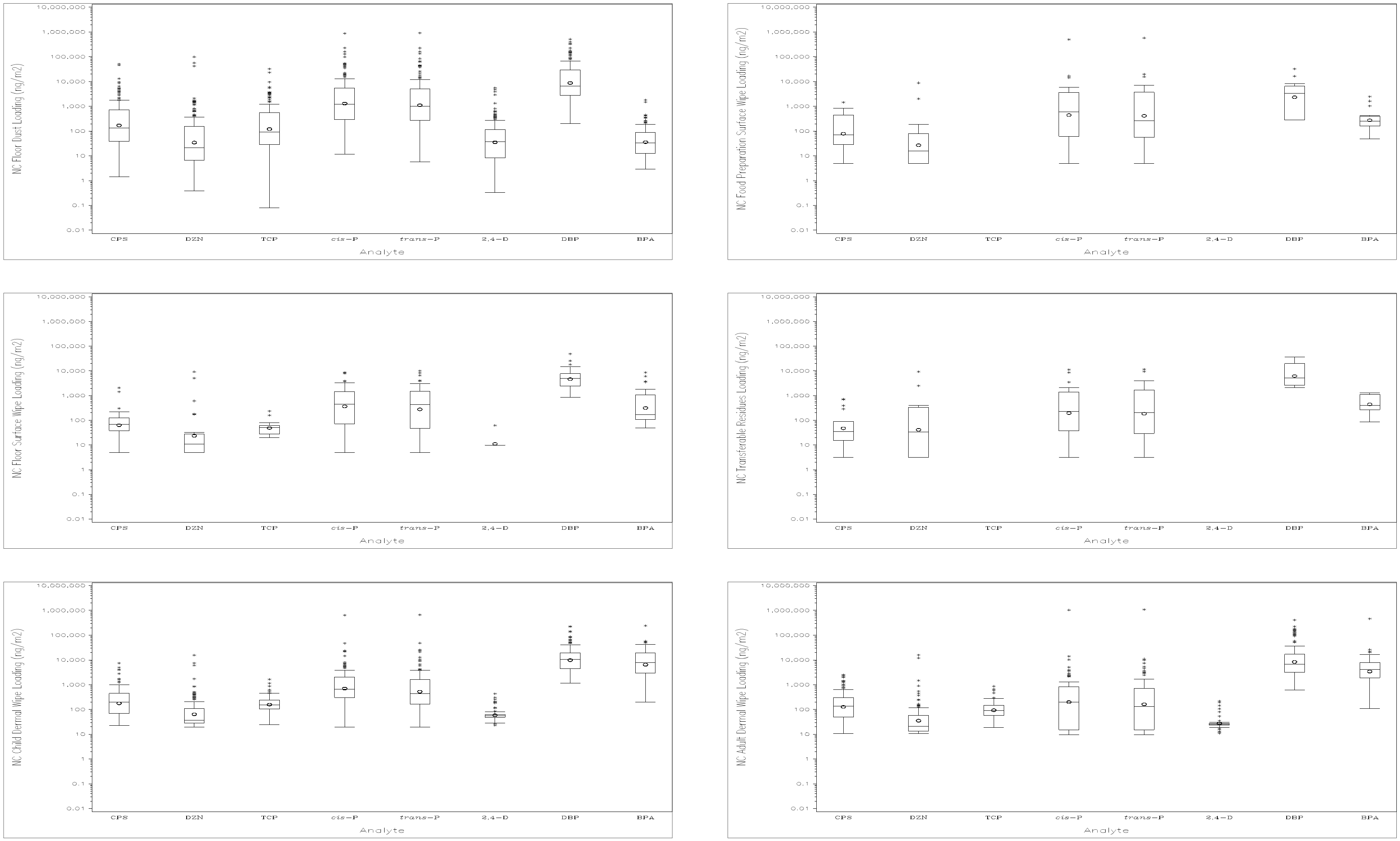

Figure 9.3.3 Boxplots of Pollutant Loadings in Dust, Hard Floor Surface Wipe, Food Preparation Surface Wipe, Transferable Residues, and Children and Adult Dermal Wipe Samples Collected at the Homes and Day Care Centers of Participating NC Children, for Eight Pollutants

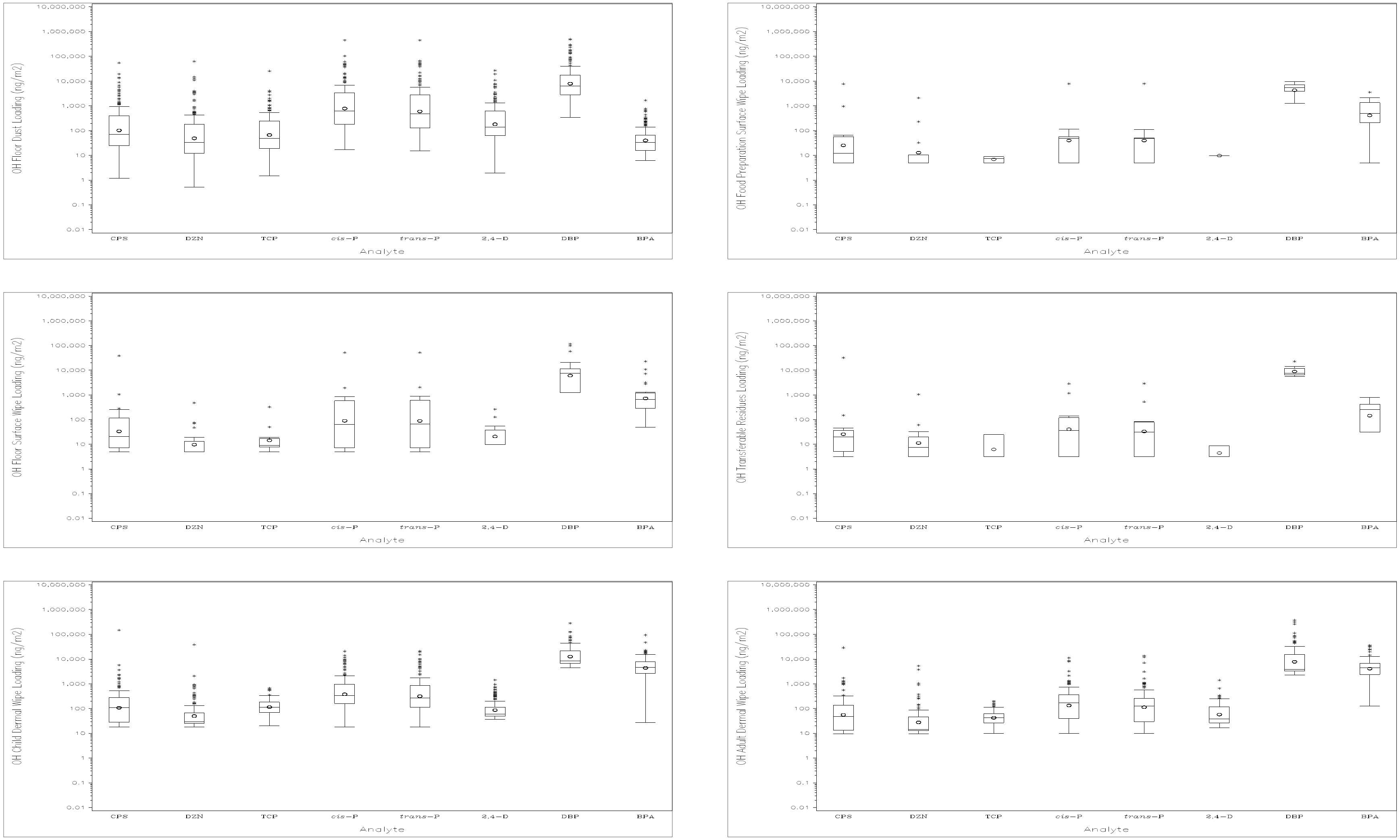

Figure 9.3.4 Boxplots of Pollutant Loadings in Dust, Hard Floor Surface Wipe, Food Preparation Surface Wipe, Transferable Residues, and Children and Adult Dermal Wipe Samples Collected at the Homes and Day Care Centers of Participating OH Children, for Eight Pollutants

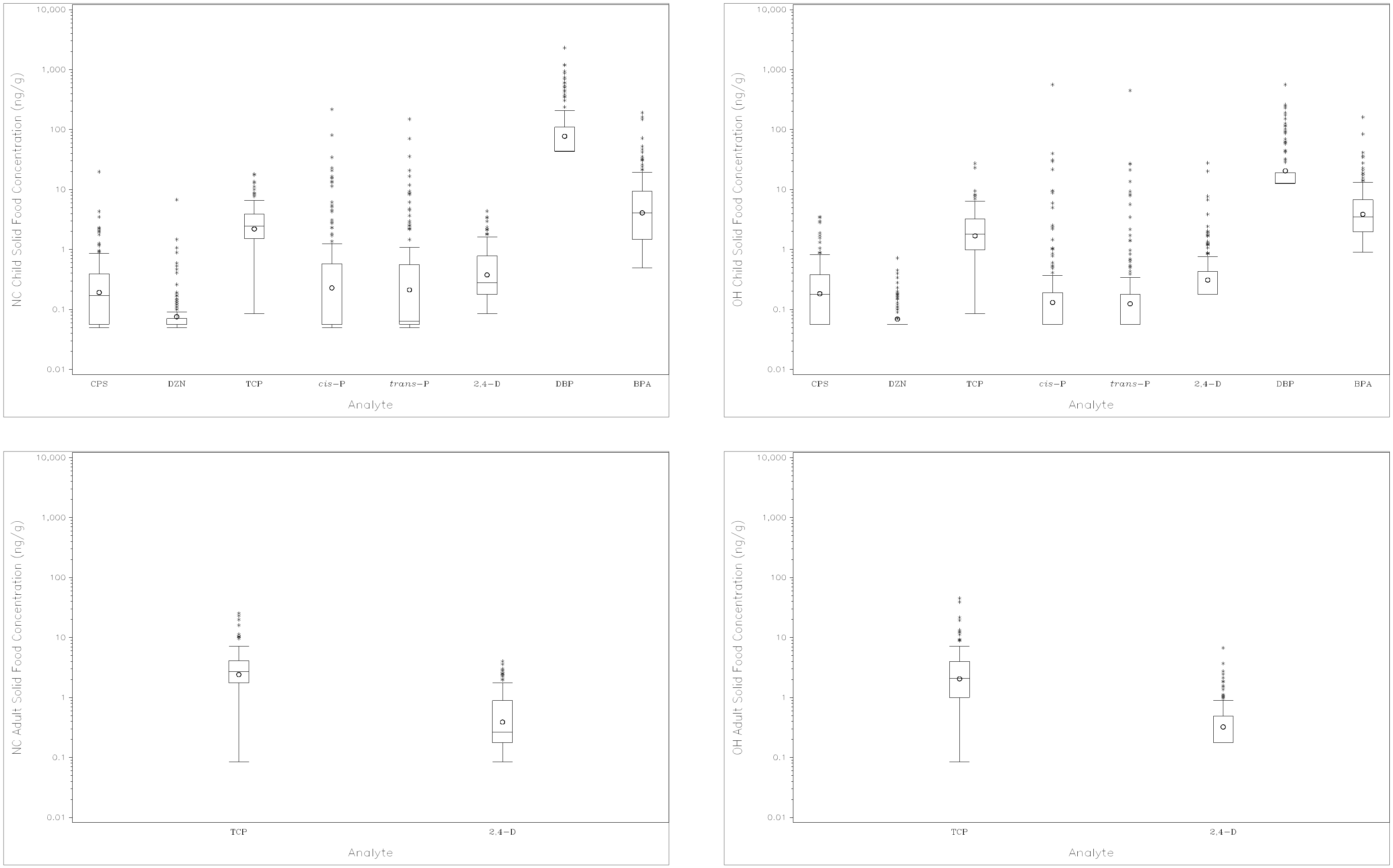

Figure 9.3.5 Boxplots of Pollutant Concentrations in Solid Food Samples Collected from Participating NC and OH Children and Adults, for Eight Pollutants

Each boxplot shows the distribution as a box-type diagram, where the lower and high limits of the box represent the 25th and 75th percentiles, respectively, of the observed data distribution. The length of the box (from top to bottom) represents the data's interquartile range (IQR), or the difference between the 75th and 25th percentiles, and is an indicator of data variability. A horizontal line within the box represents the 50th percentile, or median. The geometric mean is plotted with an open circle. Vertical lines extend from the top and/or bottom of the box to the value of the most extreme data point which falls within 1.5 IQRs from the box. Each data point extending beyond 1.5 IQRs from the box is plotted by an asterisk. Abbreviations for the pollutants that are specified along the horizontal axis of each figure were defined in the last paragraph of Section 9.2.

The boxplots show that, even when plotted using a logarithmic vertical axis, most data distributions for the eight pollutants and metabolites show skewness toward lower levels within all sample media, and most contain several measurements within the upper quartile that are at a considerable distance from the distribution's 75th percentile (i.e., top of box). This supports the approach of performing data analyses on log-transformed data, although some skewness remains in the distribution of the log-transformed data. Boxplots portrayed as very short boxes (e.g., measurements of the two permethrins within outdoor air samples from NC and OH) represent measurements that are nearly constant, which occurs most often when a large percentage of measurements are not detected. Other observations include the following:

- Indoor air and floor dust measurements tend to cover wider ranges than outdoor air and soil measurements, especially in NC.
- Soil concentrations tend to have highly skewed distributions across all pollutants, although on average, these concentrations are lower than for indoor dust.
- The distributions of loadings from surface wipe samples tend to be consistent between different surface types.
- Di-*n*-butylphthalate is frequently associated with higher measurements across the pollutants and metabolites, especially with regard to concentrations in air, dust, soil, and food samples.

9.3.2 <u>Sub-goal 1.2</u>: To Determine on Average How Multimedia Concentrations Differ Between Urban and Rural Environments, Low-Income and Middle/High-Income Environments, and Microenvironments (i.e., home for families with stay-at-home children, home for families with day care children, and day care centers)

To address this sub-goal, statistical analysis was performed on log-transformed measurements whenever at least 50% of these measurements were detected for a given pollutant and multimedia sample type. An analysis of variance using models (8-5) and (8-6) from Section 8.5.2.1 was performed to calculate a least squares mean of the log-transformed measurements for each environment type and microenvironment of interest. For a given pair of environment types or microenvironments, the difference in the least-squares mean concentrations was calculated within the analysis of variance along with a 95% confidence interval on this difference, and a t-test was applied to test whether the difference was statistically significant. This difference and its confidence interval were exponentiated back to regular units, resulting in a ratio of the least-squares geometric mean concentrations for one environment type versus another and an approximate 95% confidence interval on this ratio.

For ease of discussion here and throughout Chapter 9, children recruited from the child day care sampling frame are referred to as "day care children," while those from the telephone screening sampling frame are referred to as "stay-at-home children." Analyses were performed and results are reported separately for NC and OH phases of the study, and pollutants are addressed according to their chemical class. Because no day care centers in this study had recent pesticide applications prior to multimedia sampling, no data were available from day care centers for food preparation surface wipes and transferable residue samples. In addition, no adult food or dermal wipe data were available for the day care environment.

For indoor and outdoor environmental samples and personal (food) samples, ratios and their 95% confidence intervals are presented by pollutant and sample type in Appendix K (Table K-1 for NC and Table K-2 for OH). These ratios are of the least-squares geometric mean concentration for the first environment type specified in the column heading versus the second specified type, and 95% confidence intervals are shown in parentheses. The t-test applied to the log-transformed data also is a test of whether this ratio differs significantly from one; p-values associated with these tests are also given in Appendix K (Table K-3 for NC and Table K-4 for OH). Within these tables, p-values for tests that compare a specific pair of microenvironments, as well as home versus day care environments, are presented only when the test for general differences among the three microenvironments was significant at the 0.05 level.

Table 9.3.5 has condensed the information provided within Tables K-1 and K-2 of Appendix K for a given sample type by presenting only those pollutants whose ratios were significantly different from one at the 0.05 level for pairs of strata determined by urbanicity, income status, or environmental type. Within Table 9.3.5, a dashed cell indicate that the statistical analysis was not performed because either the study design did not permit such analysis or the data were less than 50% detected. A blank cell means that the ratio was not significantly different from one at the 0.05 level. If a pollutant or sample type does not appear in this table, then none of the estimated ratios were significantly different from one at the 0.05 level.

To illustrate how to interpret the numbers in Tables K-1 and K-2 of Appendix K and Table 9.3.5, consider the results presented for *alpha*-chlordane in NC indoor floor dust (ng/m^2). Results of the model fitting indicated that the least squares mean log-transformed measure was 4.69 for the low-income stratum and 3.93 for the middle/high-income stratum (data not shown). The difference in these two least squares means is 0.76, which when exponentiated, becomes 2.13. It is interpreted as the estimated ratio of least-squares geometric mean concentrations between low-income and middle/high-income environments, and it implies that the geometric mean of *alpha*-chlordane in floor dust (ng/m^2) was estimated to be 113% higher in low-income

Table 9.3.5. Environmental and Food Samples: Estimated Ratios of Geometric Mean Pollutant Levels Between Urban and Rural, Low-Income and Middle/High-Income, and Home and Day Care Environments, When These Ratios Were Significantly Different from One at the 0.05 Level[a]

Pollutant/Metabolite	Sample Medium[b]	Estimated Ratio of Geometric Means (When Significantly Different from 1 at the 0.05 Level)					
		North Carolina			Ohio		
		Urban vs. Rural	Low- vs. Mid/High-Income	Home vs. Day Care	Urban vs. Rural	Low- vs. Mid/High-Income	Home vs. Day Care
OP Pesticides and Metabolites							
Chlorpyrifos	Outdoor air		0.64*				1.74*
	Dust (ng/g)					2.09*	0.37*
	Dust (ng/m^2)		2.88**	0.27*		3.39**	0.14**
	C-solid food					2.06**	
Diazinon	Indoor air		3.59**				
	Outdoor air				2.70**	0.60*	
	Dust (ng/g)		2.06*	0.36*			
	Dust (ng/m^2)		6.32**	0.10**		2.24*	0.17**
IMP	Indoor air	--	--	--		1.66*	
	Outdoor air	--	--	--	3.87**	0.48**	
	Dust (ng/m^2)	--	--	--			0.39*
3,5,6-TCP	Indoor air					1.72*	
	Outdoor air		0.65*	1.84*			
	Soil			2.29*	2.80**		
	Dust (ng/m^2)		3.40**			2.35*	0.29**
	C-solid food		0.48**				
OC Pesticides							
alpha-Chlordane	Outdoor air			0.44**			1.63*
	Soil	--	--	--		2.12*	2.80*
	Dust (ng/g)			0.42*			
	Dust (ng/m^2)		2.13*	0.09**			
gamma-Chlordane	Outdoor air		1.60*	0.41*			1.62*
	Dust (ng/g)			0.40*			
	Dust (ng/m^2)			0.09**			
Pyrethroid Pesticides							
Cyfluthrin	Dust (ng/g)	--	--	--	2.33*		
	Dust (ng/m^2)	--	--	--		2.12*	0.23**
cis-Permethrin	Indoor air		4.17**		--	--	--
	Dust (ng/m^2)		3.19**	0.18**		2.21*	0.20**
trans-Permethrin	Indoor air		3.85**		--	--	--
	Dust (ng/m^2)		2.89*	0.16**			0.19**

Table 9.3.5. Environmental and Food Samples: Estimated Ratios of Geometric Mean Pollutant Levels Between Urban and Rural, Low-Income and Middle/High-Income, and Home and Day Care Environments, When These Ratios Were Significantly Different from One at the 0.05 Level[a] (cont.)

