Organophosphate esters and polybrominated diphenyl ethers in vehicle dust: Concentrations, sources and health risk assessment

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Supporting information

Table S1. Data sources and related information.

Type	Number of samples	Sampling Year	Country	References
OPEs	14	2017-2018	Greece	[1]
	30	-	Greece	[2]
	100	-	China	[3]
	15	-	Kingdom of Saudi Arabia	[4]
	25	-	Greece	[5]

	15	-	Kuwait	[6]
	15	-	Pakistan	[6]
	36	-	Egypt	[7]
	19	2013	South Africa	[8]
	15	2015	Germany	[9]
	20	2012-2013	Egypt	[10]
	21	2011-2012	England	[11]
	15	2015	Australia	[12]
	4	-	China	[13]
	12	2010-2011	Germany	[14]
	8	2012	Netherlands	[15]
	10	2021	Nigeria	[16]
PBDEs	8	-	Australia	[17]
	20	2019-2020	China	[18]
	12	2014	Egypt	[19]
	15	2019	China	[20]
	66	-	American	[21]
	20	-	Nigeria	[22]
	30	2007-2008	Thailand	[23]
	16	2014	Nigeria	[24]
	12	2014	Nigeria	[25]
	40	2018-2019	Kuwait	[26]

	15	2019	Nigeria	[27]
	30	-	Greece	[2]
	19	2011	Kuwait	[28]

Table S2. Exposure parameters for occupational and non-occupational populations with references.

Abbreviations	Exposure Factors	Exposure Values	References
C	The measured dust concentration (ng g^{-1})	Shown in Table 1	Shown in Table S1
R_{ing}	Ingestion rate (g day^{-1})	0.05	[29]
R_{inh}	Inhalation rate（m^3 day^{-1})	20	[30]
ET	Exposure time (hours day^{-1})	0.279 for occupational populations 0.042 for nonoccupational populations	[29]
EF	Exposure frequency (days $year^{-1}$)	350	[5]
ED	Exposure duration	30	[5]

	(years)		
PEF	Particle emission factor (m^3 kg^{-1})	1.36×10^9	[31]
SA	The exposure skin area (cm^2)	4615	[32]
DA	The adhered to skin (mg cm^{-2})	0.01	[31]
AF	The dermal absorption factor (unitless)	0.219 for TEHP, TBEP, TPHP, EHDPP 0.283 for TCEP 0.127for TDCIPP 0.274 for TCIPP 0.200 for TNBP 0. 100 for PBDEs	[31]
BW	Average body weight (kg)	70	[5]
AT	Average exposure time (days)	30 × 365 70 × 365	[31]
CF	Conversion factor	10^{-6}	-
RfD	Reference concentration (mg kg^{-1} day^{-1})	0.024 for TNBP 0.015 for TBEP and TDCIPP	[31]

		0.022 for TCEP 0.08 for TCIPP 0.07 for TPHP 0.0001 for BDE-47 and BDE-99 0.0002 for BDE-153 0.007 for BDE-209	
SF	Slope factor	0.009 for TNBP 0.0032 for TEHP 0.02 for TCEP 0.031 for TDCIPP 0.0007 for BDE-209	[31]

Table S3.Concentration (ng g^{-1}) of OPEs in vehicle dust in different countries

