Supplementary Table S1. Characteristics of the study participants from NHANES 2013 – 2016 based on BMI or waist circumference

Characteristics	General obesity (*n* = 2,392)		*P*	Central obesity (*n* = 2,392)		*P*
	No (*n* = 1,438)	Yes (*n* = 954)		No (*n* = 563)	Yes (*n* = 1,829)	
Age, year Mean ± SD	46.59 ± 17.24	48.37 ± 15.85	0.011	39.47 ± 15.64	49.72 ± 16.30	< 0.001
Gender, *n* (%)			< 0.001			< 0.001
Male	742 (51.60)	413 (43.29)		392 (69.63)	763 (41.72)	
Female	696 (48.40)	541 (56.71)		171 (30.37)	1066 (58.28)	
Race, *n* (%)			< 0.001			< 0.001
Mexican American	199 (13.84)	176 (18.45)		46 (8.17)	329 (17.99)	
Other Hispanic	159 (11.06)	112 (11.74)		63 (11.19)	208 (11.37)	
Non-Hispanic White	535 (37.20)	337 (35.32)		196 (34.81)	676 (36.96)	
Non-Hispanic Black	284 (19.75)	264 (27.67)		129 (22.91)	419 (22.91)	
Other Race	261 (18.15)	65 (6.81)		129 (22.91)	197 (10.77)	
Education level, *n* (%)			0.052			0.003
Less than high school	290 (20.17)	214 (22.43)		90 (15.99)	414 (22.64)	
High school or equivalent	313 (21.77)	234 (24.53)		138 (24.51)	409 (22.36)	
College or higher	835 (58.07)	506 (53.04)		335 (59.50)	1006 (55.00)	
Smoking status, *n* (%)			0.959			0.083
Never	845 (58.76)	555 (58.18)		339 (60.21)	1061 (58.01)	
Former	295 (20.51)	199 (20.86)		98 (17.41)	396 (21.65)	
Current	298 (20.72)	200 (20.96)		126 (22.38)	372 (20.34)	
Alcohol use, *n* (%)			0.001			0.001
Never	365 (25.38)	301 (31.55)		125 (22.20)	541 (29.58)	
Former	1,073 (74.62)	653 (68.45)		438 (77.80)	1,288 (70.42)	
Family income-poverty ratio, *n* (%)			0.064			0.800
< 2	671 (46.66)	482 (50.52)		274 (48.67)	879 (48.06)	
≥2	767 (53.34)	472 (49.48)		289 (51.33)	950 (51.94)	
MET minutes/week, *n* (%)			0.094			< 0.001
< 600	513 (35.67)	380 (39.83)		168 (29.84)	725 (39.64)	
600–4,000	533 (37.07)	320 (33.54)		208 (36.94)	645 (35.27)	
≥ 4,000	392 (27.26)	254 (26.62)		187 (33.21)	459 (25.10)	
Total energy intake, *n* (%)			0.813			0.076
Low	579 (40.26)	373 (39.10)		205 (36.41)	747 (40.84)	
Adequate	608 (42.28)	407 (42.66)		243 (43.16)	772 (42.21)	
High	251 (17.45)	174 (18.24)		115 (20.43)	310 (16.95)	

Note. SD, standard deviation; MET, metabolic equivalent.

Supplementary Table S2. Distributions of urinary phthalate and bisphenol concentrations (*N* = 2,392)

Chemicals (ng/mL)	Detection frequency (%)	Mean	Min	25% tile	50% tile	75% tile	Max
MBP	98.4	17.7	< LLOQ	5	10.5	19.8	1239.4
MCOP	99.6	37.6	< LLOQ	4.7	11.5	32.5	1813.1
MECPP	99.8	16.2	< LLOQ	5.1	9.9	17.8	629.1
MEP	99.7	188.3	< LLOQ	14.4	35.6	111	17358
BPA	94.1	2.7	< LLOQ	0.6	1.2	2.5	792
BPF	56.0	2.4	< LLOQ	0.1	0.3	0.9	246.5
BPS	90.6	1.4	< LLOQ	0.2	0.5	1.1	140.3

Note. LLOQ, the lower limit of detection; BPA, bisphenol A; BPF, bisphenol F; BPS, bisphenol S; MBP, Mono-n-butyl phthalate; MEP, mono-ethyl phthalate; MCOP, mono (carboxyoctyl) phthalate; MECPP, mono (2-ethyl-5-carboxypentyl) phthalate.