Pollutant/Metabolite	Sample Medium[b]	Estimated Ratio of Geometric Means (When Significantly Different from 1 at the 0.05 Level)					
		North Carolina			Ohio		
		Urban vs. Rural	Low- vs. Mid/High-Income	Home vs. Day Care	Urban vs. Rural	Low- vs. Mid/High-Income	Home vs. Day Care
Acid Herbicides							
2,4-D	Dust (ng/g)	3.20**	0.22**		2.38*	0.24**	
	Dust (ng/m²)	2.64*				0.39*	0.38*
	C-solid food[c]	1.60*			--	--	--
PAHs							
Benz[*a*]anthracene	Outdoor Air	1.58*					
	Soil		2.55**				
	Dust (ng/g)		0.54**		3.97**	0.58*	0.45*
	Dust (ng/m²)			0.12**	3.19**		0.17**
Benzo[*b*]fluoranthene	Indoor air		1.95**		--	--	--
	Soil		2.54*				
	Dust (ng/g)		0.57**		3.63**	0.57*	0.44**
	Dust (ng/m²)			0.12**	2.92**		0.16**
Benzo[*k*]fluoranthene	Soil		2.21*				
	Dust (ng/g)		0.56**		3.35**	0.58*	0.43**
	Dust (ng/m²)			0.13**	2.70*		0.16**
Benzo[*ghi*]perylene	Indoor air		1.76**		--	--	--
	Soil		2.49**				
	Dust (ng/g)		0.57**		3.28**	0.56*	0.43**
	Dust (ng/m²)			0.12**	2.64*		0.16**
Benzo[*a*]pyrene	Indoor air		1.94**		--	--	--
	Outdoor air	1.47*			--	--	--
	Soil		2.30*				
	Dust (ng/g)		0.55**		3.57**	0.55*	0.49*
	Dust (ng/m²)			0.13**	2.87*		0.18**
Benzo[*e*]pyrene	Soil		2.49**				
	Dust (ng/g)		0.60*		3.40**	0.57*	0.45*
	Dust (ng/m²)			0.12**	2.73*		0.16**
Chrysene	Indoor air		1.76**		--	--	--
	Soil		2.53**				
	Dust (ng/g)		0.59*		3.71**	0.56*	0.43**
	Dust (ng/m²)			0.12**	2.99**		0.16**

Table 9.3.5. Environmental and Food Samples: Estimated Ratios of Geometric Mean Pollutant Levels Between Urban and Rural, Low-Income and Middle/High-Income, and Home and Day Care Environments, When These Ratios Were Significantly Different from One at the 0.05 Level[a] (cont.)

Pollutant/Metabolite	Sample Medium[b]	Estimated Ratio of Geometric Means (When Significantly Different from 1 at the 0.05 Level)					
		North Carolina			Ohio		
		Urban vs. Rural	Low- vs. Mid/High-Income	Home vs. Day Care	Urban vs. Rural	Low- vs. Mid/High-Income	Home vs. Day Care
Dibenz[*a*,*h*]anthracene	Dust (ng/g)		0.57**	0.52*	3.66**	0.58*	0.42**
	Dust (ng/m^2)			0.12**	2.94*		0.15**
Indeno[1,2,3-*cd*]pyrene	Indoor air		1.90**		--	--	--
	Soil		2.61**				
	Dust (ng/g)		0.59**		3.43**	0.56*	0.41**
	Dust (ng/m^2)			0.12**	2.75*		0.15**
Phthalates							
Benzylbutylphthalate	Dust (ng/g)		1.76**	0.48**			0.41**
	Dust (ng/m^2)		4.75**	0.10**		2.52**	0.14**
Di-*n*-butylphthalate	Indoor air			0.56**			0.56**
	Dust (ng/g)			0.50**			0.38**
	Dust (ng/m^2)		2.56**	0.10**		1.76*	0.14**
Phenols							
Bisphenol-A	Dust (ng/m^2)	--	--	--			0.33**
Pentachlorophenol	Indoor air		1.77*				2.16*
	Outdoor air		0.69*				
	Dust (ng/m^2)		2.56*	0.24*			
PCBs							
PCB 52	Dust (ng/m^2)	--	--	--			0.24**

[a] Dashed cells indicate that no analysis was performed due to the data being less than 50% detected. Blank cells indicate that a ratio was estimated but was not significantly different from one at the 0.05 level. Note that pollutants, or sample media for a given pollutant, have been excluded from this table if all cells within the rows corresponding to these pollutants or media would have been blank or dashed within this table. All estimated ratios for each sample medium and each pollutant, along with corresponding 95% confidence intervals on these ratios, are presented in Table K-1 (NC) and Table K-2 (OH) of Appendix K.
[b] "Dust" = Indoor floor dust collected via HVS3 vacuum. "C-solid food" = Children's solid food.

* Significantly different from 1 at the 0.05 level, but not at the 0.01 level.
** Significantly different from 1 at the 0.01 level.

environments than in middle/high-income environments. The 95% confidence interval of (1.03, 4.41) indicates that we can conclude with 95% confidence that the actual ratio falls within this interval. The single asterisk indicates that the estimated ratio (2.13) was significantly different from one (and, equivalently, that the difference of 0.76 between the least squares means of the log-transformed measurements was significantly different from zero) at the 0.05 level, but not at the 0.01 level (p=0.041). For *alpha*-chlordane in NC outdoor air samples, the estimated ratio of home versus day care environments was 0.44, implying that the geometric mean concentration at home environments was 44% of the corresponding geometric mean for day care centers. This ratio was significantly different from one at the 0.01 level (p=0.009).

For dermal wipe loadings, ratios and confidence intervals are presented by pollutant for children and adults in Appendix K (Table K-5 for NC and Table K-6 for OH). Appendix K also contains tables of p-values associated with t-tests applied to the log-transformed dermal wipe loadings (Table K-7 for NC and Table K-8 for OH). Those ratios found to be significantly different from one at the 0.05 level are listed in Table 9.3.6 for both states. All of these tables are constructed, and their contents are interpreted, in the same manner as in Tables K-1 through K-4 of Appendix K and Table 9.3.5.

9.3.2.1 Comparing Pollutant Concentrations in NC Multimedia Samples Among Strata

Significant differences between urban and rural sampling locations were observed rather infrequently in the NC data. Significant differences occurred at the 0.01 level only in two instances: for concentrations of 2,4-D in indoor floor dust (ng/g), and for loadings of bisphenol-A in adult dermal wipes. On average, concentrations of 2,4-D in floor dust (ng/g) were about 3.2 times higher in urban locations than in rural locations. Bisphenol-A levels in adult dermal wipe samples were about 2.6 times higher when taken in urban locations.

Within Table 9.3.5 and 9.3.6, across all pollutants and sample media for NC, significant differences in pollutant levels were most frequently observed between low-income and middle/high-income locations. In fact, whenever a pollutant had at least 50% detected data for NC in at least one sample medium, therefore allowing that data to be analyzed statistically, significant differences were observed at the 0.05 level between low-income and middle/high-income strata for that pollutant in at least one sample medium. Incidences of significant differences at the 0.01 level between low-income and middle/high-income strata were as follows, according to pollutant class:

- For the two OP pesticides, chlorpyrifos and diazinon, along with the metabolite 3,5,6-TCP, significant differences were observed at the 0.01 level in floor dust loadings (ng/m^2), with loadings in low-income households ranging from 2.9 times (chlorpyrifos) to 6.3 times (diazinon) higher on average than middle/high-income households. Levels of 3,5,6-TCP in children's solid food samples collected in low-income households were about 48% of the levels in samples collected in middle/high-income areas; this difference was significant at the 0.01 level. Diazinon levels in indoor

Table 9.3.6. Dermal Wipe Samples: Estimated Ratios of Geometric Mean Pollutant Levels Between Urban and Rural, Low-Income and Middle/High-Income, and Home and Day Care Environments, When These Ratios Were Significantly Different from One at the 0.05 Level[a]

Pollutant/Metabolite	Type of Dermal Wipe Sample	Estimated Ratio of Geometric Means (When Significantly Different from 1 at the 0.05 Level)					
		North Carolina			Ohio		
		Urban vs. Rural	Low- vs. Mid/High-Income	Home vs. Day Care	Urban vs. Rural	Low- vs. Mid/High-Income	Home vs. Day Care
OP Pesticides and Metabolites							
Chlorpyrifos	Child			1.75*		2.53**	
	Adult		1.91*	--		4.08**	--
3,5,6-TCP	Child			1.88**			
	Adult		1.47*	--			--
PAHs							
Chrysene	Adult	--	--	--	1.81*		--
Phthalates							
Benzylbutylphthalate	Child		1.64*		--	--	--
Phenols							
Bisphenol-A	Child			0.33**			2.90**
	Adult	2.61**		--			--

[a] Dashed cells indicate that the study data or design did not permit the given ratio to be estimated for the specified type of dermal wipe sample, or that no analysis was performed due to the data being less than 50% detected. Blank cells indicate that a ratio was estimated but was not significantly different from one at the 0.05 level. Note that pollutants, or sample types for a given pollutant, have been excluded from this table if all cells within the rows corresponding to these pollutants or sample types would have been blank or dashed within this table. All estimated ratios for each sample type and each pollutant, along with corresponding 95% confidence intervals on these ratios, are presented in Table K-5 (NC) and Table K-6 (OH) of Appendix K.

* Significantly different from 1 at the 0.05 level, but not at the 0.01 level.
** Significantly different from 1 at the 0.01 level.

air were about 3.6 times higher in low-income areas compared to middle/high-income areas; this difference was significant at the 0.01 level.

- Concentrations of *cis*- and *trans*-permethrin in indoor air were about 4 times higher in low-income locations compared to middle/high-income locations, with the difference being significant at the 0.01 level. For both pollutants, low-income locations had higher loadings in floor dust compared to middle/high-income locations, with loadings being about 220% higher for *cis*-permethrin (which was significant at the 0.01 level).

- Concentrations of 2,4-D in floor dust (ng/g) were about 4.5 times higher in middle/high-income locations compared to low-income locations; this difference was significant at the 0.01 level.

- Among the PAHs, concentrations in indoor floor dust were higher for middle/high-income locations, while concentrations in yard soil and indoor air were higher for low-income locations. For all nine target PAHs, indoor floor dust from middle/high-income locations had concentrations (ng/g) that were from 67% to 85% higher than low-income locations, with the difference being significant at the 0.01 level for all but benzo[*e*]pyrene and chrysene. For all PAHs except dibenz[*a,h*]anthracene, yard soil from low-income locations had concentrations that were from 121% to 161% higher than middle/high-income locations, with the difference being significant at the 0.01 level for benz[*a*]anthracene, benzo[*ghi*]perylene, benzo[*e*]pyrene, chrysene, and indeno[1,2,3-*cd*]pyrene. For five PAHs (benzo[*b*]flouranthene, benzo[*ghi*]perylene, benzo[*a*]pyrene, chrysene, and indeno[1,2,3-*cd*]pyrene), indoor air concentrations ranged from 76% to 94% higher in low-income areas than in middle/high-income areas, with the difference being significant at the 0.01 level.

- For di-*n*-butylphthalate and benzylbutylphthalate, loadings in indoor floor dust (ng/m^2) were 2.6 and 4.8 times as high, respectively, in low-income locations than in middle/high-income locations, with the difference being significant at the 0.01 level. In addition, benzylbutylphalate concentration in indoor floor dust (ng/g) averaged nearly 80% higher in low-income locations, with the difference also being significant at the 0.01 level.

Across pollutants and sample media, frequent incidences of significant differences in the NC data also occurred between home and day care environments. Home environments often had lower pollutant levels on average compared to day care environments, with 3,5,6-TCP being the primary exception. Incidences of significant differences at the 0.01 level were as follows:

- Among the OC pesticides and metabolite, only two instances of significant difference between home and day care environments at the 0.01 level were observed: for diazinon in floor dust (ng/m^2), where home environments averaged only 10% of the loading found in day care environments, and for 3,5,6-TCP in children's dermal wipes, where samples taken in home environments averaged 88% higher than in day care environments.

- For both *alpha*- and *gamma*-chlordane, differences in loadings found in indoor floor dust (ng/m^2) were significant between home and day care environments at the 0.01 level, with home environments averaging only 9% of the loadings in day care environments. For indoor floor dust concentration (ng/g) and outdoor air concentration, home environments averaged about 44% of the levels of *alpha*- and *gamma*-chlordane compared to day care environments, with the difference being significant at the 0.01 level for *alpha*-chlordane in outdoor air samples.

- For both *cis*- and *trans*-permethrin, significant differences were observed at the 0.01 level between home and day care environments for loadings in indoor floor dust (ng/m^2), with home environments having slightly less than 20% of the loadings observed in day care environments, on average.

- For each of the nine PAHs, loadings (ng/m^2) in indoor floor dust differed significantly at the 0.01 level between home and day care environments, with home environments having approximately 12% of the loadings observed in day care environments, on average.

- For benzylbutylphthalate and di-*n*-butylphthalate, levels in indoor floor dust samples taken from home environments averaged approximately 10% of the levels for day care environments when expressed as a loading (ng/m^2) and approximately 50% of the levels for day care environments when expressed as a concentration (ng/g). In each case, the difference was significant at the 0.01 level. In addition, concentrations of di-*n*-butylphthalate in indoor air were significantly different at the 0.01 level, with home environments averaging about 56% of the levels observed in day care environments.

- Among the two phenols, significant differences occurred between home and day care environments at the 0.01 level only for bisphenol-A in children's dermal wipe samples, where samples taken from day care environments had loadings that were approximately three times higher than for samples taken from home environments.

9.3.2.2 Comparing Pollutant Concentrations in OH Multimedia Samples Among Strata

Incidences of significant differences in sample media concentrations between urban and rural locations occurred more frequently for OH data compared to NC data, with the following differences being significant at the 0.01 level:

- Among the OP pesticides and metabolites, significant differences in outdoor air concentrations between urban and rural locations were observed at the 0.01 level for diazinon and IMP, with urban locations averaging 2.7 and 3.9 times the concentrations, respectively, of rural locations. In addition, for 3,5,6-TCP, significant differences in soil concentrations were observed at the 0.01 level, with urban locations averaging 2.8 times the concentrations of rural locations.

- Among all nine PAHs, significant differences were observed between urban and rural locations for indoor floor dust levels. When expressed as a concentration (ng/g), significance was at the 0.01 level, and urban locations averaged from 3.3 to 4.0 times higher loadings compared to rural locations. When expressed as a loading (ng/m^2), significance was at the 0.01 level for three PAHs (benz[*a*]anthracene, benzo[*b*]fluoranthene, and chrysene), where urban locations averaged from 2.9 to 3.2 times higher concentrations compared to rural locations.

While frequent occurrences of significant differences were observed in the OH data between low-income and middle/high-income strata, their occurrence was somewhat less frequent for OH than for NC. Incidences of significant differences at the 0.01 level were as follows, according to pollutant class:

- The most frequent occurrences of significant differences among income strata occurred with the OP pesticides and metabolites. Significant differences at the 0.01 level occurred for chlorpyrifos in dermal wipe samples for both children and adults, with low-income locations having 2.5 and 4.1 times the levels of middle/high-income locations, respectively. Significant differences at the 0.01 level also occurred for chlorpyrifos in children's solid food samples, where low-income locations had roughly twice the levels of middle/high-income locations, and for IMP in outdoor air samples, where middle/high-income locations had roughly twice the levels of low-income locations. For chlorpyrifos, diazinon, and 3,5,6-TCP, loadings in indoor floor dust (ng/m^2) averaged from 2.2 to 3.4 times higher in low-income locations than in middle/high-income locations, with the difference significant at the 0.01 level for chlorpyrifos.

- Concentrations of 2,4-D in indoor floor dust (ng/g) differed significantly at the 0.01 level between low-income and middle/high-income locations, with middle/high-income locations having about four times higher concentrations on average compared to low-income locations.

- Loadings of benzylbutylphthalate in indoor floor dust (ng/m^2) differed significantly at the 0.01 level, with loadings in low-income locations being 2.5 times higher than for middle/high-income locations.

The following occurrences of significant differences in OH data between home and day care environments were observed at the 0.01 level:

- For all OP pesticides and metabolites except IMP, significant differences in loadings were observed at the 0.01 level between home and day care environments for indoor floor dust (ng/m^2), with home environments having from 14% to 29% of the loadings observed in day care environments, on average.

- For all three pyrethroid pesticides, significant differences in loadings were observed at the 0.01 level between home and day care environments for indoor floor dust (ng/m^2), with day care environments having about five times higher loadings compared to home environments.

- Among the PAHs, significant differences were observed between home and day care environments for indoor floor dust levels. When expressed as a loading (ng/m^2), significance was at the 0.01 level for all nine PAHs, where home environments averaged from 15% to 18% of the loadings associated with day care environments. When expressed as a concentration (ng/g), significance was at the 0.01 level all but three PAHs (benz[*a*]anthracene, benzo[*a*]pyrene, and benzo[*e*]pyrene), where home environments averaged from 41% to 45% of the concentrations associated with day care environments.

- Similar to the PAHs, significant differences were present at the 0.01 level for both phthalates in indoor floor dust samples, regardless of whether the levels were expressed as a concentration or a loading. When expressed as a loading (ng/m^2), home environments averaged 14% of the loadings associated with day care environments, while when expressed as a concentration (ng/g), home environments averaged about 40% of the concentrations associated with day care environments. In addition, indoor air concentrations of di-*n*-butylphthalate differed significantly at the 0.01 level between home and day care environments, with day care environments having roughly twice the concentration on average compared to home environments.

- For bisphenol-A, significant differences were observed at the 0.01 level between home and day care environments for loadings in floor dust samples (ng/m^2), with day care environments averaging roughly three times higher loadings compared to home environments, and for children's dermal wipe samples, where samples taken in home environments had about 2.9 times higher levels compared to day care environments.

- Significant differences were observed at the 0.01 level in floor dust loading (ng/m^2) of PCB 52, with day care environments having roughly four times the loadings, on average, compared to home environments.

9.4 Goal 2: To Quantify the Distributions of Child Characteristics, Activities, and Location that are Important for Exposure.

Important factors for helping to determine the estimated potential exposures and potential absorbed doses of the children and their primary caregivers to pollutants in these environments included their physical characteristics, activity patterns, locations where they spend their time, and the amount of food they consume. Table 9.4.1 contains summary statistics of the physical characteristics of the children and their primary caregivers including age, gender, body weight, height, and hand surface area in both states. Table 9.4.2 provides the common activities of the preschool children that were recorded by the parents in the questionnaires. These included such activities as frequency of placing toys and other objects in the mouth, pacifier use, teething, and frequency of washing hands. Table 9.4.3 and Table 9.4.4 contain the daily percentage of time that the participating children and adults, respectively, spent indoors or outdoors at their homes, day care centers, or other places. The children spent a daily average of 94% and 90% of their time indoors in NC and OH, respectively, while adults spent a daily average of 73% and 69% of their time indoors at their home in NC and OH, respectively. Table 9.4.5 contains summary statistics for the amount of solid food (g) and liquid food (mL) samples that were collected over the 48-h sampling period from children and their primary caregivers by group (stay at home or attended day care). Many of these factors were used to determine the children's estimated potential exposures and potential absorbed doses to pollutants at homes and day care centers.

Table 9.4.1 Summary of Selected Physical and Demographic Characteristics of the Participating Children and Their Primary Caregivers, for NC and OH

Physical Characteristics	Children		Adults	
	NC	OH	NC	OH
# Participants	129[a]	127	129[a]	127
# Participants, by Gender				
Male	58	63	8	12
Female	71	64	121	115
Age of participants (yr)[b]				
Mean	3.9/46.8	3.9/47.1	31.3	32.2
SE[c]	0.9/0.9	0.8/0.9	6.8	6.5
Median	3.9/47.2	4.0/47.9	31.0	32.0
Minimum	1.7/20.0	1.7/20.3	19.0	19.0
Maximum	5.5/65.5	5.6/66.6	46.0	49.0
Height of participants (cm)				
Mean	103.0	102.1	165.9	166.4
SE	8.8	9.0	7.9	8.3
Median	104.1	101.6	165.1	165.1
Minimum	78.7	78.7	144.8	152.4
Maximum	124.5	121.9	190.5	203.2
Weight of participants (kg)				
Mean	17.2	17.7	76.1	75.2
SE	4.3	4.0	19.4	19.4
Median	16.7	17.1	72.5	72.0
Minimum	10.4	10.8	45.0	45.0
Maximum	44.1	33.3	151.7	140.0
Hand surface area[d] of participants (cm^2)				
Mean	261.5	269.2	571.2	561.5
SE	42.1	44.6	70.0	73.7
Median	255.0	260.0	560.0	550.0
Minimum	175.0	190.0	460.0	410.0
Maximum	380.0	405.0	825.0	840.0
Highest education level				
11^{th} grade or less			12.3%	6.3%
High school (HS) graduate/GED			20.8%	22.1%
Post-HS training			5.4%	5.5%
Some college			23.1%	20.5%
College graduate			23.1%	34.6%
Post-graduate			14.6%	11.0%
Unknown (missing)			0.8%	0.0%

Table 9.4.1 Summary of Selected Physical and Demographic Characteristics of the Participating Children and Their Primary Caregivers, for NC and OH (cont.)

Physical Characteristics	Children		Adults	
	NC	OH	NC	OH
Racial background				
White	55.4%	70.1%	57.7%	73.2%
Black	36.9%	25.2%	36.9%	22.8%
Hispanic	3.9%	2.4%	2.3%	2.4%
Asian/Pacific Islander	0.0%	2.4%	0.0%	1.6%
Other	3.1%	0.0%	2.3%	0.0%
Unknown (missing)	0.8%	0.0%	0.8%	0.0%
Total household income				
Less than $15,000			20.0%	9.5%
$15,001 to $25,000			17.7%	16.5%
$25,001 to $35,000			6.9%	7.9%
$35,001 to $50,000			16.1%	24.4%
More than $50,000			35.4%	30.7%
Refused			3.1%	5.5%
Don't know			0.8%	2.4%
Unknown (missing)			0.0%	3.2%

[a] One adult and their child dropped out of the study before field sampling was completed.
[b] For children, age is given in total years, followed by total months.
[c] Standard error of the mean
[d] Hand surface are of both hands.