	China	Kuwait	Pakistan	Egypt	South Africa	Germany	England	Greece	Nigeria	Australia	Kingdom of Saudi Arabia	Netherlands
TnBP	1.00E+02	1.69E+03	5.00E+01	4.95E+01	-	2.60E+02	1.40E+02	4.36E+02	2.60E+01	1.70E+02	5.40E+02	4.35E+01
TBOEP	3.60E+03	5.27E+03	1.25E+02	2.16E+02	-	1.43E+04	-	3.70E+02	9.90E+01	4.60E+04	1.65E+03	2.65E+04
TEHP	2.90E+03	2.12E+02	4.70E+01	1.20E-01	-	2.00E+03	-	6.37E+03	-	4.50E+02	1.95E+02	-
TCEP	1.66E+04	3.48E+03	2.55E+02	1.15E+02	3.51E+04	1.18E+03	1.95E+03	3.39E+03	8.20E+00	1.20E+03	7.02E+03	1.70E+03
TCiPP	1.16E+04	3.60E+04	5.90E+02	3.56E+02	1.01E+04	5.45E+03	8.30E+04	2.50E+03	7.10E+01	2.60E+04	1.63E+04	5.00E+03
TDCiPP	9.00E+02	3.58E+04	1.30E+02	1.30E+02	8.92E+04	6.74E+04	1.10E+05	9.98E+02	1.80E+01	1.50E+03	8.85E+03	6.35E+04
TPhP	-	2.17E+03	6.65E+02	2.69E+02	9.33E+03	2.60E+03	1.50E+04	1.06E+03	1.90E+01	6.70E+03	7.86E+02	2.05E+03
EHDPP	2.20E+03	8.75E+02	7.30E+01	3.30E+01	-	-	2.90E+03	0.00E+00	3.70E+01	3.90E+04	1.05E+03	1.13E+03
$\sum_8$OPEs	3.79E+04	8.54E+04	1.94E+03	1.17E+03	1.44E+05	9.31E+04	2.13E+05	1.51E+04	2.78E+02	1.21E+05	3.63E+04	9.99E+04

Note: "-" indicates that the substance was not detected.

Table S4.Concentration (ng g^{-1}) of PBDEs in vehicle dust in different countries

	China	Germany	Kuwait	Nigeria	Thailand	Pakistan	American	Egypt	Greece	Australia
BDE-28	2.69E+01	-	3.90E+00	1.17E+01	3.20E-01	2.00E-01	1.32E+01	3.75E+00	1.22E+01	-
BDE-47	6.28E+01	1.70E+01	1.64E+01	2.53E+02	1.80E+00	1.80E+00	1.87E+03	4.65E+01	1.81E+02	1.40E+02
BDE-99	1.36E+02	3.20E+01	2.00E+01	4.82E+02	3.00E+00	2.50E+00	9.22E+02	5.80E+01	3.43E+02	1.80E+02
BDE-100	9.58E+01	-	2.11E+00	1.08E+02	4.50E+01	4.00E-01	3.44E+02	1.38E+01	4.31E+01	4.00E+01
BDE-153	8.58E+01	-	3.39E+00	2.06E+02	4.50E-01	1.00E+00	2.22E+02	3.45E+01	5.86E+01	1.70E+01
BDE-154	6.67E+01	-	1.52E+00	1.34E+02	2.30E-01	4.00E-01	2.31E+01	8.97E+00	3.67E+01	1.20E+01
BDE-183	5.26E+01	3.70E+00	2.43E+00	4.88E+01	-	3.00E+00	4.46E+00	1.09E+01	3.04E+02	-
BDE-209	1.95E+03	9.40E+02	5.43E+03	5.07E+03	-	3.01E+04	3.72E+04	6.81E+03	1.31E+04	1.40E+04
$\sum_8$PBDEs	2.48E+03	9.93E+02	5.48E+03	6.31E+03	5.08E+01	3.01E+04	4.06E+04	6.99E+03	1.41E+04	1.44E+04

Note: "-" indicates that the substance was not detected.

Table S5. Rotated component matrix for OPEs.

OPEs	F1	F2	F3	F4
TnBP	-0.068	-0.020	**0.997**	-0.004
TBOEP	**0.793**	0.529	-0.073	0.015
TEHP	0.003	-0.004	-0.004	**1.000**

TDCiPP	**0.941**	-0.127	-0.030	-0.012
TPhP	**0.954**	0.073	-0.052	0.009
EHDPP	0.027	**0.983**	-0.011	-0.007
Variance (%)	40.510	21.145	16.732	16.673

Table S6. Rotated component matrix for PBDEs.

PBDEs	F1	F2	F3
BDE-28	0.593	-0.148	-0.295
BDE-47	**0.933**	-0.037	0.090
BDE-99	**0.869**	0.329	0.277
BDE-100	**0.964**	-0.013	0.019
BDE-153	**0.909**	0.356	0.027
BDE-154	0.459	**0.710**	-0.011
BDE-183	-0.130	**0.760**	-0.060
BDE-209	0.061	-0.090	**0.956**
Variance (%)	49.577	16.854	13.636

Note: extraction method based on principal component analysis; a: bold is the main load.