Supplementary Table S3. Association between ln-transformed concentration of single urinary chemical metabolites and obesity

Chemicals	Quartile	*OR* (95% *CI*)	*P*
MCOP	Ref.		
	2	1.33 (0.94, 1.88)	0.0988
	3	1.5 (0.99, 2.26)	0.0556
	4	1.77 (1.27, 2.45)	0.0013
P for trend			< 0.0001
MECPP	Ref.		
	2	2.07 (1.5, 2.86)	0.0001
	3	2.1 (1.58, 2.79)	< 0.0001
	4	2.38 (1.76, 3.21)	< 0.0001
P for trend			< 0.0001
MEP	Ref.		
	2	1.12 (0.81, 1.55)	0.4734
	3	1.47 (1.1, 1.97)	0.0113
	4	1.78 (1.15, 2.76)	0.0116
P for trend			< 0.0001
MBP	Ref.		
	2	1.96 (1.45, 2.64)	0.0001
	3	1.78 (1.31, 2.42)	0.0006
	4	2.23 (1.58, 3.15)	0.0001
P for trend			< 0.0001
BPA	Ref.		
	2	1.08 (0.85, 1.37)	0.5369
	3	1.45 (1.07, 1.98)	0.0194
	4	1.87 (1.4, 2.5)	0.0001
P for trend			< 0.0001
BPS	Ref.		
	2	1.2 (0.88, 1.63)	0.2461
	3	1.55 (1.14, 2.11)	0.0066
	4	1.47 (1.02, 2.11)	0.0384
P for trend			< 0.0001

Note. Models were adjusted for age, gender, race, education, family income-to-poverty ratio, smoking status, alcohol use, physical activity, and total energy intake; MBP, mono-n-butyl phthalate; MEP, mono-ethyl phthalate; MCOP, mono (carboxyoctyl) phthalate; MECPP, mono (2-ethyl-5-carboxypentyl) phthalate; BPA, bisphenol A; BPS, bisphenol S; OR, odds ratio.

Supplementary Table S4. Association between ln-transformed concentration of single urinary chemical metabolites and general obesity and central obesity

Chemicals	Quartile	General obesity *OR* (95% *CI*)	*P*	Central obesity *OR* (95% *CI*)	*P*
MCOP	Ref.				
	2	1.34 (0.95, 1.89)	0.091	1.4 (1, 1.96)	0.049
	3	1.5 (0.99, 2.26)	0.056	1.58 (1.12, 2.22)	0.011
	4	1.78 (1.28, 2.46)	0.001	1.5 (1.1, 2.05)	0.011
P for trend			< 0.0001		0.005
MECPP	Ref.				
	2	2.08 (1.51, 2.88)	< 0.0001	1.46 (1.03, 2.07)	0.033
	3	2.1 (1.58, 2.79)	< 0.0001	1.71 (1.14, 2.55)	0.011
	4	2.39 (1.77, 3.23)	< 0.0001	1.82 (1.22, 2.71)	0.005
P for trend			< 0.0001		< 0.0001
MEP	Ref.				
	2	1.13 (0.81, 1.57)	0.453	1.46 (1.01, 2.1)	0.042
	3	1.47 (1.1, 1.96)	0.012	1.31 (0.92, 1.86)	0.131
	4	1.79 (1.15, 2.76)	0.011	2.14 (1.3, 3.52)	0.004
P for trend			< 0.0001		< 0.0001
MBP	Ref.				
	2	1.94 (1.44, 2.62)	< 0.0001	1.22 (0.84, 1.77)	0.281
	3	1.78 (1.31, 2.41)	0.001	1.42 (0.89, 2.28)	0.138
	4	2.21 (1.56, 3.13)	< 0.0001	1.57 (1.02, 2.41)	0.039
P for trend			< 0.0001		< 0.0001
BPA	Ref.				
	2	1.08 (0.85, 1.38)	0.507	1.35 (0.97, 1.88)	0.071
	3	1.45 (1.07, 1.98)	0.02	1.56 (1.05, 2.32)	0.029
	4	1.87 (1.4, 2.51)	< 0.0001	1.88 (1.34, 2.62)	0.001
P for trend			< 0.0001		0.049
BPS	Ref.				
	2	1.2 (0.88, 1.64)	0.229	1.04 (0.74, 1.46)	0.796
	3	1.55 (1.14, 2.11)	0.007	1.22 (0.85, 1.77)	0.273
	4	1.47 (1.02, 2.12)	0.038	1.31 (0.88, 1.96)	0.174
P for trend			< 0.0001		0.003