Table 9.4.2 Prevalence of Selected Daily Activities Among the Participating Children, as Recorded on Study Questionnaires

Daily Activities During the Previous Month	NC Children (n=129)	OH Children (n=127)
How often did your child play with sand or dirt?		
Most of the time	34%	29%
Sometimes	40%	36%
Almost never	26%	35%
Have you ever seen your child eat.....?		
Dirt	12%	8%
Sand	9%	5%
Snow	29%	5%
Did your child use a pacifier?		
Yes	5%	4%
No	95%	96%
Did your child ever put their mouth on the floor or lick the floor?		
Yes	10%	8%
No	89%	92%
Don't know	1%	–
Is your child currently teething?		
Yes	5%	2%
No	94%	98%
Don't know	1%	–
How often did your child put toys in their mouth?		
Frequently	25%	18%
Sometimes	33%	31%
Almost never	42%	51%
Did your child put anything[a] other than toys or food in their mouth?	33%	25%
Yes	67%	74%
No	–	1%
Missing data		
Did your child suck or chew their thumb or fingers?		
Yes	42%	15%
No	58%	85%
Did your child suck or chew their toe or foot?		
Yes	5%	1%
No	95%	99%
When your child was outside the house, how often did he/she walk barefoot?		
Most of the time	8%	22%
Sometimes	21%	24%
Almost never	71%	54%

Table 9.4.2 Prevalence of Selected Daily Activities Among the Participating Children, as Recorded on Study Questionnaires (cont.)

Daily Activities During the Previous Month	NC Children (n=129)	OH Children (n=127)
How often did your child take something to eat or drink when he/she were playing outside the house?		
Most of the time	15%	17%
Sometimes	35%	39%
Almost never	50%	44%
When your child was inside the house, how often did he/she walk barefoot		
Most of the time	75%	74%
Sometimes	16%	18%
Almost never	8%	8%
When your child was inside the house, how often did he/she sit or play on the floor?		
Most of the time	78%	74%
Sometimes	21%	23%
Almost never	1%	3%
How often did your child sleep or take a nap on the floor?		
Most of the time	5%	3%
Sometimes	12%	13%
Almost never	83%	84%
How often were your child's hand's washed before eating meals?		
Most of the time	77%	83%
Sometimes	20%	16%
Almost never	3%	1%
How often were your child's hands washed before eating snacks?		
Most of the time	35%	39%
Sometimes	43%	35%
Almost never	22%	25%
Don't know	–	1%
How often were your child's hands washed after playing outside the house?		
Most of the time	67%	60%
Sometimes	24%	32%
Almost never	9%	8%
How often were their hands washed before going to bed?		
Most of the time	83%	74%
Sometimes	8%	17%
Almost never	9%	9%

[a] "Anything" refers to objects other than toys or food that could be placed into the mouth.

Table 9.4.3 Daily Percentage of Time that Participating Children Spent Indoors or Outdoors at Homes, Day Care Centers, Or Other Places

Location	# Children	Percentage of Time Spent at the Given Location				
		Mean	SD	Median	Minimum	Maximum
North Carolina						
Indoors	129	94	4	95	81	100
at Home	129	72	15	71	48	100
at Day Care	63	27	6	26	14	41
Other location	129	9	7	8	0	36
Outdoors	129	6	4	5	0	19
at Home	129	4	4	3.1	0	19
at Day Care	63	3	2	3.0	0	10
Ohio						
Indoors	127	90	8	92	58	100
at Home	127	68	16	68	8	99
at Day Care	58	30	12	30	8	89
Other location	127	8	7	6	0	47
Outdoors	127	10	8	8	0	42
at Home	127	8	8	5	0	42
at Day Care	58	5	5	4	0	17

Table 9.4.4 Daily Percentage of Time that Participating Adults Spent Indoors or Outdoors at Homes or Other Places

Location	Percentage of Time Spent at the Given Location				
	Mean	SD	Median	Minimum	Maximum
North Carolina (N=129 adults)					
Indoors at Home	73	15	72	48	100
Outdoors at Home	3	4	2	0	21
Away from Home	24	15	25	0	48
Ohio (N=127 adults)					
Indoors at Home	69	17	69	8	100
Outdoors at Home	6	8	3	0	54
Away from Home	24	19	19	0	91

Table 9.4.5 Summary Statistics on the Daily Amount of Solid and Liquid Food Collected from Participating Children and Their Primary Caregivers in the Stay-at-Home and Day Care Groups[a]

Food Sample Type	State	N	Mean	SD	Median	Min	Max
Weight of Solid Food (g)							
Stay-at-home group Adults	NC	66	498.6	206.6	509.0	20.6	925.9
	OH	69	577.7	208.7	571.6	221.6	1102.8
Stay-at- home group Children	NC	66	355.4	151.0	328.7	74.7	891.3
	OH	69	364.9	104.1	353.0	141.5	623.9
Day care group Adults	NC	63	342.7	193.7	323.4	6.2	1378.5
	OH	58	310.4	149.1	274.4	102.5	792.0
Day care group Children	NC	63	504.9	143.6	511.9	207.7	773.3
	OH	58	432.0	138.8	417.1	188.1	806.0
Volume of Liquid Food (mL)							
Stay-at-home group Adults	NC	64	723.9	430.9	692.5	69.0	2326.0
	OH	67	748.6	392.6	700.0	124.0	1802.5
Stay-at-home group Children	NC	65	597.3	246.6	600.0	83.0	1550.0
	OH	69	559.4	230.6	545.0	144.0	1655.0
Day care group Adults	NC	57	565.4	320.2	548.0	80.0	1380.0
	OH	55	456.1	329.3	370.0	110.0	1387.5
Day care group Children	NC	62	777.5	277.9	780.0	237.0	1351.0
	OH	57	600.8	226.8	600.0	200.0	1140.0

[a] Solid and liquid food samples were composited separately over a 48-h period.

9.5 Goal 3: To Estimate the Exposures of Participating Preschool Children to CTEPP Pollutants that They May Encounter in Their Everyday Environments

The formulas used to estimate potential exposure level and potential absorbed dose for a given study participant via the inhalation, dietary ingestion, and indirect ingestion routes were given in Sections 8.4.1, 8.4.2, and 8.4.3, respectively. For the eight target pollutants specified at the end of Section 9.2, potential exposure level and potential absorbed dose were estimated for each exposure route in all study participants. For the remaining target pollutants specified in Table 8.3 of Section 8.4 (19 pollutants in NC and 18 pollutants in OH), potential exposure level and potential absorbed dose via a given exposure route were estimated for study participants within a given state only when the following criteria were satisfied:

- Inhalation route: When at least 45% of the state's samples have detected results (i.e., at or above the MDL) for indoor air and/or outdoor air

- Dietary ingestion route: When at least 45% of the state's samples have detected results (i.e., at or above the MDL) for solid food.
- Indirect ingestion route: When at least 45% of the state's samples have detected results (i.e., at or above the MDL) for floor dust.

For target pollutants achieving these criteria within a given exposure route, potential exposure level and potential absorbed dose results are presented in this section.

9.5.1 Sub-goal 3.1: To Quantify the Distribution of Potential Exposure and Potential Absorbed Dose by Exposure Route

Descriptive statistics of potential exposure level and potential absorbed dose estimates are presented by exposure route in Appendix L for NC children, Appendix M for OH children, Appendix N for NC adults, and Appendix O for OH adults. The descriptive statistics are calculated across all study participants, as well as for study participants within each stratum: urban, rural, low-income, middle/high-income, stay-at-home children (or adults with stay-at-home children), and day care children (or adults with day care children). The descriptive statistics in these tables are presented and interpreted in the same way as was discussed in Section 9.3.1, except the sample size (N) now corresponds to numbers of study participants.

For the target pollutants, overall median values of estimated potential exposure level and potential absorbed dose are summarized by exposure route in Table 9.5.1 for NC children, Table 9.5.2 for OH children, Table 9.5.3 for NC adults, and Table 9.5.4 for OH adults. For the eight pollutants for which potential exposure level and potential absorbed dose were calculated for each exposure route, boxplots of the distribution of estimated potential exposure level and potential absorbed dose are given in Figures 9.5.1 through 9.5.6, with each figure focused on either children or adults and a specific exposure route:

- Figure 9.5.1: inhalation route for children
- Figure 9.5.2: dietary ingestion route for children
- Figure 9.5.3: indirect ingestion route for children
- Figure 9.5.4: inhalation route for adults
- Figure 9.5.5: dietary ingestion route for adults (3,5,6-TCP and 2,4-D only)
- Figure 9.5.6: indirect ingestion route for adults.

Each figure contains separate boxplots for potential exposure level and potential absorbed dose, for each pollutant for which data were available to make these estimates, and for each state. See Section 9.3.1 for how to interpret these boxplots.

Table 9.5.1 Median Values of Estimated Potential Exposure and Potential Absorbed Dose for Target Pollutants in Participating NC Preschool Children, by Exposure Route

Pollutant/Metabolite	Potential Exposure Level (ng/day)			Potential Absorbed Dose (ng/kg/day)		
	Inhalation	Dietary Ingestion	Indirect Ingestion	Inhalation	Dietary Ingestion	Indirect Ingestion
OP Pesticide and Metabolite						
Chlorpyrifos	47	81	5.2	1.4	2.5	0.16
Diazinon	17	<[a]	0.98	0.51	<	0.030
3,5,6-TCP	14	1,200	4.5	0.43	38	0.12
OC Pesticides						
alpha-Chlordane	8.3	<	1.6	0.24	<	0.048
gamma-Chlordane	13	<	2.7	0.42	<	0.083
p,p'-DDE	<	88	0.21	<	2.6	0.0074
Heptachlor	62	<	0.92	1.7	<	0.028
Pyrethroid Pesticides						
Cyfluthrin	<	<	3.6	<	<	0.13
cis-Permethrin	4.6	85	48	0.14	2.6	1.4
trans-Permethrin	2.7	74	35	0.088	2.2	1.0
Acid Herbicides						
2,4-D	4.0	190	1.4	0.099	4.8	0.042
PAHs						
Benz[*a*]anthracene	0.75	<	5.5	0.023	<	0.17
Benzo[*b*]fluoranthene	1.2	<	14	0.035	<	0.46
Benzo[*k*]fluoranthene	0.61	<	4.8	0.019	<	0.15
Benzo[*ghi*]perylene	1.0	<	8.6	0.029	<	0.25
Benzo[*a*]pyrene	0.80	<	7.7	0.025	<	0.25
Benzo[*e*]pyrene	0.73	<	7.7	0.022	<	0.24
Chrysene	0.85	<	7.5	0.027	<	0.23
Dibenz[*a,h*]anthracene	<	<	1.9	<	<	0.058
Indeno[1,2,3-*cd*]pyrene	0.83	<	7.4	0.025	<	0.24
Phthalates						
Benzylbutylphthalate	<	<	920	<	<	26
Di-*n*-butylphthalate	1,800	39,000	350	56	1,100	9.7
Phenols						
Bisphenol-A	14	2,700	<	0.41	74	<
Pentachlorophenol	12	<	3.4	0.34	<	0.11
PCBs						
PCB 52	4.2	<	<	0.13	<	<
PCB 95	0.69	<	<	0.021	<	<
PCB 101	0.55	<	<	0.017	<	<

[a] “<” indicates that the estimates were labeled as “not detected” for more than 50% of participating NC children, meaning that all pollutant concentrations entering into the calculation of the estimate were not detected.

Table 9.5.2 Median Values[a] of Estimated Potential Exposure and Potential Absorbed Dose for Target Pollutants in Participating <u>OH Preschool Children</u>, by Exposure Route

Pollutant/Metabolite	Potential Exposure Level (ng/day)			Potential Absorbed Dose (ng/kg/day)		
	Inhalation	Dietary Ingestion	Indirect Ingestion	Inhalation	Dietary Ingestion	Indirect Ingestion
OP Pesticide and Metabolite						
Chlorpyrifos	15	78	2.7	0.38	2.1	0.083
Diazinon	8.0	<[a]	1.0	0.24	<	0.031
3,5,6-TCP	5.1	860	1.6	0.14	25	0.049
OC Pesticides						
alpha-Chlordane	2.1	<	0.40	0.063	<	0.011
gamma-Chlordane	2.7	<	0.45	0.088	<	0.012
p,p'-DDE	<	78	0.27	<	2.1	0.0075
Pyrethroid Pesticides						
Cyfluthrin	<	<	7.1	<	<	0.20
cis-Permethrin	<	<	18	<	<	0.49
trans-Permethrin	<	<	12	<	<	0.34
Acid Herbicides						
2,4-D	1.9	120	4.8	0.049	3.6	0.15
PAHs						
Benz[*a*]anthracene	<	<	22	<	<	0.62
Benzo[*b*]fluoranthene	<	31	53	<	0.93	1.5
Benzo[*k*]fluoranthene	<	<	22	<	<	0.60
Benzo[*ghi*]perylene	<	<	28	<	<	0.82
Benzo[*a*]pyrene	<	<	29	<	<	0.81
Benzo[*e*]pyrene	<	<	30	<	<	0.79
Chrysene	0.56	<	29	0.018	<	0.82
Dibenz[*a,h*]anthracene	<	<	6.2	<	<	0.18
Indeno[1,2,3-*cd*]pyrene	<	<	28	<	<	0.80
Phthalates						
Benzylbutylphthalate	<	9,400	630	<	270	18
Di-*n*-butylphthalate	2,000	<	210	57	<	5.7
Phenols						
Bisphenol-A	7.8	1,700	1.0	0.24	52	0.028
Pentachlorophenol	18	<	1.8	0.58	<	0.051
PCBs						
PCB 52	3.6	–[b]	0.23	0.10	--	0.0058
PCB 95	0.81	--	0.15	0.025	--	0.0041
PCB 101	0.72	--	0.18	0.021	--	0.0057

[a] "<" indicates that the estimates were labeled as "not detected" for more than 50% of participating OH children, meaning that all pollutant concentrations entering into the calculation of the estimate were not detected.

[b] Dashes indicate that no valid concentrations for the given pollutant were available for those sample media that enter into the calculation of the potential exposure and potential absorbed dose estimates for the given exposure route.

Table 9.5.3 Median Values[a] of Estimated Potential Exposure and Potential Absorbed Dose for Target Pollutants in Participating NC Adults, by Exposure Route

Pollutant/Metabolite	Potential Exposure Level (ng/day)			Potential Absorbed Dose (ng/kg/day)		
	Inhalation	Dietary Ingestion	Indirect Ingestion	Inhalation	Dietary Ingestion	Indirect Ingestion
OP Pesticides and Metabolites						
Chlorpyrifos	69	–[b]	3.2	0.45	--	0.021
Diazinon	23	--	0.43	0.14	--	0.0030
3,5,6-TCP	21	1,200	2.3	0.14	7.9	0.016
OC Pesticides						
alpha-Chlordane	9.5	--	0.55	0.064	--	0.0037
gamma-Chlordane	17	--	0.74	0.11	--	0.0052
p,p'-DDE	<[a]	--	<	<	--	<
Heptachlor	80	--	<	0.54	--	<
Pyrethroid Pesticides						
Cyfluthrin	<	--	1.2	<	--	0.0077
cis-Permethrin	5.6	--	20	0.036	--	0.14
trans-Permethrin	3.9	--	16	0.020	--	0.11
Acid Herbicides						
2,4-D	2.1	140	0.80	0.016	0.97	0.0058
PAHs						
Benz[*a*]anthracene	0.97	--	2.8	0.0067	--	0.018
Benzo[*b*]fluoranthene	1.6	--	7.0	0.011	--	0.051
Benzo[*k*]fluoranthene	0.77	--	2.5	0.0061	--	0.017
Benzo[*ghi*]perylene	1.5	--	4.2	0.010	--	0.029
Benzo[*a*]pyrene	1.0	--	4.2	0.0078	--	0.028
Benzo[*e*]pyrene	0.97	--	4.3	0.0069	--	0.026
Chrysene	1.2	--	4.1	0.0083	--	0.027
Dibenz[*a,h*]anthracene	<	--	0.96	<	--	0.0064
Indeno[1,2,3-*cd*]pyrene	1.1	--	3.9	0.0080	--	0.026
Phthalates						
Benzylbutylphthalate	<	--	420	<	--	3.1
Di-*n*-butylphthalate	2,600	--	130	18	--	0.96
Phenols						
Bisphenol-A	20	--	<	0.13	--	<
Pentachlorophenol	17	<	1.5	0.11	<	0.011
PCBs						
PCB 52	6.0	--	<	0.040	--	<
PCB 95	1.0	--	<	0.0065	--	<
PCB 101	0.68	--	<	0.0047	--	<

[a] "<" indicates that the estimates were labeled as "not detected" for more than 50% of participating NC adults, meaning that all pollutant concentrations entering into the calculation of the estimate were not detected.
[b] Dashes indicate that no valid concentrations for the given pollutant were available for those sample media that enter into the calculation of the potential exposure and potential absorbed dose estimates for the given exposure route.

Table 9.5.4 Median Values[a] of Estimated Potential Exposure and Potential Absorbed Dose for Target Pollutants in Participating OH Adults, by Exposure Route

Pollutant/Metabolite	Potential Exposure Level (ng/day)			Potential Absorbed Dose (ng/kg/day)		
	Inhalation	Dietary Ingestion	Indirect Ingestion	Inhalation	Dietary Ingestion	Indirect Ingestion
OP Pesticides and Metabolites						
Chlorpyrifos	20	–[b]	1.2	0.13	--	0.0079
Diazinon	11	--	0.48	0.076	--	0.0031
3,5,6-TCP	7.0	980	0.99	0.046	6.1	0.0068
OC Pesticides						
alpha-Chlordane	3.0	--	0.26	0.021	--	0.0018
gamma-Chlordane	4.1	--	0.31	0.030	--	0.0019
p,p'-DDE	<[a]	--	0.17	<	--	0.0012
Pyrethroid Pesticides						
Cyfluthrin	<	--	4.4	<	--	0.028
cis-Permethrin	<	--	10	<	--	0.074
trans-Permethrin	<	--	8.0	<	--	0.060
Acid Herbicides						
2,4-D	1.9	<	2.9	0.015	<	0.021
PAHs						
Benz[*a*]anthracene	<	--	13	<	--	0.092
Benzo[*b*]fluoranthene	<	--	34	<	--	0.23
Benzo[*k*]fluoranthene	<	--	13	<	--	0.075
Benzo[*ghi*]perylene	<	--	18	<	--	0.11
Benzo[*a*]pyrene	<	--	17	<	--	0.12
Benzo[*e*]pyrene	<	--	19	<	--	0.12
Chrysene	0.77	--	18	0.0061	--	0.12
Dibenz[*a,h*]anthracene	<	--	3.9	<	--	0.027
Indeno[1,2,3-*cd*]pyrene	<	--	18	<	--	0.11
Phthalates						
Benzylbutylphthalate	<	--	410	<	--	2.7
Di-*n*-butylphthalate	2,700	--	130	19	--	0.86
Phenols						
Bisphenol-A	11	--	<	0.076	--	<
Pentachlorophenol	23	<	1.3	0.16	<	0.0091
PCBs						
PCB 52	4.8	--	0.11	0.033	--	0.00072
PCB 95	1.2	--	0.084	0.0077	--	0.00065
PCB 101	1.0	--	0.11	0.0064	--	0.00076

[a] "<" indicates that the estimates were labeled as "not detected" for more than 50% of participating OH adults, meaning that all pollutant concentrations entering into the calculation of the estimate were not detected.
[b] Dashes indicate that no valid concentrations for the given pollutant were available for those sample media that enter into the calculation of the potential exposure and potential absorbed dose estimates for the given exposure route.