Table S7. HI and CR values for OPEs and PBDEs via ingestion, dermal absorption, and inhalation.

	Occupational populations			Nonoccupational populations		
	HQ_{ing}	HQ_{inh}	HQ_{der}	HQ_{ing}	HQ_{inh}	HQ_{der}
TnBP	1.52E-06	4.48E-13	2.81E-07	2.29E-07	6.74E-14	4.23E-08

TBOEP	1.25E-04	3.68E-11	2.53E-05	1.88E-05	5.53E-12	3.80E-06
TCEP	4.68E-05	1.38E-11	1.22E-05	7.04E-06	2.07E-12	1.84E-06
TCiPP	2.26E-05	6.65E-12	5.72E-06	3.41E-06	1.00E-12	8.61E-07
TDCiPP	5.53E-04	1.63E-10	6.48E-05	8.32E-05	2.45E-11	9.75E-06
TPhP	1.65E-05	4.87E-12	3.34E-06	2.49E-06	7.33E-13	5.03E-07
BDE-47	8.44E-04	2.48E-10	7.79E-05	1.27E-04	3.73E-11	1.17E-05
BDE-99	6.65E-04	1.96E-10	6.14E-05	1.00E-04	2.95E-11	9.25E-06
BDE-153	9.70E-05	2.85E-12	8.95E-06	1.46E-05	4.29E-12	1.35E-06
BDE-209	4.14E-04	1.22E-10	3.82E-05	6.23E-05	1.83E-11	5.75E-06
	HI_{ing}	HI_{inh}	HI_{der}	HI_{ing}	HI_{inh}	HI_{der}
	2.79E-03	8.20E-10	2.98E-04	4.19E-04	1.23E-10	4.48E-05
	CR_{ing}	CR_{inh}	CR_{der}	CR_{ing}	CR_{inh}	CR_{der}
TnBP	1.41E-10	4.15E-17	2.60E-11	2.12E-11	6.24E-18	3.92E-12
TEHP	1.54E-10	4.53E-17	2.84E-11	2.32E-11	6.82E-18	4.69E-12
TCEP	8.82E-09	2.59E-15	1.63E-09	1.33E-09	3.91E-16	3.47E-10
TDCiPP	1.10E-07	3.24E-14	2.03E-08	1.66E-08	4.88E-15	1.94E-09
BDE-209	8.69E-10	2.56E-16	8.02E-11	1.31E-10	3.85E-17	1.21E-11
	TCR_{ing}	TCR_{inh}	TCR_{der}	TCR_{ing}	TCR_{inh}	TCR_{der}
	1.20E-07	3.53E-14	2.21E-08	1.81E-08	5.32E-15	2.31E-09

Table S8. Statistics of probabilistic estimation of lifetime carcinogenic risk values.

	Group	Distribution	Parameters		10%	50%	90%
			Mean	SD			
HI	Occupation	Lognormal	3.14×10^{-3}	3.60×10^{-3}	1.00×10^{-3}	2.28×10^{-3}	5.85×10^{-3}
	Nonoccupation	Lognormal	3.34×10^{-4}	5.25×10^{-4}	1.52×10^{-4}	3.43×10^{-4}	8.80×10^{-4}
CR	Occupation	Lognormal	1.39×10^{-7}	2.80×10^{-7}	1.52×10^{-8}	5.98×10^{-8}	3.00×10^{-7}
	Nonoccupation	Lognormal	2.08×10^{-8}	4.23×10^{-8}	2.33×10^{-9}	9.11×10^{-9}	4.63×10^{-8}