Note. Models were adjusted for age, gender, race, education, family income-to-poverty ratio, smoking status, alcohol use, physical activity, and total energy intake; MBP, mono-n-butyl phthalate; MEP, mono-ethyl phthalate; MCOP, mono (carboxyoctyl) phthalate; MECPP, mono (2-ethyl-5-carboxypentyl) phthalate; BPA, bisphenol A; BPS, bisphenol S; OR, odds ratio.

Supplementary Table S5. Association between ln-transformed concentration of multi-chemical urinary metabolites and general obesity and central obesity

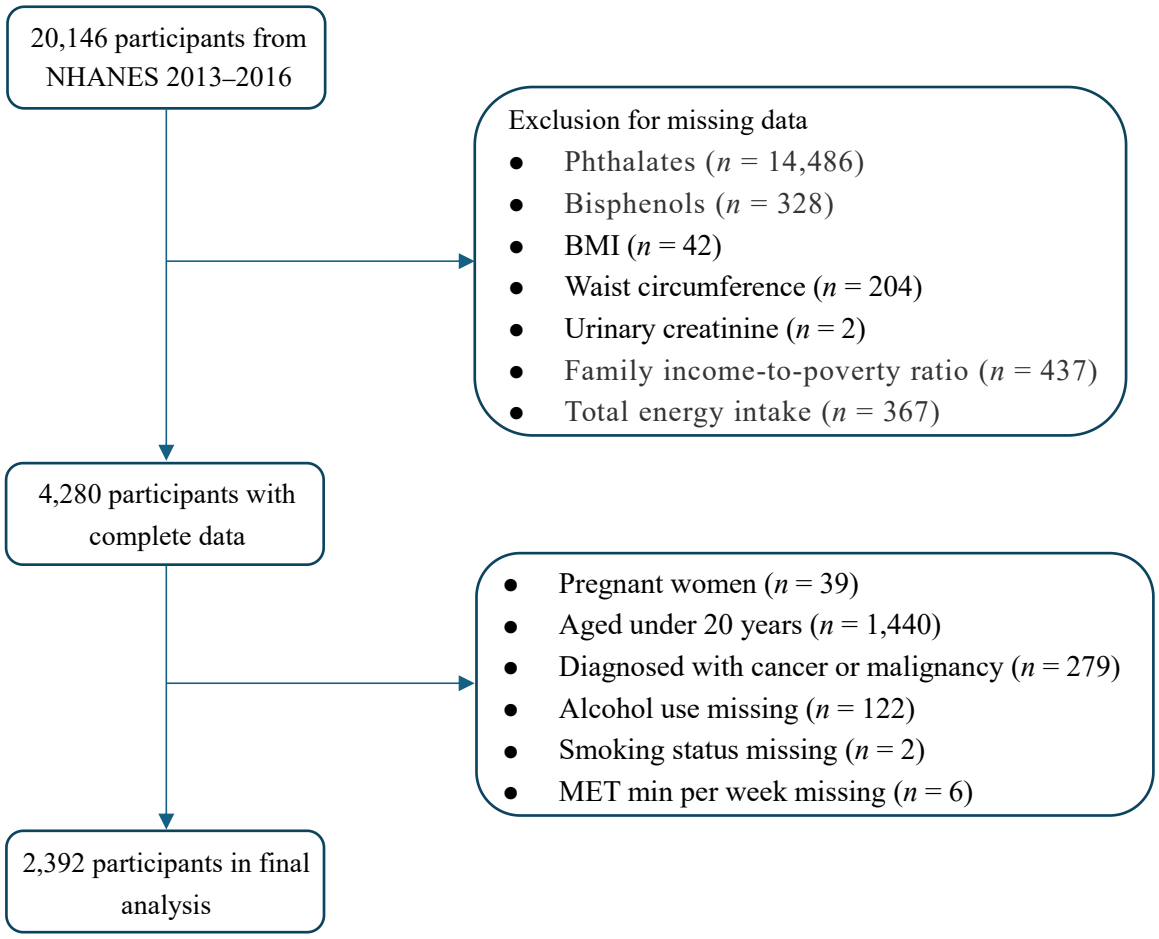
Chemicals	Quartile	General obesity *OR* (95% *CI*)	*P*	Central obesity *OR* (95% *CI*)	*P*
MCOP	Ref.				
	2	1.038 (0.718, 1.501)	0.8416	1.148 (0.825, 1.596)	0.4138
	3	1.118 (0.724, 1.725)	0.6161	1.225 (0.851, 1.763)	0.2754
	4	1.187 (0.862, 1.635)	0.2937	1.091 (0.732, 1.628)	0.6679
MECPP	Ref.				
	2	1.72 (1.149, 2.575)	0.0084	1.282 (0.905, 1.815)	0.1623
	3	1.558 (1.024, 2.371)	0.0384	1.382 (0.829, 2.303)	0.2145
	4	1.647 (1.075, 2.525)	0.022	1.429 (0.84, 2.433)	0.1883
MEP	Ref.				
	2	0.899 (0.644, 1.256)	0.534	1.286 (0.862, 1.92)	0.2182