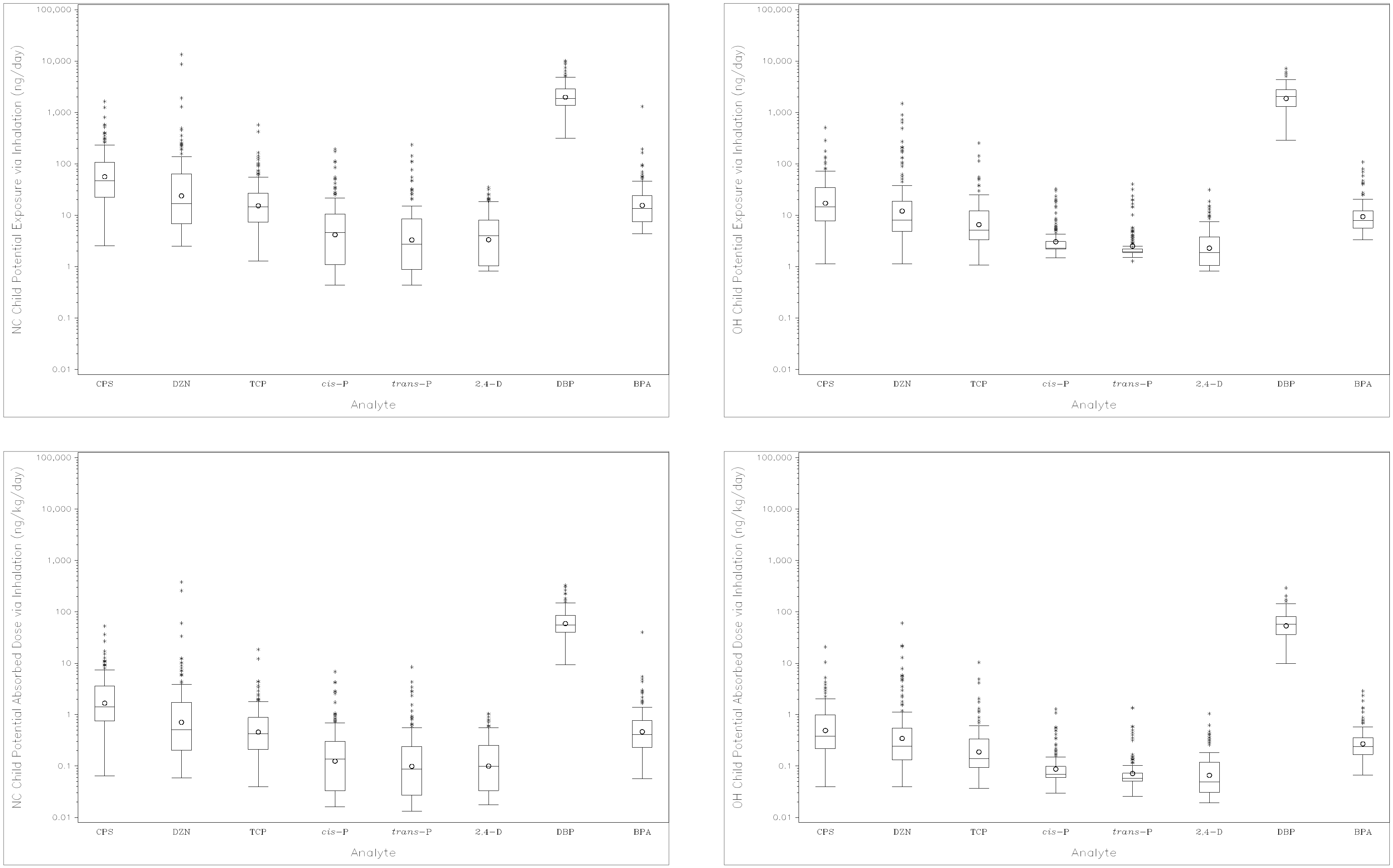

Figure 9.5.1 Boxplots of Estimated Potential Exposure and Potential Absorbed Dose via Inhalation for Participating NC and OH Children, for Eight Pollutants

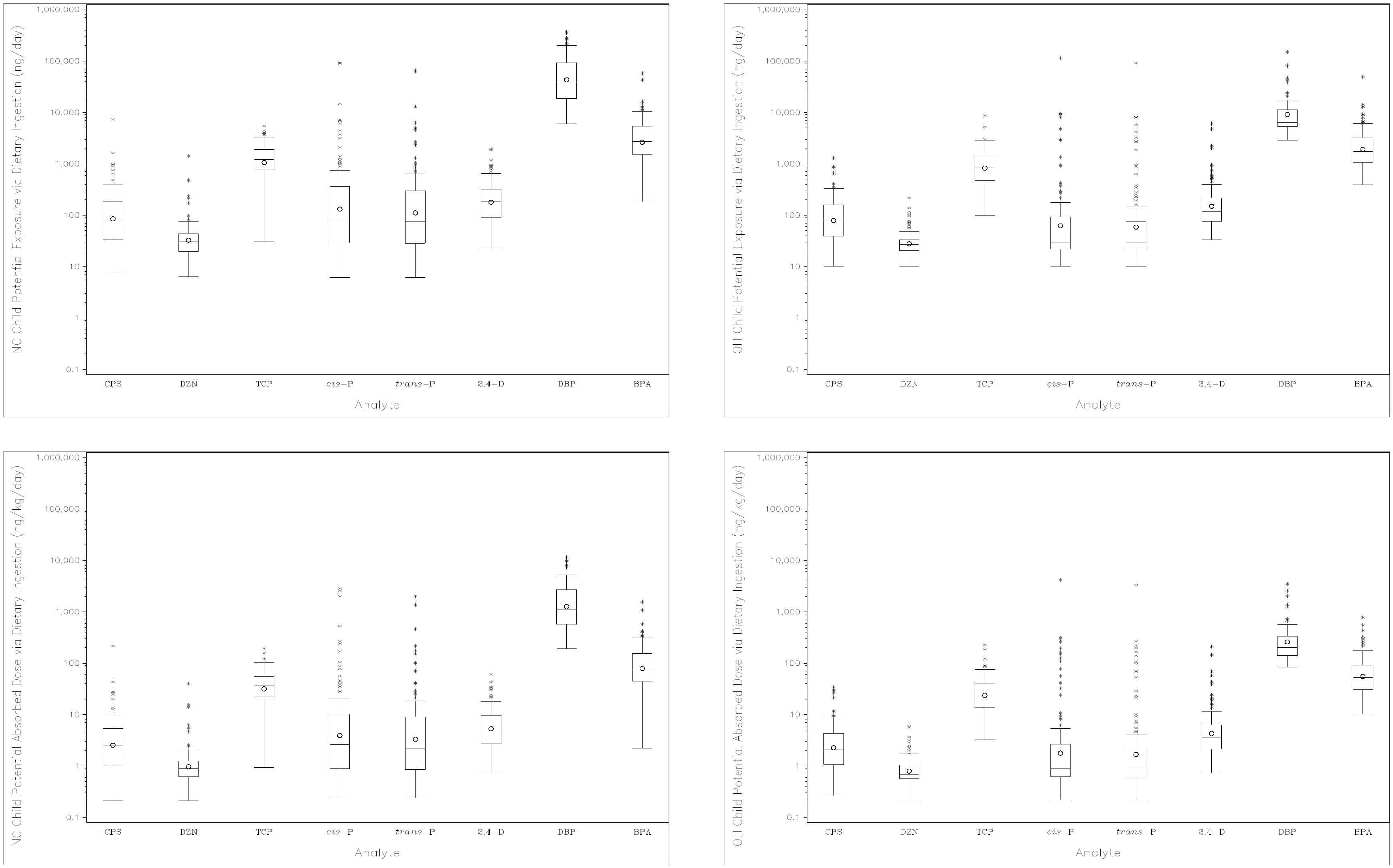

Figure 9.5.2 Boxplots of Estimated Potential Exposure and Potential Absorbed Dose via Dietary Ingestion for Participating NC and OH Children, for Eight Pollutants

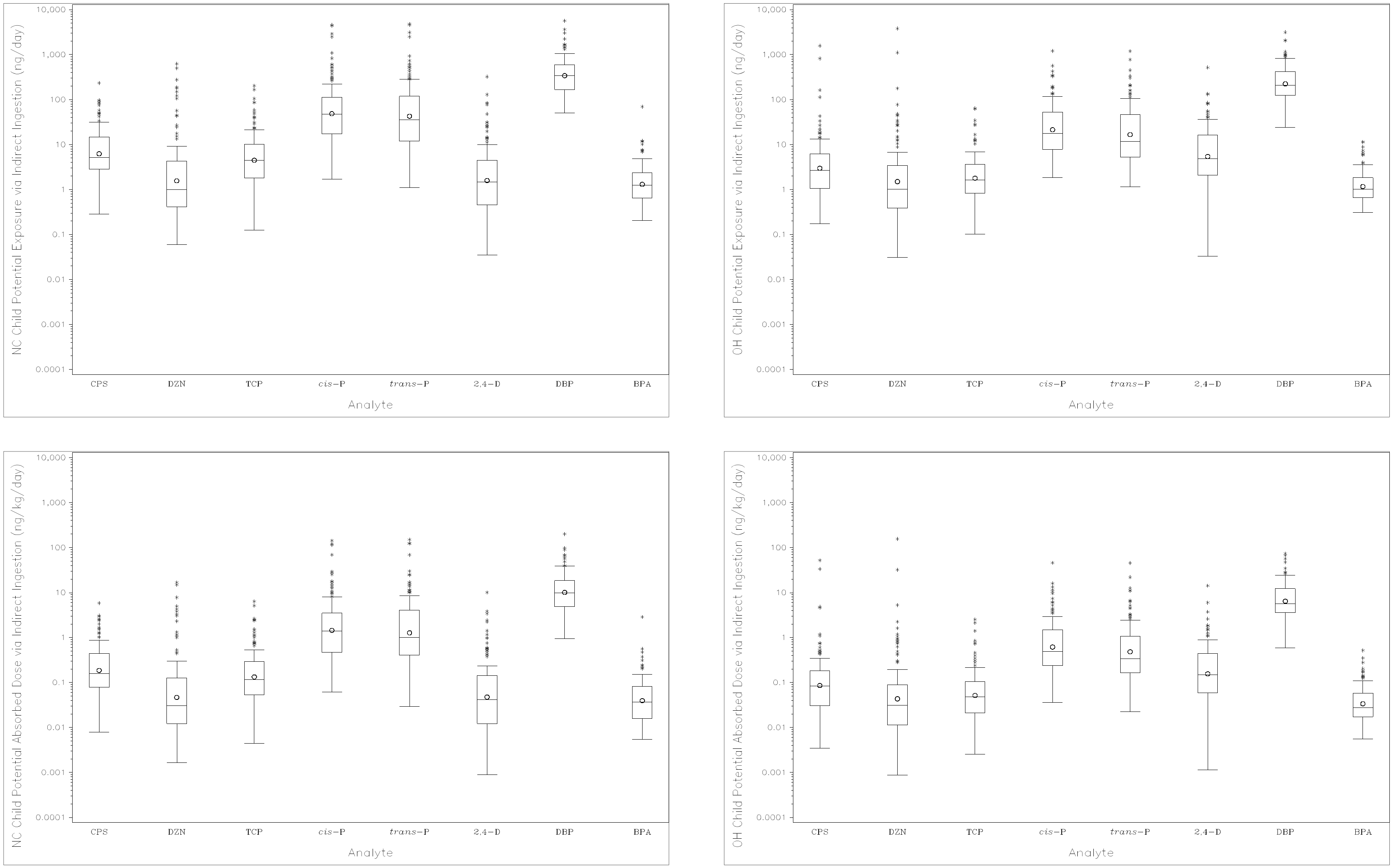

Figure 9.5.3 Boxplots of Estimated Potential Exposure and Potential Absorbed Dose via Indirect Ingestion for Participating NC and OH Children, for Eight Pollutants

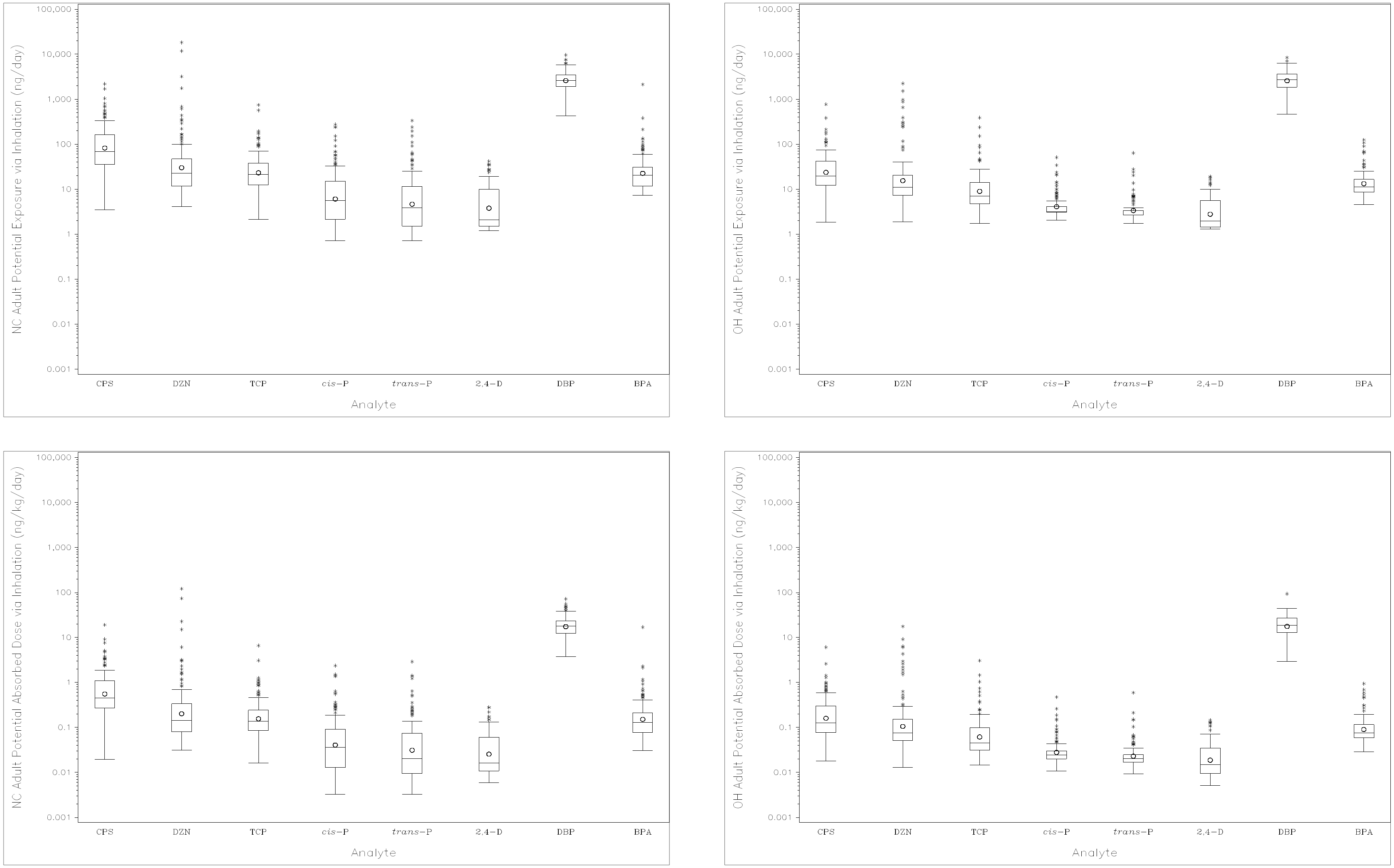

Figure 9.5.4 Boxplots of Estimated Potential Exposure and Potential Absorbed Dose via Inhalation for Participating NC and OH Adults, for Eight Pollutants

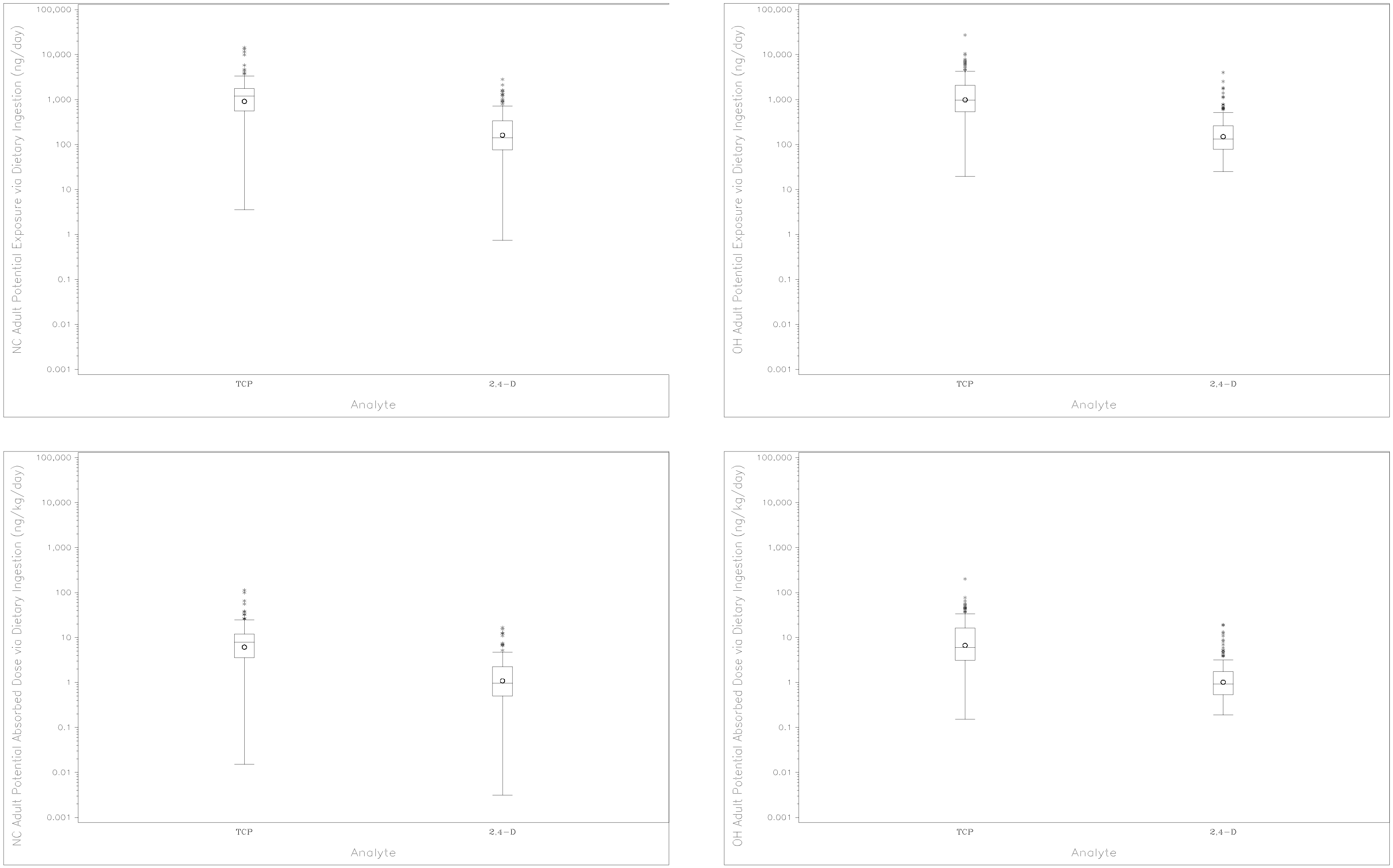

Figure 9.5.5 Boxplots of Estimated <u>Potential Exposure and Potential Absorbed Dose via Dietary Ingestion</u> for Participating NC and OH <u>Adults</u>, for Eight Pollutants Measured in Adult Food

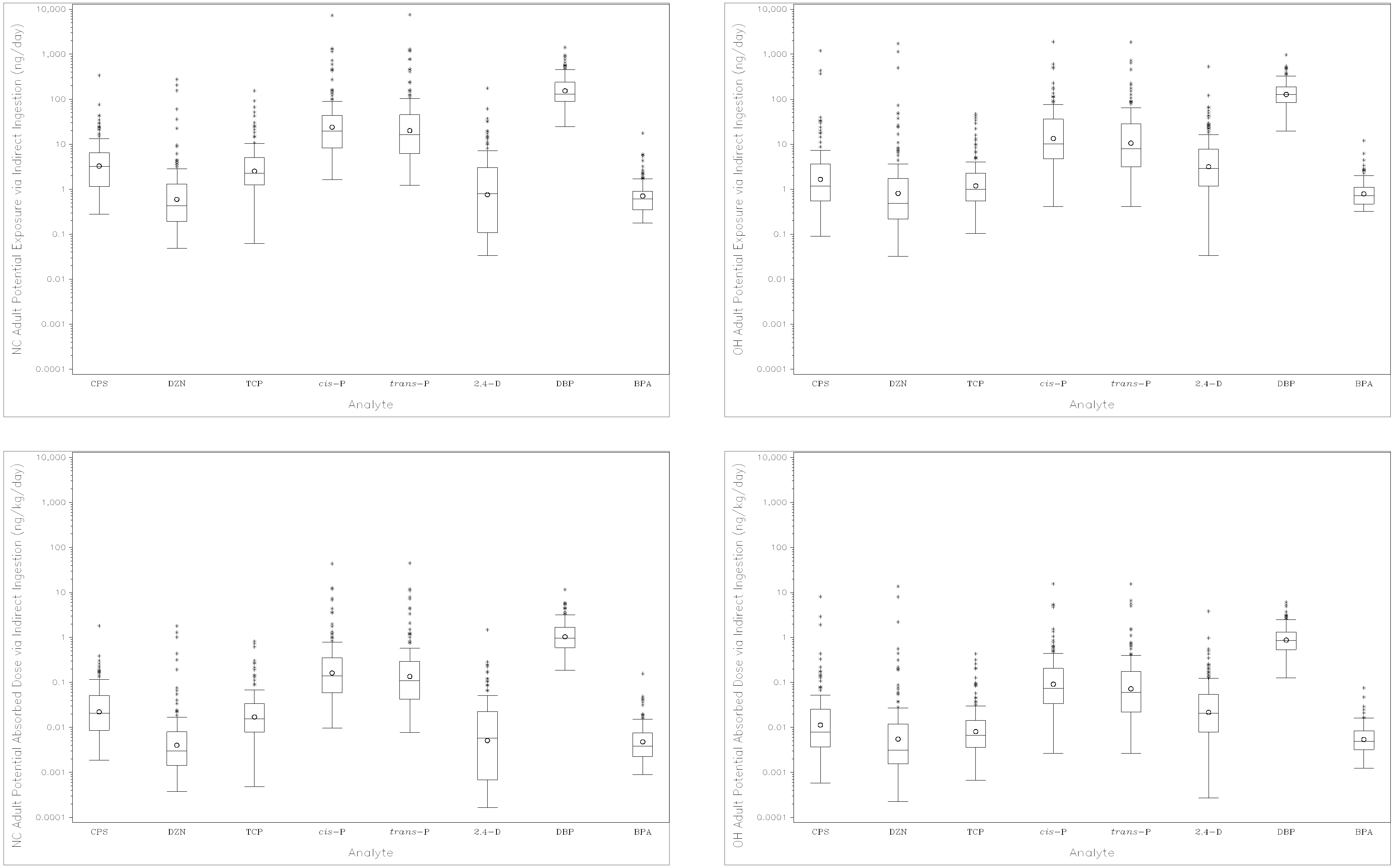

Figure 9.5.6 Boxplots of Estimated Potential Exposure and Potential Absorbed Dose via Indirect Ingestion for Participating NC and OH Adults, for Eight Pollutants

The shapes of the distributions of potential exposure and potential absorbed dose estimates that are portrayed in Figures 9.5.1 through 9.5.6 closely resemble those for the environmental and personal media that are given in Section 9.3.1. Di-*n*-butylphthalate estimates tend to be higher than estimates for the other pollutants, especially for inhalation. In addition, estimates tend to be higher across the board for NC than for OH under each exposure route.