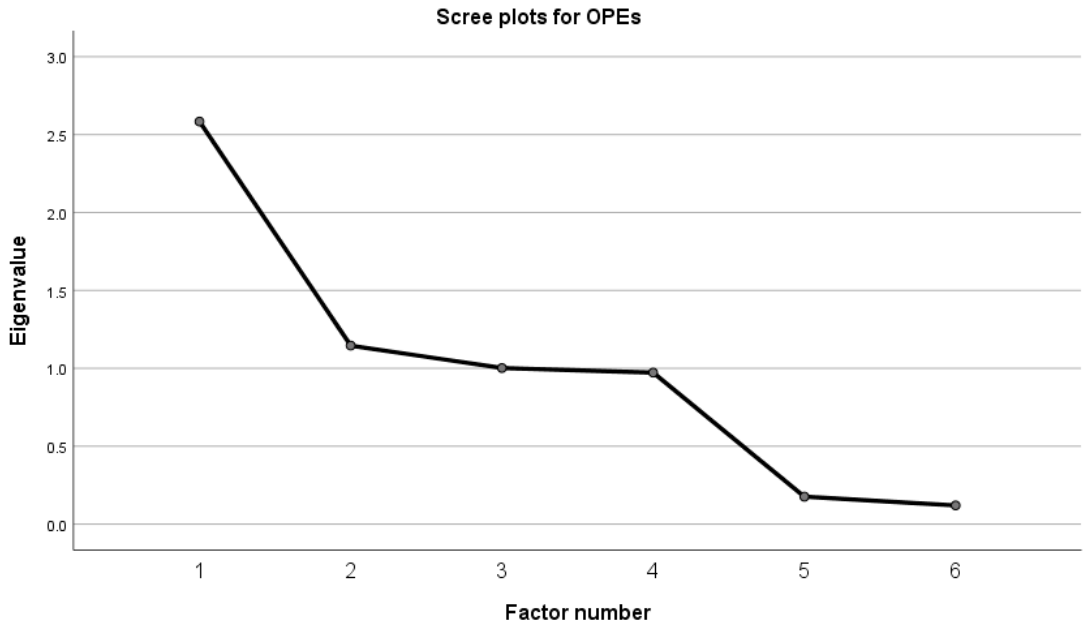

Figure S1. Scree plots for OPEs.

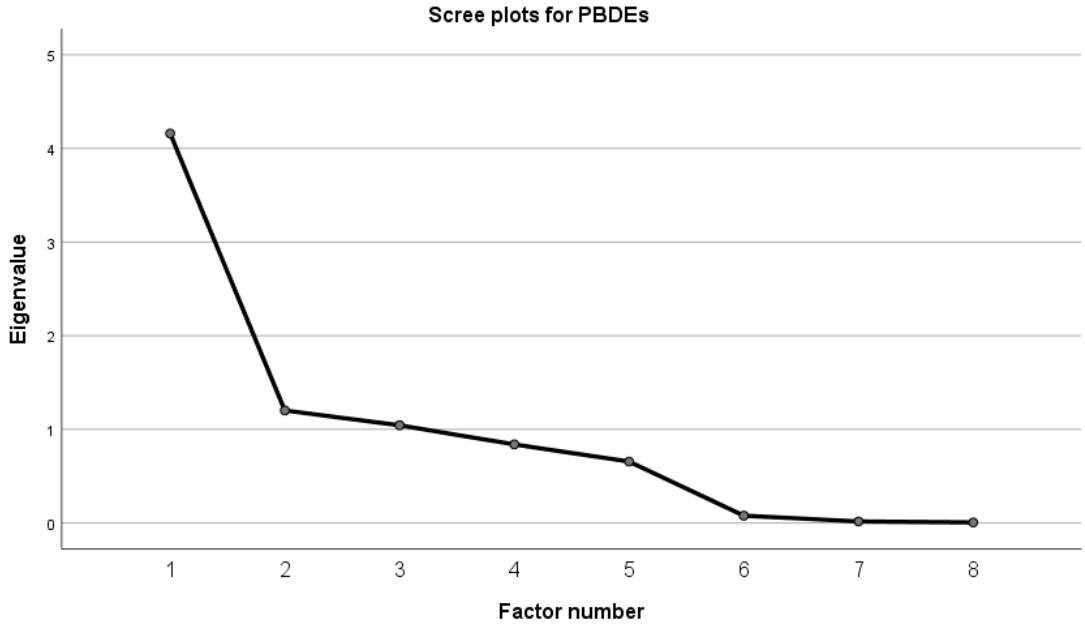

Figure S2. Scree plots for PBDEs.

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