9.5.2 Sub-goal 3.2: To Quantify the Distribution of Potential Exposure and Potential Dose Aggregated over All Exposure Routes

As discussed in Section 8.4, aggregate potential exposure and aggregate potential absorbed dose associated with a study participant were defined as the sums of the potential exposure and potential absorbed dose estimates, respectively, across all three exposure routes considered in this study (inhalation, dietary ingestion, and indirect ingestion). These aggregate estimates were calculated only for the eight target pollutants mentioned at the end of Section 9.2, for which potential exposure and potential absorbed dose estimates were calculated for each of the three exposure routes for each study participant.

Descriptive statistics of the potential aggregate exposure level and potential aggregate absorbed dose estimates are presented in Appendix L for NC children, Appendix M for OH children, Appendix N for NC adults, and Appendix O for OH adults. They are presented only in those tables that are associated with the eight target pollutants. (Note that these tables also contain route-specific data summaries.) Within these tables and in Table 9.5.5 and Table 9.5.6 for NC and OH, respectively, these descriptive statistics are presented across all study participants, separately for children and adults. In addition, within the appendix tables, descriptive statistics are presented for each stratum: urban, rural, low-income, middle/high-income, stay-at-home children (or adults with stay-at-home children), and day care children (or adults with day care children).

Boxplots of potential aggregate exposure level and potential aggregate absorbed dose estimates are given in Figure 9.5.7 for participating children and in Figure 9.5.8 for their adult caregivers. Each figure contains separate boxplots for potential aggregate exposure level and potential aggregate absorbed dose, for each pollutant for which data were available to make these estimates, and for each state. The boxplots show that aggregate potential exposure and dose estimates in the participating children were highest for di-*n*-butylphthalate and bisphenol-A, and to a lesser extent, 3,5,6-TCP. See Section 9.3.1 for how to interpret these boxplots.

9.5.3 Sub-goal 3.3: To Quantify the Distribution of Urinary Biomarkers Concentrations as an Indicator of Absorbed Dose

Concentrations of selected acid pollutants and metabolites in urine collected over the 48-h sampling period were used as biomarkers of exposure in study participants. These concentrations were summarized and analyzed 1) after adjusting for the urine sample's specific gravity, 2) after adjusting for the urine sample's creatinine level, and 3) without any adjustment.

Table 9.5.5 Summary of Aggregate Potential Exposure and Aggregate Potential Absorbed Dose Estimates for Eight Pollutants in NC Study Participants[a]

Pollutant/ Metabolite	Type of Measure	N	% Detected	Arith. Mean	S.D.	Geom. Mean	Percentiles				Max.
							25th	50th	75tt	95th	
OP Pesticides and Metabolite											
Chlorpyrifos	Children -- Aggregate Exposure[a]	109	100	359	801	174	78.9	152	295	1,180	7,630
	Children -- Aggregate Dose[b]	109	100	10.6	23.8	5.18	2.49	4.59	8.84	31.7	227
	Adults -- Aggregate Exposure	--[c]	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
Diazinon	Children -- Aggregate Exposure	109	100	354	1,720	68.1	30.4	51.6	110	544	15,100
	Children -- Aggregate Dose	109	100	10.2	49.4	2.02	0.965	1.44	2.60	15.8	428
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
3,5,6-TCP	Children -- Aggregate Exposure	113	100	1,480	1,010	1,110	804	1,230	1,960	3,780	5,600
	Children -- Aggregate Dose	113	100	43.8	30.9	33.3	22.6	37.7	57.8	100	199
	Adults -- Aggregate Exposure	117	100	1,660	2,130	1,010	596	1,310	1,770	4,390	14,400
	Adults -- Aggregate Dose	117	100	11.6	15.5	6.81	3.95	8.37	12.6	33.1	113
Pyrethroid Pesticides											
cis-Permethrin	Children -- Aggregate Exposure	109	100	3,290	15,000	306	88.9	246	656	6,840	93,300
	Children -- Aggregate Dose	109	100	92.5	412	9.08	2.71	6.72	21.5	243	2,850
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
trans-Permethrin	Children -- Aggregate Exposure	106	100	1,870	8,720	252	77.9	193	555	4,870	65,300
	Children -- Aggregate Dose	106	100	52.4	235	7.52	2.37	5.82	19.5	154	2,000
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
Acid Herbicides											
2,4-D	Children -- Aggregate Exposure	105	96	279	302	188	96.4	193	343	836	2,250
	Children -- Aggregate Dose	105	96	8.33	9.35	5.56	2.95	4.93	9.75	22.5	70.8
	Adults -- Aggregate Exposure	110	96	318	441	183	92.9	164	338	1,310	2,840
	Adults -- Aggregate Dose	110	96	2.11	2.90	1.24	0.557	1.12	2.28	6.86	16.8
Phthalates											
Di-*n*-butylphthalate	Children -- Aggregate Exposure	78	100	72,900	76,600	47,100	21,600	42,900	94,800	270,000	365,000
	Children -- Aggregate Dose	78	100	2,100	2,190	1,360	652	1,250	2,910	7,800	11,400
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
Phenols											
Bisphenol-A	Children -- Aggregate Exposure	102	100	4,190	6,190	2,500	1,500	2,560	5,240	11,300	57,200
	Children -- Aggregate Dose	102	100	125	175	75.6	42.4	71.4	153	342	1,570
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--

[a] Aggregate potential exposure level (ng/day)
[b] Aggregate potential absorbed dose (ng/kg/day)
[c] Dashes indicate that insufficient data prevented aggregate potential exposure or aggregate potential absorbed dose from being estimated. An estimate is labeled "detected" if at least one of the sample media levels entering into its calculation is labeled "detected."

Table 9.5.6 Summary of Aggregate Potential Exposure and Aggregate Potential Absorbed Dose Estimates for Eight Pollutants in OH Study Participants[a]

Pollutant/ Metabolite	Type of Measure	N	% Detected	Arith. Mean	S.D.	Geom. Mean	Percentiles				Max.
							25^{th}	50^{th}	75^{tt}	95^{th}	
OP Pesticides and Metabolite											
Chlorpyrifos	Children -- Aggregate Exposure [a]	96	100	178	234	117	77.7	109	172	491	1,520
	Children -- Aggregate Dose [c]	96	100	5.39	8.25	3.37	2.04	3.10	5.11	17.1	61.8
	Adults -- Aggregate Exposure	-- [c]	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
Diazinon	Children -- Aggregate Exposure	112	100	142	534	54.1	29.9	38.6	67.0	378	5,430
	Children -- Aggregate Dose	112	100	4.62	21.3	1.56	0.872	1.13	1.89	11.0	221
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
3,5,6-TCP	Children -- Aggregate Exposure	103	100	1,180	1,110	852	488	930	1,500	2,610	8,700
	Children -- Aggregate Dose	103	100	34.1	32.9	24.4	15.2	25.4	42.3	80.3	228
	Adults -- Aggregate Exposure	108	100	2,010	3,210	1,050	554	1,000	2,170	7,080	27,300
	Adults -- Aggregate Dose	108	100	14.5	23.4	7.22	3.27	6.39	16.5	47.1	200
Pyrethroid Pesticides											
cis-Permethrin	Children -- Aggregate Exposure	111	100	665	1,960	118	38.8	90.1	167	4,790	9,430
	Children -- Aggregate Dose	111	100	18.3	54.1	3.40	1.29	2.22	4.71	151	315
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
trans-Permethrin	Children -- Aggregate Exposure	97	100	280	784	87.5	36.6	72.0	146	1,960	5,790
	Children -- Aggregate Dose	97	100	8.39	25.1	2.52	1.07	1.78	4.00	53.1	199
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
Acid Herbicides											
2,4-D	Children -- Aggregate Exposure	95	99	350	736	175	81.0	141	245	2,070	6,090
	Children -- Aggregate Dose	95	99	10.1	23.5	5.05	2.35	4.13	7.48	39.1	210
	Adults -- Aggregate Exposure	106	99	278	393	166	92.5	147	269	1,140	2,540
	Adults -- Aggregate Dose	106	99	1.97	2.96	1.12	0.589	0.978	1.83	8.37	19.3
Phthalates											
Di-*n*-butylphthalate	Children -- Aggregate Exposure	43	100	19,500	27,600	12,200	7,330	8,310	16,900	81,000	152,000
	Children -- Aggregate Dose	43	100	539	703	353	205	262	467	2,080	3,570
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--
Phenols											
Bisphenol-A	Children -- Aggregate Exposure	67	100	3,620	6,310	2,150	1,270	1,880	3,540	12,800	48,600
	Children -- Aggregate Dose	67	100	101	130	63.8	34.1	60.8	93.9	328	775
	Adults -- Aggregate Exposure	--	--	--	--	--	--	--	--	--	--
	Adults -- Aggregate Dose	--	--	--	--	--	--	--	--	--	--

[a] Aggregate potential exposure level (ng/day)
[b] Aggregate potential absorbed dose (ng/kg/day)
[c] Dashes indicate that insufficient data prevented aggregate potential exposure or aggregate potential absorbed dose from being estimated. An estimate is labeled “detected” if at least one of the sample media levels entering into its calculation is labeled “detected.”

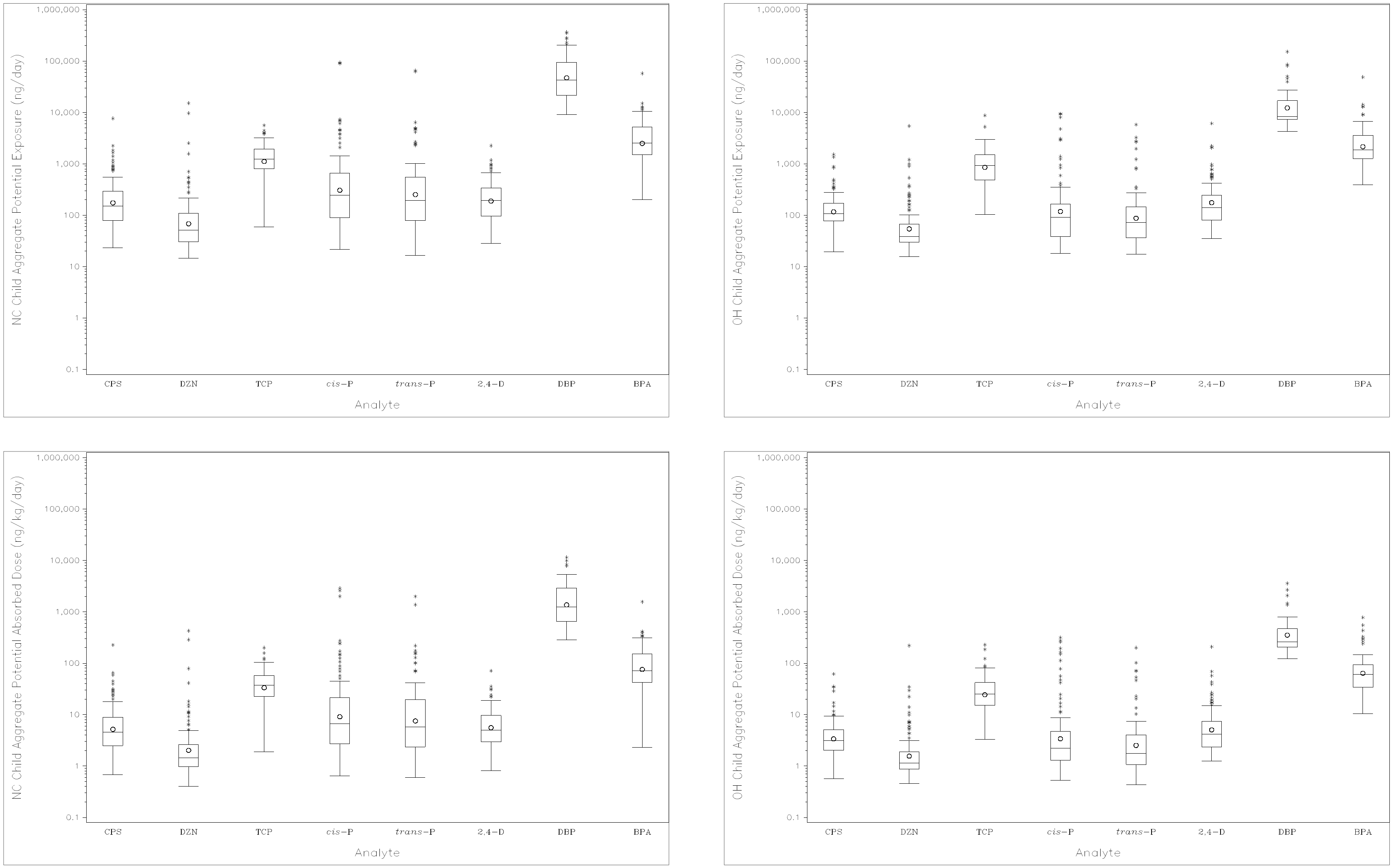

Figure 9.5.7 Boxplots of Estimated Aggregate Potential Exposure and Aggregate Potential Absorbed Dose for Participating NC and OH Children, for Eight Pollutants

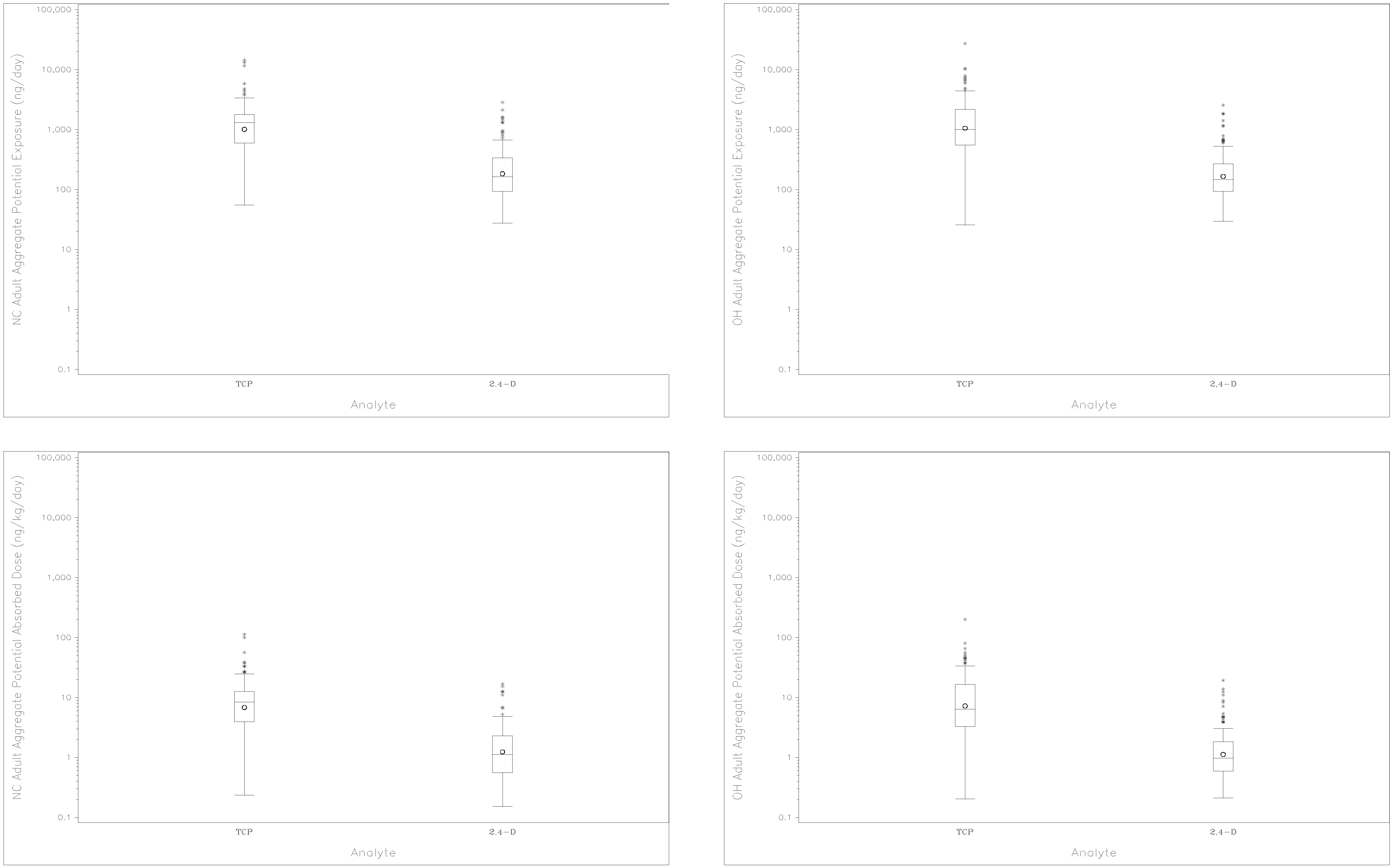

Figure 9.5.8 Boxplots of Estimated <u>Aggregate Potential Exposure and Aggregate Potential Absorbed Dose</u> for Participating NC and OH <u>Adults</u>, for Eight Pollutants

When multiple urine samples were taken for a given study participant during the study, the geometric mean concentration was used in the summaries and analyses.

Descriptive statistics of the urine biomarker concentrations are presented in Appendix P for NC and Appendix Q for OH. Each appendix contains separate sets of tables for children and adults, and within each set, each pollutant and metabolite is represented by two tables for ease in display. The descriptive statistics are presented across all study participants, as well as separately for each stratum: urban, rural, low-income, middle/high-income, stay-at-home children (or adults with stay-at-home children), and day care children (or adults with day care children).

For both states, 3,5,6-TCP and 2,4-D were measured in urine samples of study participants and were considered in estimating aggregate potential exposure level and aggregate potential absorbed dose estimates for study participants. For these two target pollutants, along with pentachlorophenol, the descriptive statistics associated with unadjusted urine concentrations are also presented in Table 9.5.7 and Table 9.5.8 for NC children and OH children, respectively.

Boxplots of the unadjusted urine concentrations for 3,5,6-TCP and 2,4-D are presented in Figure 9.5.9, with separate boxplots for children and adults, as well as by state. These boxplots show that, in general, levels of 3,5,6-TCP covered a higher range than for 2,4-D, and for both, similar distributions were observed between children and adults and between NC and OH. While the boxplots in Figure 9.5.9 resemble those for aggregate potential exposure and absorbed dose that are given in Figure 9.5.8, the urine concentrations have less of a difference between the two states in the range covered by the distributions. See Section 9.3.1 for how to interpret the boxplots.

9.5.4 Sub-goal 3.4: To Determine on Average How These Exposure and Dose Metrics for Each Route and Aggregated over Routes Differ Between Children in Urban and Rural Settings, Children in Low- and Middle/High-Income Families, Day Care and Stay-at-Home Children, Children and Adults in the Same Household Overall, and Children and Adults by Stratum

To address this sub-goal, a statistical analysis was performed on the (log-transformed) potential exposure level and potential absorbed dose estimates (by exposure route and aggregated across routes[1]) and on urine biomarker concentrations to determine whether these measures differ significantly 1) between children in urban and rural settings, 2) between children in low- and middle/high-income families, and 3) between day care and stay-at-home children. In each case, an analysis of variance using model (8-7) in Section 8.5.2.2 was performed to calculate a least squares mean of the log-transformed measures for each stratum (i.e., urban, rural, low-income, middle/high-income, stay-at-home child, day care child). Then, in the manner described in

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[1] Analysis of aggregated exposures and absorbed dose estimates was performed only for the eight pollutants mentioned at the end of Section 9.2.

Table 9.5.7 Summary of Unadjusted Urinary Biomarker Concentrations (ng/mL) for Three Pollutants and Metabolites Measured in the Urine of Participating NC Children[a]

Strata	N	% Detected	Arith. Mean	Standard Deviation	Geom. Mean	25th Percentile	50th Percentile	75th Percentile	95th Percentile	Maximum
3,5,6-TCP										
Overall	128	98	7.28	10.3	5.22	3.70	5.26	8.18	15.5	104
Urban	107	98	7.28	10.9	5.18	3.68	5.22	8.28	13.3	104
Rural	21	100	7.28	6.93	5.46	3.95	5.29	6.51	19.9	30.9
Low-Income	59	98	6.55	7.36	4.90	3.40	5.08	5.86	19.9	49.1
Mid/High-Income	65	99	8.02	12.7	5.48	3.81	5.22	10.1	14.7	104
Home Children	65	97	8.12	13.7	5.15	3.68	5.16	8.27	15.5	104
Day Care Children	63	100	6.42	4.76	5.31	3.74	5.29	7.82	12.0	30.9
2,4-D										
Overall	128	94	0.775	0.561	0.594	0.343	0.652	1.09	1.97	2.64
Urban	107	94	0.812	0.575	0.624	0.349	0.690	1.10	2.11	2.64
Rural	21	95	0.583	0.453	0.465	0.280	0.430	0.656	1.40	1.97
Low-Income	59	97	0.836	0.558	0.665	0.405	0.736	1.10	1.97	2.64
Mid/High-Income	65	91	0.707	0.573	0.522	0.276	0.510	0.945	2.11	2.61
Home Children	65	88	0.715	0.556	0.519	0.245	0.510	1.07	1.93	2.41
Day Care Children	63	100	0.836	0.565	0.684	0.412	0.707	1.10	2.17	2.64
Pentachlorophenol										
Overall	128	89	0.605	0.629	0.433	0.262	0.394	0.654	1.92	3.45
Urban	107	89	0.639	0.672	0.447	0.258	0.400	0.694	2.43	3.45
Rural	21	91	0.433	0.280	0.369	0.290	0.328	0.500	0.901	1.33
Low-Income	59	95	0.659	0.625	0.498	0.296	0.460	0.773	1.92	3.45
Mid/High-Income	65	85	0.571	0.649	0.388	0.220	0.335	0.564	2.43	3.08
Home Children	65	80	0.641	0.734	0.419	0.246	0.370	0.658	2.70	3.45
Day Care Children	63	98	0.567	0.500	0.448	0.281	0.402	0.646	1.38	2.84

[a] For a given study subject, multiple sample results have been log-transformed (after replacing not detected results by the MDL divided by the square root of 2), averaged, and exponentiated back to regular units prior to summarizing the data within a stratum. This result is labeled as "detected" if any measurement entering into the calculation was detected. Thus, N specifies the number of participants having data entering into the summaries.

Table 9.5.8 Summary of Unadjusted Urinary Biomarker Concentrations (ng/mL) for Three Pollutants and Metabolites Measured in the Urine of Participating OH Children[a]

Strata	N	% Detected	Arith. Mean	Standard Deviation	Geom. Mean	25th Percentile	50th Percentile	75th Percentile	95th Percentile	Maximum
3,5,6-TCP										
Overall	122	100	5.61	3.38	4.64	2.87	5.07	7.33	12.3	15.3
Urban	107	100	5.68	3.43	4.71	2.90	4.79	7.50	12.8	15.3
Rural	15	100	5.08	3.07	4.21	2.08	5.28	6.12	12.3	12.3
Low-Income	40	100	5.68	3.11	4.89	3.38	5.15	7.42	12.0	14.1
Mid/High-Income	70	100	5.69	3.59	4.60	2.73	5.12	7.78	13.3	15.3
Home Children	67	100	6.05	3.73	4.90	3.01	5.28	9.08	12.9	15.3
Day Care Children	55	100	5.06	2.84	4.34	2.68	4.43	6.88	11.2	12.8
2,4-D										
Overall	126	98	1.32	1.59	0.927	0.566	1.02	1.35	3.59	12.5
Urban	109	98	1.32	1.68	0.902	0.560	0.994	1.34	3.59	12.5
Rural	17	100	1.30	0.904	1.11	0.857	1.15	1.36	4.35	4.35
Low-Income	40	100	1.36	1.14	1.03	0.589	1.12	1.60	3.97	5.63
Mid/High-Income	73	97	1.37	1.90	0.908	0.550	1.02	1.33	7.04	12.5
Home Children	69	97	1.50	1.84	1.03	0.710	1.16	1.44	4.35	12.5
Day Care Children	57	100	1.10	1.21	0.816	0.525	0.809	1.17	3.21	7.55
Pentachlorophenol										
Overall	126	99	1.27	2.20	0.876	0.536	0.835	1.39	2.71	23.8
Urban	109	99	1.23	2.32	0.830	0.520	0.755	1.38	2.47	23.8
Rural	17	100	1.52	1.19	1.25	0.871	1.24	1.52	5.23	5.23
Low-Income	40	100	1.05	0.884	0.797	0.486	0.769	1.59	2.33	5.02
Mid/High-Income	73	99	1.47	2.80	0.959	0.640	0.876	1.39	3.56	23.8
Home Children	69	99	1.54	2.89	0.993	0.640	0.920	1.39	3.96	23.8
Day Care Children	57	100	0.946	0.638	0.753	0.483	0.738	1.36	2.37	2.71

[a] For a given study subject, multiple sample results have been log-transformed (after replacing not detected results by the MDL divided by the square root of 2), averaged, and exponentiated back to regular units prior to summarizing the data within a stratum. This result is labeled as "detected" if any measurement entering into the calculation was detected. Thus, N specifies the number of participants having data entering into the summaries.

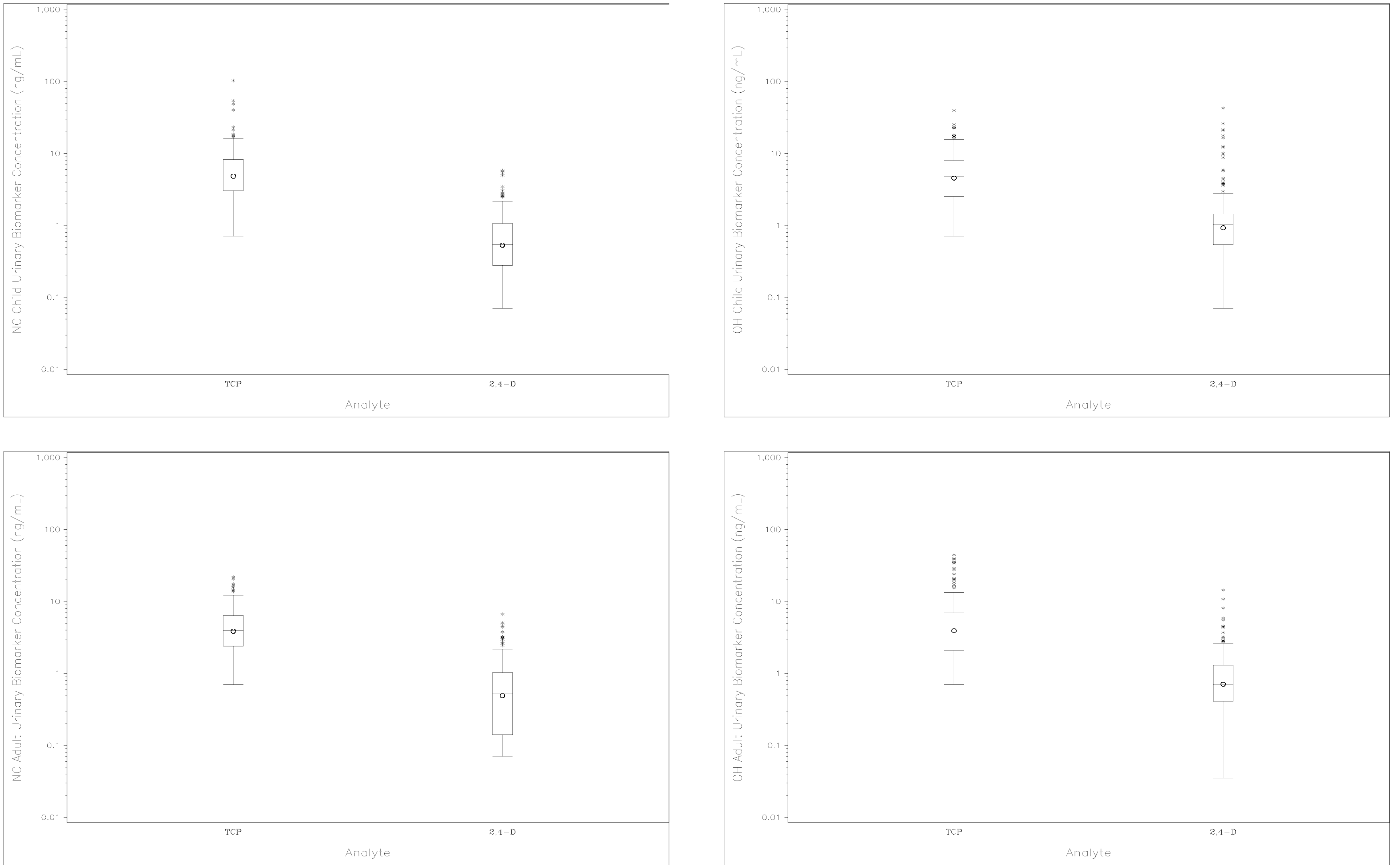

Figure 9.5.9 Boxplots of <u>Urinary Biomarker Concentrations</u> for Participating NC and OH Children and Adults, for Eight Pollutants

Section 9.3.2, a ratio of least-squares geometric mean concentrations was calculated between the above pairs of strata, along with an approximate 95% confidence interval on this ratio.

For children's potential exposure level and potential absorbed dose estimates, ratios and confidence intervals are presented by pollutant and exposure route in Appendix R (Table R-1 for NC and Table R-2 for OH). These ratios are of the least-squares geometric mean for the first stratum specified in the column heading versus the second specified stratum, and 95% confidence intervals are shown in parentheses. The t-test applied to the log-transformed data also is a test of whether this ratio differs significantly from one; p-values associated with these tests are also given in Appendix R, within the second, third, and fourth columns in Table R-3 (for NC) and Table R-4 (for OH).

Table 9.5.9 has condensed the information presented in Tables R-1 and R-2 of Appendix R by presenting only those ratios which were significantly different from one at the 0.05 level. Thus, Table 9.5.9 contains one row for each combination of pollutant, parameter, and exposure route having at least one of the three ratios significantly different from one at the 0.05 level in either state. When a ratio is not specified in this table and a dash does not appear in its place (meaning that the criteria placed on the percentage of detected concentrations entering into calculation of the exposure/dose estimate were met for performing statistical analysis), then the ratio was not significantly different from one at the 0.05 level.

To illustrate how to interpret the numbers in Table 9.5.9 and Tables R-1 and R-2, analysis of 3,5,6-TCP data from OH suggest that potential exposure level via inhalation is about 70% higher in low-income children than in middle/high-income children (ratio=1.70), and potential exposure level via indirect ingestion is about 81% higher in day care children than in stay-at-home children (ratio=1.81). Both are significantly different from one at the 0.05 level but not at the 0.01 level.

For the urinary biomarker concentrations, ratios between the specified strata and 95% confidence intervals on these ratios are presented by pollutant in Appendix R (Table R-5 for NC and Table R-6 for OH). For a given state, these concentrations were statistically analyzed, and ratios were reported, only for those pollutants in which at least 50% of urine samples had detected concentrations. P-values associated with t-tests applied to the log-transformed urinary biomarker concentrations to test whether these ratios differ significantly from one are also given in Appendix R, within the second, third, and fourth columns in Table R-7 (for NC) and Table R-8 (for OH). Among all ratios reported in Table R-5 and R-6 of Appendix R, significant differences from one were reported only for 2,4-D in OH, where the geometric mean for OH stay-at-home children was about 65% of the geometric mean for OH day care children under each form of the urinary concentration (i.e., unadjusted, creatinine-adjusted, specific gravity-adjusted).

Table 9.5.9 Estimated Ratios Between Selected Strata of Geometric Mean Potential Exposure and Potential Absorbed Dose Estimates in Participating NC and OH Children, When These Ratios Were Significantly Different from One at the 0.05 Level[a]

Pollutant/ Metabolite	Exposure/Dose Parameter and Pathway	Estimated Ratio of Geometric Means (When Significantly Different from 1 at the 0.05 Level)					
		North Carolina			Ohio		
		Urban vs. Rural	Low- vs. Mid/High-Income	Day Care vs. Home	Urban vs. Rural	Low- vs. Mid/High-Income	Day Care vs. Home
OP Pesticides and Metabolites							
Chlorpyrifos	Exposure/Dietary Ingestion[b]					2.00**	
	Exposure/Indirect Ingestion[c]						2.52**
	Dose/Dietary Ingestion[d]					2.06**	
	Dose/Indirect Ingestion[e]						2.33*
	Aggregated Exposure[f]					1.64*	
	Aggregated Dose[g]					1.66*	
Diazinon	Exposure/Inhalation[h]		2.24*				2.02*
	Exposure/Dietary Ingestion						1.37**
	Exposure/Indirect Ingestion						3.45**
	Dose/Inhalation[i]		2.14*				1.88*
	Dose/Dietary Ingestion						1.28*
	Dose/Indirect Ingestion						3.22*
	Aggregated Exposure						1.66*
	Aggregated Dose						1.52*
3,5,6-TCP	Exposure/Inhalation					1.70*	
	Exposure/Dietary Ingestion		0.65*	1.82*			
	Exposure/Indirect Ingestion						1.81*
	Dose/Inhalation					1.73*	
	Dose/Dietary Ingestion		0.60**				
	Aggregated Exposure		0.61*	1.76*			
	Aggregated Dose		0.56**				
Pyrethroid Pesticides							
Cyfluthrin	Exposure/Indirect Ingestion				2.47*		
	Dose/Indirect Ingestion				2.44*		
cis-Permethrin	Exposure/Inhalation		2.38**				
	Exposure/Dietary Ingestion						3.14**
	Exposure/Indirect Ingestion						1.95*
	Dose/Inhalation		2.26**				
	Dose/Dietary Ingestion						2.92**
	Aggregated Exposure						2.34*
	Aggregated Dose						2.16*

Table 9.5.9 Estimated Ratios Between Selected Strata of Geometric Mean Potential Exposure and Potential Absorbed Dose Estimates in Participating NC and OH Children, When These Ratios Were Significantly Different from One at the 0.05 Level[a] (cont.)

Pollutant/ Metabolite	Exposure/Dose Parameter and Pathway	Estimated Ratio of Geometric Means (When Significantly Different from 1 at the 0.05 Level)					
		North Carolina			Ohio		
		Urban vs. Rural	Low- vs. Mid/High-Income	Day Care vs. Home	Urban vs. Rural	Low- vs. Mid/High-Income	Day Care vs. Home
trans-Permethrin	Exposure/Inhalation		2.45**				
	Exposure/Dietary Ingestion						2.92**
	Dose/Inhalation		2.31**				
	Dose/Dietary Ingestion						2.72*
Acid Herbicides							
2,4-D	Exposure/Inhalation			2.23**			
	Exposure/Dietary Ingestion			1.59*			
	Exposure/Indirect Ingestion	3.39**	0.27**	0.54*	2.80*	0.29**	
	Dose/Inhalation			1.94*			
	Dose/Indirect Ingestion	3.68**	0.25**	0.47*	2.84*	0.29**	
PAHs							
Benz[*a*]anthracene	Exposure/Indirect Ingestion				3.69**	0.43**	3.29**
	Dose/Indirect Ingestion				3.65**	0.43**	3.08**
Benzo[*b*]fluoranthene	Exposure/Inhalation		1.58*				
	Exposure/Indirect Ingestion			1.81*	3.55**	0.43**	3.15**
	Dose/Inhalation		1.52*				
	Dose/Indirect Ingestion				3.52**	0.43**	2.94**
Benzo[*k*]fluoranthene	Exposure/Inhalation		1.25*				
	Exposure/Indirect Ingestion				3.18**	0.43**	3.16**
	Dose/Indirect Ingestion				3.16**	0.43**	2.95**
Benzo[*ghi*]perylene	Exposure/Indirect Ingestion				3.18**	0.43**	3.12**
	Dose/Indirect Ingestion				3.16**	0.43**	2.92**
Benzo[*a*]pyrene	Exposure/Inhalation		1.57**				
	Exposure/Indirect Ingestion				3.35**	0.41**	3.09**
	Dose/Inhalation		1.51*				
	Dose/Indirect Ingestion				3.32**	0.41**	2.89**
Benzo[*e*]pyrene	Exposure/Inhalation		1.36*				
	Exposure/Indirect Ingestion				3.23**	0.43**	3.04**
	Dose/Inhalation		1.31*				
	Dose/Indirect Ingestion				3.21**	0.44**	2.84**

Table 9.5.9 Estimated Ratios Between Selected Strata of Geometric Mean Potential Exposure and Potential Absorbed Dose Estimates in Participating NC and OH Children, When These Ratios Were Significantly Different from One at the 0.05 Level[a] (cont.)

Pollutant/ Metabolite	Exposure/Dose Parameter and Pathway	Estimated Ratio of Geometric Means (When Significantly Different from 1 at the 0.05 Level)					
		North Carolina			Ohio		
		Urban vs. Rural	Low- vs. Mid/High-Income	Day Care vs. Home	Urban vs. Rural	Low- vs. Mid/High-Income	Day Care vs. Home
Chrysene	Exposure/Inhalation		1.57**				
	Exposure/Indirect Ingestion				3.51**	0.42**	3.24**
	Dose/Inhalation		1.52*				
	Dose/Indirect Ingestion				3.47**	0.42**	3.03**
Dibenz[*a*,*h*] anthracene	Exposure/Indirect Ingestion				3.50**	0.44**	3.19**
	Dose/Indirect Ingestion				3.47**	0.44**	2.98**
Indeno[1,2,3-*cd*] pyrene	Exposure/Inhalation		1.48*				
	Exposure/Indirect Ingestion				3.34**	0.43**	3.20**
	Dose/Inhalation		1.43*				
	Dose/Indirect Ingestion				3.31**	0.43**	3.00**
Phthalates							
Benzylbutylphthalate	Exposure/Dietary Ingestion	--	--	--			2.83**
	Exposure/Indirect Ingestion						2.73**
	Dose/Dietary Ingestion	--	--	--			2.44*
	Dose/Indirect Ingestion						2.54**
Di-*n*-butylphthalate	Exposure/Inhalation			1.77**	0.65*		1.44*
	Exposure/Dietary Ingestion						2.17**
	Exposure/Indirect Ingestion						2.02**
	Dose/Inhalation			1.54**	0.63*		1.34*
	Dose/Dietary Ingestion		0.58*				1.87*
	Dose/Indirect Ingestion						1.88**
	Aggregated Exposure						2.07**
	Aggregated Dose						1.76*
Phenols							
Bisphenol-A	Exposure/Inhalation					1.38*	
	Exposure/Dietary Ingestion			2.47**			
	Dose/Dietary Ingestion			2.19**			
	Aggregated Exposure			2.12**			
	Aggregated Dose			1.85**			

Table 9.5.9 Estimated Ratios Between Selected Strata of Geometric Mean Potential Exposure and Potential Absorbed Dose Estimates in Participating NC and OH Children, When These Ratios Were Significantly Different from One at the 0.05 Level[a] (cont.)

Pollutant/ Metabolite	Exposure/Dose Parameter and Pathway	Estimated Ratio of Geometric Means (When Significantly Different from 1 at the 0.05 Level)					
		North Carolina			Ohio		
		Urban vs. Rural	Low- vs. Mid/High-Income	Day Care vs. Home	Urban vs. Rural	Low- vs. Mid/High-Income	Day Care vs. Home
PCBs							
PCB101	Exposure/Inhalation						1.73*

[a] Dashed cells indicate that no analysis was performed on the exposure/dose estimates for the given exposure route due to the sample media entering into their calculation not achieving requirements on the percentage of detected measures. Blank cells indicate that a ratio was estimated but was not significantly different from one at the 0.05 level. Note that pollutants, or exposure routes for a given pollutant, have been excluded from this table if all cells within the rows corresponding to these pollutants or exposure routes would have been blank or dashed within this table. All estimated ratios for each exposure route and each pollutant, along with corresponding 95% confidence intervals on these ratios, are presented in Table R-1 (NC) and Table R-2 (OH) of Appendix R.
[b] Potential exposure level via dietary ingestion
[c] Potential exposure level via indirect ingestion
[d] Potential absorbed dose via dietary ingestion
[e] Potential absorbed dose via indirect ingestion
[f] Aggregated potential exposure level
[g] Aggregated potential absorbed dose
[h] Potential exposure level via inhalation
[i] Potential absorbed dose via inhalation

* Statistically significantly different from 1 at the 0.05 level, but not at the 0.01 level.
** Statistically significantly different from 1 at the 0.01 level.

9.5.4.1 Results of Analyses on NC Exposure/Dose Estimates and Urinary Biomarker Concentrations

Between urban and rural NC children, potential exposure level and potential absorbed dose differed significantly at the 0.01 level in only one instance: for 2,4-D via indirect ingestion. On average, urban NC children had estimated potential exposure/dose estimates for 2,4-D via indirect ingestion that exceeded three times that of rural NC children.

Significant differences between low-income and middle/high-income strata in estimated potential exposure and/or absorbed dose via inhalation for NC children were observed at the 0.01 level for *cis*- and *trans*-permethrin and chrysene, and at the 0.05 level for five other PAHs (benzo[*b*]fluoranthene, benzo[*k*]fluoranthene, benzo[*a*]pyrene, benzo[*e*]pyrene, and indeno[1,2,3-*cd*]pyrene) and diazinon. Via the inhalation route, low-income NC children tended to have 36% to 58% higher exposure levels and absorbed doses of the PAHs compared to middle/high-income children, and from 100% to 150% higher exposure levels and absorbed doses for diazinon, *cis*- and *trans*-permethrin. Via the indirect ingestion route, significant differences existed in potential exposures and absorbed dose at the 0.01 level for 2,4-D, where low-income NC children experienced only 25% of the potential exposure levels and absorbed doses compared to middle/high-income children. For 3,5,6-TCP, significant differences were observed at the 0.01 level for potential absorbed dose via the dietary ingestion route and for aggregate potential absorbed dose (and at the 0.05 level for potential exposure level via indirect ingestion and for aggregate potential exposure), where low-income NC children averaged about 60% of the potential exposures and absorbed doses compared to middle/high-income children.

Compared to stay-at-home children, NC children who attend day care centers were associated with 59% to 123% higher estimated potential exposure levels and absorbed doses to 2,4-D via the inhalation and dietary ingestion routes, but approximately 50% lower exposures/doses via the indirect ingestion route. These differences were statistically significant at the 0.05 level, with one (exposure via inhalation) significant at the 0.01 level. These two groups of children also differed significantly at the 0.01 level in estimated potential exposure levels and absorbed doses via dietary ingestion for bisphenol-A and via inhalation for di-*n*-butylphthalate. In each case, day care children tended to have from 54% to 147% higher estimated exposure or absorbed dose estimates compared to stay-at-home children. For bisphenol-A, the estimated aggregated potential exposure and absorbed dose for day care children was significantly different from (and approximately twice as high as) stay-at-home children at the 0.01 level.

Table R-5 of Appendix R shows that statistical analysis of urinary biomarker concentration was limited to 2,4-D, 3,5,6-TCP, and pentachlorophenol, as these were the only pollutants that were analyzed in urine (out of six) and detected in at least 50% of the samples for NC children. IMP measurements in NC urine samples were not statistically analyzed because the analytical method did not provide adequate quantitative recoveries. Urine concentrations for participating NC children did not differ significantly at the 0.05 level between the three pairs of strata (urban vs. rural, low-income vs. middle/high-income, day care vs. stay-at-home children) for these three pollutants, regardless of whether the concentrations were adjusted for specific gravity or creatinine levels.

9.5.4.2 Results of Analyses on OH Exposure/Dose Estimates and Urinary Biomarker Concentrations

Between urban and rural OH children, estimated potential exposure level and potential absorbed dose via the indirect ingestion route differed significantly at the 0.01 level for all nine target PAHs, where urban OH children had estimated potential exposure/dose estimates that were from three to four times as high, on average, than rural OH children, and at the 0.05 level for cyfluthrin and 2,4-D, where estimates for urban OH children were from two to three times as high as rural children. For di-*n*-butylphthalate via the inhalation route, estimated potential exposure/dose estimates for urban OH children differed significantly at the 0.05 level and were only about 65% of the estimates for rural OH children, on average. For those pollutants having aggregate exposure/dose calculated, no significant differences were observed at the 0.05 level between urban and rural OH children.

Significant differences between low-income and middle/high-income OH children in potential exposure and/or absorbed dose were observed at the 0.01 level for 2,4-D and all target PAHs via indirect ingestion and for chlorpyrifos via dietary ingestion. When significant differences occurred via indirect ingestion, low-income OH children tended to have exposures/doses that were 30% to 45% lower than middle/high-income OH children. In contrast, low-income OH children had chlorpyrifos exposures via dietary ingestion that were twice as high on average as for middle/high-income OH children. Exposures via inhalation to bisphenol-A and 3,5,6-TCP were 38% and 70% higher, respectively, for low-income children compared to middle/high-income children, but these were significant only at the 0.05 level. For those pollutants having aggregate exposure/dose calculated, significant differences in these aggregated estimates between low-income and middle/high-income OH children were observed only for chlorpyrifos and at the 0.05 level, with low-income children averaging about 65% higher estimates for both potential exposure and absorbed dose.

Significant differences in potential exposure and/or potential absorbed dose estimates between OH day care children and OH stay-at-home children were observed at the 0.01 level for chlorpyrifos, the nine target PAHs, benzylbutylphthalate, and *cis*-permethrin via indirect ingestion; for *cis*- and *trans*-permethrin via dietary ingestion; and for diazinon, benzylbutylphthalate, and di-*n*-butylphthalate via both exposure routes. In all of these instances, day care children averaged higher exposures and/or doses compared to stay-at-home children. The largest differences occurred with the PAHs and diazinon via indirect ingestion, where exposure/dose estimates averaged over three times higher for day care children than for stay-at-home children. Aggregate potential exposure level and/or aggregate potential absorbed dose differed significantly between day care and stay-at-home children at the 0.01 level for di-*n*-butylphthalate, and at the 0.05 level for diazinon and *cis*- and *trans*-permethrin, with the largest differences between the two groups occurring for the two permethrins (where day care children averaged more than double the exposure levels and/or doses compared to stay-at-home children when they differed significantly).

Table R-6 of Appendix R shows that statistical analysis of urinary biomarker concentration was performed for five pollutants (2,4-D, 3,5,6-TCP, 1-hydroxypyrene, pentachlorophenol, 3-PBA) that were analyzed in urine for OH and were detected in at least 50% of the samples for OH children. Urine concentrations differed significantly at the 0.05 level between day care and stay-at-home OH children only for 2,4-D, with this result holding for unadjusted and adjusted urine concentrations. Here, day care children tended to have 2,4-D concentrations in urine samples that were only about 65% of the concentrations for stay-at-home children. No other significant differences between strata were observed for any other pollutant, regardless of whether the concentrations were adjusted for specific gravity or creatinine levels.

9.5.4.3 Comparing Potential Exposure, Potential Absorbed Dose, and Urine Concentrations Between Children and Adults in the Same Household

For potential exposure level and potential absorbed dose, Table R-9 of Appendix R presents estimated ratios of geometric means for NC children versus adults in the same household for a given exposure route, along with 95% confidence intervals on this ratio. Table R-10 presents the same results for the urinary biomarker concentrations for NC. The corresponding tables for the OH portion of the study are Table R-11 (potential exposure level and potential absorbed dose) and Table R-12 (urinary biomarker) of Appendix R. In Tables R-9 through R-12, a ratio of greater than one implies that the given exposure or dose measurement tended to be higher for the monitored child than for the child's adult caregiver in the same household. The columns of these tables specify the strata for which the ratio represents, with the first of these columns representing the entire set of study households within the given state. P-values for the statistical tests which were below 0.05 (indicating significant differences at the 0.05 level) are found in the last four columns of Table R-3 (for NC potential exposure and absorbed dose), Table R-4 (for OH potential exposure and absorbed dose), Table R-7 (for NC urinary biomarker concentrations) and Table R-8 (for OH urinary biomarker concentrations) in Appendix R.

For both states and for nearly all exposure routes, statistically significant differences were observed at the 0.01 level in potential exposure/dose estimates for each target pollutant between participating children and their adult caregivers living in the same households. The nature of the differences between children and adults was heavily influenced by the physiological and behavioral differences between them. For example, via the inhalation route, children tended to have lower potential exposures to these pollutants than their adult caregivers, but this was primarily due to their lower ventilation rates. In contrast, potential absorbed doses were higher for children than for adults because of their smaller body weights. Via the indirect ingestion route, children tended to have higher potential exposure/dose levels than adults, partly because children tend to have higher soil and dust ingestion rates than adults due to their different activity patterns. For the dietary ingestion route, statistical analyses to compare children and adult exposures could be performed only on 2,4-D, PCP, and 3,5,6-TCP data, due to neutral pollutants not being measured in adult food samples. When significant differences were present between children and adults for potential exposure/dose via dietary ingestion, children tended to have higher estimates than adults. For both states, estimated aggregate potential absorbed dose levels for 2,4-D and 3,5,6-TCP differed significantly at the 0.01 level between children and their adult caregivers within the same household, with children having roughly 4 to 5 times the potential absorbed dose compared to adults.

The estimates in Table R-10 of Appendix R indicate that there is no statistically significant difference in urinary 2,4-D concentrations (ng/mL) at the 0.05 level between participating NC children and adults in the same household when the concentrations are either unadjusted or adjusted for specific gravity. However, if adjusted for creatinine (μmole/mole), 2,4-D concentrations averaged about 80% higher in children samples versus adult samples. This difference was statistically significant at the 0.01 level, as were differences associated with children in NC urban areas, from low-income families, or who attended day care centers. When either unadjusted or adjusted for specific gravity, urinary concentrations in children were from 30% to 40% higher than their adult caregivers for PCP and 3,5,6-TCP, with the differences being statistically significant at the 0.05 level. However, when urinary concentrations were adjusted for creatinine levels, these differences became considerably larger and significant at the 0.01

level. This trend (i.e., children having higher concentrations of 2,4-D, PCP, and 3,5,6-TCP compared to their adult caregivers) agreed with that seen for estimated aggregate potential absorbed dose in Table R-9.

The descriptive statistics of NC urinary biomarker concentrations, found in Appendix P, show that two hydroxy-PAHs were detected in fewer children's urine samples than adults' urine samples. These two pollutants were detected in less than 3% of all children's urine samples (n=128). In contrast, detectable levels of 1-hydroxybenz[*a*]anthracene and 3-hydroxychrysene were found in approximately 31% and 8%, respectively, of adults' urine samples (n=128). In the previous pilot study (7), these two hydroxy-PAHs were detected in more than 70% of the urine samples (24 children and 24 adults). This greater detection in the earlier study is primarily due to the analytical method used in the previous study, which was targeted at PAH metabolites and had a lower estimated detection limits (~0.01 ng/mL). The method used for the CTEPP study was modified in order to include metabolites from other pollutant classes such as 2,4-D, PCP, and 3,5,6-TCP, which increased the estimated detection limit for hydroxy-PAHs to ~0.2 ng/mL.

For all five pollutants included in the analysis of OH urine data and in Table R-12, urine concentrations adjusted for creatinine levels differed significantly at the 0.01 level between OH children and adults in the same household, both overall and separately within each stratum. These creatinine-adjusted concentrations were higher in children samples by factors of 2 or 3 compared to adult samples. If no adjustment is made or when adjusting for specific gravity, urine concentrations differed significantly between children and adults at the 0.01 level for only three of the five pollutants (i.e., all but 1-hydroxypyrene and 3-phenoxybenzoic acid), and the extent to which children's concentrations were higher than adults was less than when a creatinine adjustment was made. Selected strata (rural, middle/high-income, day care children) did not see a significant difference at the 0.05 level between children and adults for 2,4-D urine concentrations that were either unadjusted or adjusted for specific gravity.

The descriptive statistics of OH urinary biomarker concentrations, found in Appendix Q, show that seven hydroxy-PAHs, 2,4-D, 3,5,6-TCP, 3-phenoxybenzoic acid, and PCP were measured in OH children and adults' urine samples. While IMP was also measured, the analytical method employed in this study could not provide quantitative recoveries for IMP, which contributed to less than 10% of urine samples having measurable levels of IMP. Detectable concentrations for 2,4-D, 3,5,6-TCP, 3-phenoxybenzoic acid, and PCP were found in most urine samples. While most OH children and adult urine samples had detectable concentrations for 1-hydroxypyrene, fewer urine samples had detectable levels of 1- and 3-hydroxybenz[*a*]anthracene and 3- and 6-hydroxy chrysene.

9.6 Goal 4: To Apportion Exposures among the Inhalation, Dietary Ingestion, and Indirect Ingestion Routes

For the eight pollutants and metabolites listed at the end of Section 9.2, aggregate potential exposure level and aggregate potential absorbed dose were estimated by summing the route-specific exposure/dose estimates across the three exposure routes characterized in this study (inhalation, dietary ingestion, and indirect ingestion). The statistical analyses performed in support of Goal 4 characterized how these aggregate exposure/dose estimates were apportioned across the three exposure routes, so that the routes could be evaluated based on their contribution to total exposure/dose.

9.6.1 *Sub-goal 4.1: To Estimate the Proportion of Aggregated Exposure and Dose that is Associated with a Given Exposure Route for Participating Children, Overall and by Stratum*

Analysis #1 under Goal 4 involved calculating the proportion of aggregate potential exposure level and absorbed dose under each exposure route for each child participant, then fitting the logistic regression model (8-8) in Section 8.5.2.3 to these proportions to estimate mean proportions as a function of urbanicity, income category, and day care status. Table 9.6.1 contains estimates of the mean proportions that are attributable to each exposure route, calculated separately by pollutant and state across all participating children. Tables 9.6.2 and 9.6.3 contain mean proportions by stratum for NC and OH children, respectively, when the test for significance of the given strata (i.e., urban and rural strata, low-income and middle/high-income strata, or stay-at-home and day care strata) on the overall proportion was significant at the 0.05 level. Tables S-1 and S-2 of Appendix S contain estimates of mean proportions for each stratum and exposure route and 95% confidence intervals on these mean proportions, for participating children in NC and OH, respectively. Results presented in these tables represent mean proportions of both aggregate potential exposure level and aggregate potential absorbed dose.

Note that in some cases, the outcome of the statistical analysis presented in Tables 9.6.2 and 9.6.3, as well as Tables S-1 through S-4 in Appendix S, suggested that a significant stratum effect was present when, in fact, the estimated mean proportions within the different strata were either each very large or very small. Such an outcome does not necessarily suggest that the difference in the estimated proportion between the strata was significant from a practical standpoint. Thus, caution should be taken in making inferences from the results in these tables when the overall mean percentages for certain exposure routes were either very small (e.g., less than 5%) or very large (e.g., greater than 95%).

Among the adults in this study, exposure and dose estimates for all three exposure routes, and therefore aggregate exposure/dose estimates, could be characterized for only two of the eight pollutants (2,4-D and 3,5,6-TCP). This is because adult food samples were not analyzed for the other six pollutants, and therefore, dietary exposure/dose estimates could not be calculated for them. For these two pollutants, Table 9.6.4 contains estimates of the mean proportions attributable to each exposure route as calculated over all participating adult caregivers, by pollutant and state. Tables S-3 and S-4 of Appendix S contain estimates of mean proportions for each stratum and exposure route, as well as 95% confidence intervals on these mean proportions, for participating adults in NC and OH, respectively. Note from these two tables that for NC and OH adults, the stratum effect on the overall proportion was not significant at the 0.05 level for either of the two pollutants or for any of the exposure routes.

Table 9.6.1. Estimated Mean Proportion of Aggregate Potential Exposure Level and Potential Absorbed Dose in Participating NC and OH Children That is Attributable to Each Exposure Route, Calculated Across All Children[a]

Pollutant/Metabolite	Estimate of the Overall Mean Proportion of Aggregate Exposure/Dose in Participating Children					
	North Carolina			Ohio		
	Inhalation	Dietary Ingestion	Indirect Ingestion	Inhalation	Dietary Ingestion	Indirect Ingestion
OP Pesticides and Metabolite						
Chlorpyrifos	0.39	0.54	0.06	0.19	0.76	0.04
Diazinon	0.40	0.55	0.05	0.33	0.62	0.05
3,5,6-TCP	0.03	0.95	0.02	0.02	0.98	<0.01
Pyrethroid Pesticides						
cis-Permethrin	0.05	0.55	0.39	0.04	0.56	0.39
trans-Permethrin	0.04	0.57	0.37	0.04	0.58	0.37
Acid Herbicides						
2,4-D	0.03	0.95	0.02	0.03	0.92	0.03
Phthalates						
Di-*n*-butylphthalate	0.06	0.93	0.01	0.18	0.80	0.02
Phenols						
Bisphenol-A	0.01	0.99	<0.01	0.01	0.99	<0.01

[a] Estimates of mean proportions are based on a logistic regression analysis fitted to the mean proportions calculated for each participating child. Estimated 95% confidence intervals on these mean proportions are given in the second column of Table S-1 (NC) and Table S-2 (OH) of Appendix S.

Table 9.6.2 Estimated Mean Proportion of Aggregate Potential Exposure Level and Potential Absorbed Dose in Participating NC Children That is Attributable to Each Exposure Route, Calculated by Stratum, When Differences Between Pairs of Strata Were Significant at the 0.05 Level[a]

Pollutant/ Metabolite	Exposure Route	Stratum	Estimate of Stratum Mean Proportion	P-value of Test for Significant Stratum Effect
OP Pesticides and Metabolite				
Diazinon	Inhalation	Low-Income Children	0.46	0.008**
		Middle/High-Income Children	0.34	
	Indirect Ingestion	Low-Income Children	0.04	0.049*
		Middle/High-Income Children	0.06	
3,5,6-TCP	Inhalation	Low-Income Children	0.04	0.018*
		Middle/High-Income Children	0.02	
		Non-Day Care Children	0.03	0.019*
		Day Care Children	0.01	
Pyrethroid Pesticides				
cis-Permethrin	Inhalation	Low-Income Children	0.07	0.020*
		Middle/High-Income Children	0.03	
trans-Permethrin	Inhalation	Low-Income Children	0.07	0.004**
		Middle/High-Income Children	0.03	
		Non-Day Care Children	0.06	0.048*
		Day Care Children	0.03	
Acid Herbicides				
2,4-D	Dietary Ingestion	Urban Children	0.92	0.038*
		Rural Children	0.96	
	Inhalation	Urban Children	0.04	0.021*
		Rural Children	0.02	
	Indirect Ingestion	Low-Income Children	0.01	0.009**
		Middle/High-Income Children	0.03	
Phthalates				
Di-*n*-butylphthalate	Dietary Ingestion	Urban Children	0.91	0.014*
		Rural Children	0.94	
	Inhalation	Urban Children	0.08	0.010*
		Rural Children	0.05	
Phenols				
Bisphenol-A	Dietary Ingestion	Non-Daycare Children	0.98	<0.001**
		Daycare Children	0.99	
	Inhalation	Non-Daycare Children	0.02	<0.001**
		Daycare Children	0.01	

[a] Estimates of mean proportions for specific strata are based on a logistic regression analysis fitted to the mean proportions calculated for each participating child. Estimated 95% confidence intervals on these mean proportions are given in the fourth column of Table S-1 of Appendix S.
* Statistically significant at the 0.05 level, but not at the 0.01 level.
** Statistically significant at the 0.01 level.

Table 9.6.3 Estimated Mean Proportion of Aggregate Potential Exposure Level and Potential Absorbed Dose in Participating OH Children That is Attributable to Each Exposure Route, Calculated by Stratum, When Differences Between Pairs of Strata Were Significant at the 0.05 Level[a]

Pollutant/ Metabolite	Exposure Route	Stratum	Estimate of Stratum Mean Proportion	P-value of Test for Significant Stratum Effect
OP Pesticides and Metabolite				
Chlorpyrifos	Indirect Ingestion	Low-Income Children	0.03	<0.001**
		Middle/High-Income Children	0.05	
		Non-Day Care Children	0.03	0.038*
		Day Care Children	0.06	
Diazinon	Indirect Ingestion	Low-Income Children	0.03	0.009**
		Middle/High-Income Children	0.07	
3,5,6-TCP	Dietary Ingestion	Low-Income Children	0.97	0.023*
		Middle/High-Income Children	0.99	
	Inhalation	Low-Income Children	0.03	0.010**
		Middle/High-Income Children	0.01	
Pyrethroid Pesticides				
cis-Permethrin	Inhalation	Urban Children	0.06	0.010*
		Rural Children	0.03	
trans-Permethrin	Inhalation	Low-Income Children	0.02	<0.001**
		Middle/High-Income Children	0.06	
		Urban Children	0.05	0.015*
		Rural Children	0.03	
Acid Herbicides				
2,4-D	Dietary Ingestion	Low-Income Children	0.95	0.040*
		Middle/High-Income Children	0.89	
	Indirect Ingestion	Urban Children	0.07	<0.001**
		Rural Children	0.02	
Phthalates				
Di-*n*-butylphthalate	Dietary Ingestion	Non-Day Care Children	0.76	0.017*
		Day Care Children	0.84	
	Inhalation	Non-Day Care Children	0.22	0.047*
		Day Care Children	0.15	
	Indirect Ingestion	Non-Day Care Children	0.02	0.008**
		Day Care Children	0.01	
Phenols				
Bisphenol-A	Dietary Ingestion	Non-Daycare Children	0.99	0.015*
		Daycare Children	0.99	
	Inhalation	Urban Children	0.01	0.039*
		Rural Children	0.00	

[a] Estimates of mean proportions for specific strata are based on a logistic regression analysis fitted to the mean proportions calculated for each participating child. Estimated 95% confidence intervals on these mean proportions are given in the fourth column of Table S-2 of Appendix S.
* Statistically significant at the 0.05 level, but not at the 0.01 level.
** Statistically significant at the 0.01 level.

Table 9.6.4 Estimated Mean Proportion of Aggregate Potential Exposure Level and Potential Absorbed Dose in Participating NC and OH Adults That is Attributable to Each Exposure Route, Calculated Across All Adults[a]

Pollutant/Metabolite	Estimate of the Overall Mean Proportion in Participating Adults					
	North Carolina			Ohio		
	Inhalation	Dietary Ingestion	Indirect Ingestion	Inhalation	Dietary Ingestion	Indirect Ingestion
3,5,6-TCP	0.05	0.94	0.01	0.02	0.98	<0.01
2,4-D	0.05	0.93	0.01	0.04	0.93	0.03

[a] Estimates of mean proportions are based on a logistic regression analysis fitted to the mean proportions calculated for each participating adult. Estimated 95% confidence intervals on these mean proportions are given in the second column of Table S-3 (NC) and Table S-4 (OH) of Appendix S.

For NC children, the dietary ingestion exposure route was the dominant of the three routes for each of the eight pollutants, with the mean proportion exceeding 85% for 3,5,6-TCP, 2,4-D, di-*n*-butylphthalate, and bisphenol-A (Table 9.6.1). Similar results were observed for 3,5,6-TCP and 2,4-D in NC adults (Table 9.6.4). For the two OP pesticides (chlorpyrifos and diazinon), the mean proportion for the inhalation route in NC children was approximately 40%; this proportion was the highest seen for the inhalation route among the eight pollutants. (The estimated mean proportion for inhalation was less than 10% for each of the other six pollutants.) The mean percentage for the indirect ingestion route in NC children was below 10% for each pollutant except *cis*- and *trans*-permethrin, where the estimated percentages were 39% and 37%, respectively.

For OH children, the dietary ingestion exposure route was also the dominant of the three routes for each of the eight pollutants (Table 9.6.1). The mean proportion for the dietary ingestion route exceeded 90% for 3,5,6-TCP and 2,4-D (as it also did for OH adults), equaled 99% for bisphenol-A, equaled 80% for di-*n*-butylphthalate, exceeded 60% for the two OP pesticides (chlorpyrifos and diazinon), and exceeded 50% for *cis*- and *trans*-permethrin. The mean proportion for the inhalation route was largest for diazinon at 33%. The mean percentage for the indirect ingestion route was below 10% for most pollutants except for *cis*- and *trans*-permethrin, where the estimated percentages were 39% and 37%, respectively.

Because the two OP pesticides are more volatile than the two pyrethroid pesticides, this could partly contribute to differences in the level of importance of the exposure routes (inhalation vs. indirect ingestion) to total exposure/dose that was seen for both states.

9.6.2 Sub-goal 4.2: *For Each Exposure Route, Determine if This Proportion Differs for Children in Urban and Rural Settings, from Low-and Middle/High-Income Families, and Who Attend Day Care or Stay at Home*

The last column in Tables S-1 through S-4 of Appendix S contains p-values of tests performed in the logistic regression model fitting, with the tests determining whether the estimated mean proportion of total exposure/dose differs significantly between two strata for a given exposure route and pollutant. These tests were performed for three pairs of strata: low-income and middle/high-income level, urban and rural strata, and day care and stay-at-home children. For proportions of total exposure/dose associated with participating NC and OH children, those p-values falling below 0.05 were documented in the last columns of Tables 9.6.2 and 9.6.3, respectively. (For adults in both NC and OH, none of these p-values in Tables S-3 and S-4 of Appendix S are below 0.05 for either 3,5,6-TCP or 2,4-D.)

For NC children (Table 9.6.2), significant differences in the mean proportion were observed at the 0.05 level between low-income and middle/high-income strata for diazinon via the inhalation and indirect ingestion routes, for 3,5,6-TCP and for *cis*- and *trans*-permethrin via the inhalation route, and for 2,4-D via the indirect ingestion route. Significant differences between urban and rural children were observed at the 0.05 level for 2,4-D and di-*n*-butylphthalate via the dietary ingestion and inhalation routes. Significant differences between day care and non-day care children were observed at the 0.05 level for 3,5,6-TCP via the indirect ingestion route, for *trans*-permethrin via the inhalation route, and for bisphenol-A via each route. However, the estimated proportion of total exposure/dose of bisphenol-A attributed to indirect ingestion was virtually zero, implying that any difference among strata was not significant from a practical standpoint.

For OH children (Table 9.6.3), significant differences in the mean proportion were observed at the 0.05 level between low-income and middle/high-income strata for the two OP pesticides (chlorpyrifos and diazinon) via the indirect ingestion route, for 3,5,6-TCP via the dietary and inhalation routes, for *trans*-permethrin via the inhalation route, and for 2,4-D via the dietary ingestion route. Significant differences between OH urban and rural children were observed at the 0.05 level for bisphenol-A and *cis*- and *trans*-permethrin via the inhalation route and for 2,4-D via the indirect ingestion route. Significant differences between OH stay-at-home and day care children were observed at the 0.05 level for chlorpyrifos via the indirect ingestion route, for di-*n*-butylphthalate in each route, and for bisphenol-A via the dietary ingestion and inhalation routes.

9.6.3 Sub-goal 4.3: *Determine Whether Significant Differences Exist Between Exposure Routes*

Analysis #2 in Section 8.5.2.3 was used to compare average log-transformed potential exposure level and potential absorbed dose measures between exposure routes. This analysis involved fitting model (8-9) of Section 8.5.2.3 to log-transformed measures (represented as a vector of measures for the three exposure routes) within a multivariate analysis of variance

(ANOVA). This analysis was performed separately for each pollutant addressed under Goal 4, as well as separately for potential exposure level and potential absorbed dose, for children and adults, and for each state.

Results of the multivariate ANOVAs indicated that for each pollutant, highly significant differences existed between exposure routes for both potential exposure level and potential absorbed dose ($p<0.0001$). This result held for both children and adults in NC and OH. This result was apparent by reviewing the tables in Section 9.6.1, where one exposure route typically dominated the other two for each pollutant in each state. Note that the model was unable to converge when being fitted to potential exposure level estimates of *cis*-permethrin in OH children, and therefore, comparisons between exposure routes could not be performed in this instance.

9.6.4 <u>Sub-goal 4.4</u>: Characterize How These Estimates Differ Overall Between Pairs of Exposure Routes

For each pair of exposure routes, each multivariate ANOVA performed in Section 9.6.3 produced estimates of the ratio of geometric mean potential exposure level or potential absorbed dose between the two routes, along with a 95% confidence interval on the ratio. Tables S-5 and S-6 of Appendix S present these ratios and confidence intervals for participating children in NC and OH, respectively. Similarly, Tables S-7 and S-8 present ratios and confidence intervals for participating adult caregivers in NC and OH, respectively. Each row of these tables corresponds to a particular fit of the multivariate ANOVA. Those ratios that are significantly different from one at the 0.05 level are summarized in Table 9.6.5 for NC children, Table 9.6.6 for OH children, Table 9.6.7 for NC adults, and Table 9.6.8 for OH adults; further discussion of significant differences from one is found in Section 9.6.5.

For NC children, Table S-5 of Appendix S shows that for all eight pollutants and for both potential exposure level and potential absorbed dose, ratios of the dietary ingestion route versus either the inhalation route or the indirect ingestion route exceeded one. This implies that the estimated geometric mean exposure/dose estimate via dietary ingestion was larger than the geometric mean for either inhalation or indirect ingestion. Ratios of the inhalation route to the indirect ingestion route were greater than one for all pollutants but *cis*- and *trans*-permethrin, where the indirect ingestion route was more dominant than the inhalation route. For the two pollutants that were also included in the data analysis for NC adults (3,5,6-TCP and 2,4-D), the same conclusions held for both adults and children (Tables 9.6.5 and 9.6.6).

Table 9.6.5. Estimated Ratios Between Two Exposure Routes of Geometric Mean Potential Exposure Level and Potential Absorbed Dose Estimates in Participating NC Children, When These Ratios Were Significantly Different From One at the 0.05 Level[a]

Pollutant/ Metabolite	Parameter	Ratio of Geometric Means		
		Dietary Ingestion Route vs. Inhalation Route	Dietary Ingestion Route vs. Indirect Ingestion Route	Inhalation Route vs. Indirect Ingestion Route
OP Pesticides and Metabolite				
Chlorpyrifos	Potential Exposure Level		12.60**	8.92**
	Potential Absorbed Dose		12.61**	8.93**
Diazinon	Potential Exposure Level		20.70**	14.58**
	Potential Absorbed Dose		20.68**	14.62**
3,5,6-TCP	Potential Exposure Level	72.58**	229.05**	3.16**
	Potential Absorbed Dose	72.84**	230.39**	3.16**
Pyrethroid Pesticides				
cis-Permethrin	Potential Exposure Level	22.18**		0.09**
	Potential Absorbed Dose	22.17**		0.09**
trans-Permethrin	Potential Exposure Level	22.02**		0.08**
	Potential Absorbed Dose	21.81**		0.08**
Acid Herbicides				
2,4-D	Potential Exposure Level	48.67**	194.41**	3.99**
	Potential Absorbed Dose	48.63**	193.78**	3.98**
Phthalates				
Di-*n*-butylphthalate	Potential Exposure Level	22.92**	126.17**	5.50**
	Potential Absorbed Dose	22.61**	124.38**	5.50**
Phenols				
Bisphenol-A	Potential Exposure Level	207.17**	2235.24**	10.79**
	Potential Absorbed Dose	207.37**	2212.20**	10.67**

[a] Blank cells correspond to ratios that were not significantly different from one at the 0.05 level. All ratios are presented, regardless of their significance, along with 95% confidence intervals on these ratios, within Table S-5 of Appendix S.

** Significantly different from 1 at the 0.01 level.

Table 9.6.6. Estimated Ratios Between Two Exposure Routes of Geometric Mean Potential Exposure Level and Potential Absorbed Dose Estimates in Participating <u>OH Children</u>, When These Ratios Were Significantly Different From One at the 0.05 Level[a]

Pollutant/ Metabolite	Parameter	Ratio of Geometric Means		
		Dietary Ingestion Route vs. Inhalation Route	**Dietary Ingestion Route vs. Indirect Ingestion Route**	**Inhalation Route vs. Indirect Ingestion Route**
OP Pesticides and Metabolite				
Chlorpyrifos	Potential Exposure Level	6.03**	30.88**	5.12**
	Potential Absorbed Dose	6.06**	31.03**	5.12**
Diazinon	Potential Exposure Level	2.04**	20.68**	10.15**
	Potential Absorbed Dose	2.04**	20.78**	10.19**
3,5,6-TCP	Potential Exposure Level	132.32**	546.95**	4.13**
	Potential Absorbed Dose	129.55**	541.95**	4.18**
Pyrethroid Pesticides				
cis-Permethrin	Potential Exposure Level	–[b]	--	--
	Potential Absorbed Dose	22.00**	2.60*	0.12**
trans-Permethrin	Potential Exposure Level	24.32**	3.52**	0.14**
	Potential Absorbed Dose	24.29**	3.38**	0.14**
Acid Herbicides				
2,4-D	Potential Exposure Level	52.25**	47.52**	
	Potential Absorbed Dose	51.75**	47.22**	
Phthalates				
Di-*n*-butylphthalate	Potential Exposure Level	4.68**	53.07**	11.34**
	Potential Absorbed Dose	4.63**	51.94**	11.21**
Phenols				
Bisphenol-A	Potential Exposure Level	181.33**	1853.99**	10.22**
	Potential Absorbed Dose	183.70**	1851.10**	10.08**

[a] Blank cells correspond to ratios that were not significantly different from one at the 0.05 level. All ratios are presented, regardless of their significance, along with 95% confidence intervals on these ratios, within Table S-6 of Appendix S.
[b] No ratios were estimated due to the model being unable to converge when fitted to the data.

* Significantly different from 1 at the 0.05 level, but not at the 0.01 level.
** Significantly different from 1 at the 0.01 level.

Table 9.6.7. Estimated Ratios Between Two Exposure Routes of Geometric Mean Potential Exposure Level and Potential Absorbed Dose Estimates in Participating NC Adults, When These Ratios Were Significantly Different From One at the 0.05 Level[a]

Parameter	Ratio of Geometric Means		
	Dietary Ingestion Route vs. Inhalation Route	Dietary Ingestion Route vs. Indirect Ingestion Route	Inhalation Route vs. Indirect Ingestion Route
3,5,6-TCP (3,5,6-trichloro-2-pyridinol)			
Potential Exposure Level	41.76**	358.70**	8.59**
Potential Absorbed Dose	41.74**	358.31**	8.58**
2,4-D (2,4-dichlorophenoxyacetic acid)			
Potential Exposure Level	40.74**	379.85**	9.32**
Potential Absorbed Dose	40.88**	379.64**	9.29**

[a] Ratios are presented, along with 95% confidence intervals on these ratios, within Table S-7 of Appendix S.
** Significantly different from 1 at the 0.01 level.

Table 9.6.8. Estimated Ratios Between Two Exposure Routes of Geometric Mean Potential Exposure Level and Potential Absorbed Dose Estimates in Participating OH Adults, When These Ratios Were Significantly Different From One at the 0.05 Level[a]

Parameter	Ratio of Geometric Means (95%CI)		
	Dietary Ingestion Route vs. Inhalation Route	Dietary Ingestion Route vs. Indirect Ingestion Route	Inhalation Route vs. Indirect Ingestion Route
3,5,6-TCP (3,5,6-trichloro-2-pyridinol)			
Potential Exposure Level	102.37**	907.46**	8.86**
Potential Absorbed Dose	102.51**	907.69**	8.85**
2,4-D (2,4-dichlorophenoxyacetic acid)			
Potential Exposure Level	49.33**	78.75**	
Potential Absorbed Dose	49.32**	78.63**	

[a] Ratios are presented, along with 95% confidence intervals on these ratios, within Table S-8 of Appendix S.
** Significantly different from 1 at the 0.01 level.

For OH children, Table S-6 of Appendix S shows that for all eight pollutants and for both potential exposure level and potential absorbed dose, ratios of the dietary ingestion route versus either the inhalation route or the indirect ingestion route exceeded one in all instances, indicating that dietary ingestion was the dominant exposure route. The ratios of the inhalation route to the indirect ingestion route were greater than one for all pollutants but 2,4-D and *cis*- and *trans*-permethrin. For the two permethrins, Table 9.6.1 showed that the indirect ingestion route was more dominant than the inhalation route with regard to exposure/dose, while the two routes were equally inferior to dietary ingestion for 2,4-D. Although the ratio of 2,4-D exposure/dose estimates between the inhalation route and the indirect ingestion route exceeded one for OH adults (Table S-8 of Appendix S), implying larger exposure/dose estimates for the inhalation route in adults, the ratio was not significantly different from one at the 0.05 level for either children or adults in OH. Note that although the multivariate ANOVA model could not converge to solutions for potential exposure level in OH children for *cis*-permethrin, it is expected (upon viewing the results for the other pollutants) that the outcome would have been very similar to that given for potential absorbed dose for this pollutant.

The magnitudes of the ratios presented in the tables in this section, as well as the conclusions made by these ratios, are consistent with the findings found in the tables within Section 9.6.1. Note that in Tables S-5 through S-8, the second column presents the p-values of the tests of significant differences among exposure routes. As mentioned in Section 9.6.3, these p-values were all less than 0.0001 across all model fits for both NC and OH.

9.6.5 Sub-goal 4.5: Identify Which Pairs of Exposure Routes Differ Significantly in These Estimates

Within the multivariate ANOVA model fits discussed in Section 9.6.3 and Section 9.6.4, statistical tests were performed to determine whether the estimated ratios reported in Tables S-5 through S-8 of Appendix S were significantly different from one, thereby indicating that the pair of exposure routes had significantly different geometric mean exposure/dose measures. Those ratios that were significantly different from one at the 0.05 are presented in Tables 9.6.5 through 9.6.8, with each ratio followed by either one or two asterisks. One asterisk implies that the ratio is significantly different from one at the 0.05 level, while two asterisks indicate significance at the 0.01 level.

For NC children, Table 9.6.5 shows that the ratios of exposure/dose estimates between dietary ingestion and inhalation were significantly different from (and greater than) one at the 0.01 level for all pollutants but the two OP pesticides (chlorpyrifos and diazinon). Similarly, the ratios between dietary ingestion and indirect ingestion were significantly different from (and greater than) one at the 0.01 level for all pollutants but *cis*- and *trans*-permethrin. For all eight pollutants, the ratio of inhalation to indirect ingestion was significantly different from one at the 0.01 level, but these ratios were smaller than one for *cis*- and *trans*-permethrin and larger than one for the other six pollutants. Thus, these findings indicate that the ordering of the exposure routes for NC children based upon their relative importance to potential exposure/dose is as follows:

- *cis*- and *trans*-permethrin: dietary ingestion . indirect ingestion > inhalation.
- chlorpyrifos and diazinon: dietary ingestion . inhalation > indirect ingestion
- 2,4-D, 3,5,6-TCP, di-*n*-butylphthalate, bisphenol-A:
  dietary ingestion > inhalation > indirect ingestion

where " . " indicates statistical equivalence. For 2,4-D and 3,5,6-TCP, the same ordering of the exposure routes occurred for NC adults as for children (Table 9.6.7).

For OH children, Table 9.6.6 shows that the ratios of exposure/dose estimates between dietary ingestion and either inhalation or indirect ingestion were significantly different from (and greater than) one for all eight pollutants, where significance was at the 0.05 level for potential absorbed dose of *cis*-permethrin (for dietary versus indirect ingestion routes) and at the 0.01 level in all other instances. For seven of the eight pollutants (i.e., all pollutants except 2,4-D), the ratio of inhalation to indirect ingestion was significantly different from one at the 0.01 level, but these ratios were smaller than one for *cis*- and *trans*-permethrin and larger than one for the other five pollutants. This ratio was not significantly different from one for 2,4-D. Thus, these findings, along with the magnitude of the reported ratios, indicate that the ordering of the exposure routes for OH children based upon their relative importance to potential exposure/dose is as follows:

- *cis*- and *trans*-permethrin: dietary ingestion > indirect ingestion > inhalation.
- 2,4-D: dietary ingestion > indirect ingestion . inhalation
- chlorpyrifos, diazinon, 3,5,6-TCP, di-*n*-butylphthalate, bisphenol-A:
  dietary ingestion > inhalation > indirect ingestion.

For OH adults, the ordering of exposure routes was similar (Table 9.6.8):

- 2,4-D: dietary ingestion > inhalation . indirect ingestion
- 3,5,6-TCP: dietary ingestion > inhalation > indirect ingestion.

The findings in this section indicate that dietary ingestion and inhalation are the two most important exposure routes for children's exposure to the two OP pesticides (chlorpyrifos and diazinon). This finding is in agreement with the previous pilot study (10). For the less volatile pyrethroids (*cis*- and *trans*-permethrin), dietary and indirect ingestion were the two most important exposure routes.