	3	1.105 (0.828, 1.475)	0.4974	1.086 (0.788, 1.496)	0.6144
	4	1.327 (0.849, 2.074)	0.214	1.803 (1.039, 3.129)	0.0361
MBP	Ref.				
	2	1.491 (1.063, 2.091)	0.0208	0.944 (0.604, 1.477)	0.8013
	3	1.2 (0.844, 1.705)	0.3105	0.94 (0.53, 1.668)	0.8332
	4	1.306 (0.85, 2.006)	0.2232	0.908 (0.533, 1.545)	0.7212
BPA	Ref.				
	2	0.937 (0.742, 1.184)	0.5874	1.253 (0.88, 1.783)	0.2108
	3	1.07 (0.783, 1.463)	0.6719	1.262 (0.78, 2.041)	0.3439
	4	1.376 (1.016, 1.863)	0.0392	1.513 (1.01, 2.265)	0.0447
BPS	Ref.				
	2	0.957 (0.693, 1.321)	0.7889	0.864 (0.609, 1.226)	0.4139
	3	1.168 (0.867, 1.575)	0.3066	1.01 (0.682, 1.497)	0.96
	4	1.055 (0.731, 1.523)	0.7732	1.012 (0.678, 1.511)	0.9529

Note. Models were adjusted for age, gender, race, education, family income-to-poverty ratio, smoking status, alcohol use, physical activity, total energy intake, and other metabolite concentrations; MBP, mono-n-butyl phthalate; MEP, mono-ethyl phthalate; MCOP, mono (carboxyoctyl) phthalate; MECPP, mono (2-ethyl-5-carboxypentyl) phthalate; BPA, bisphenol A; BPS, bisphenol S; OR, odds ratio.

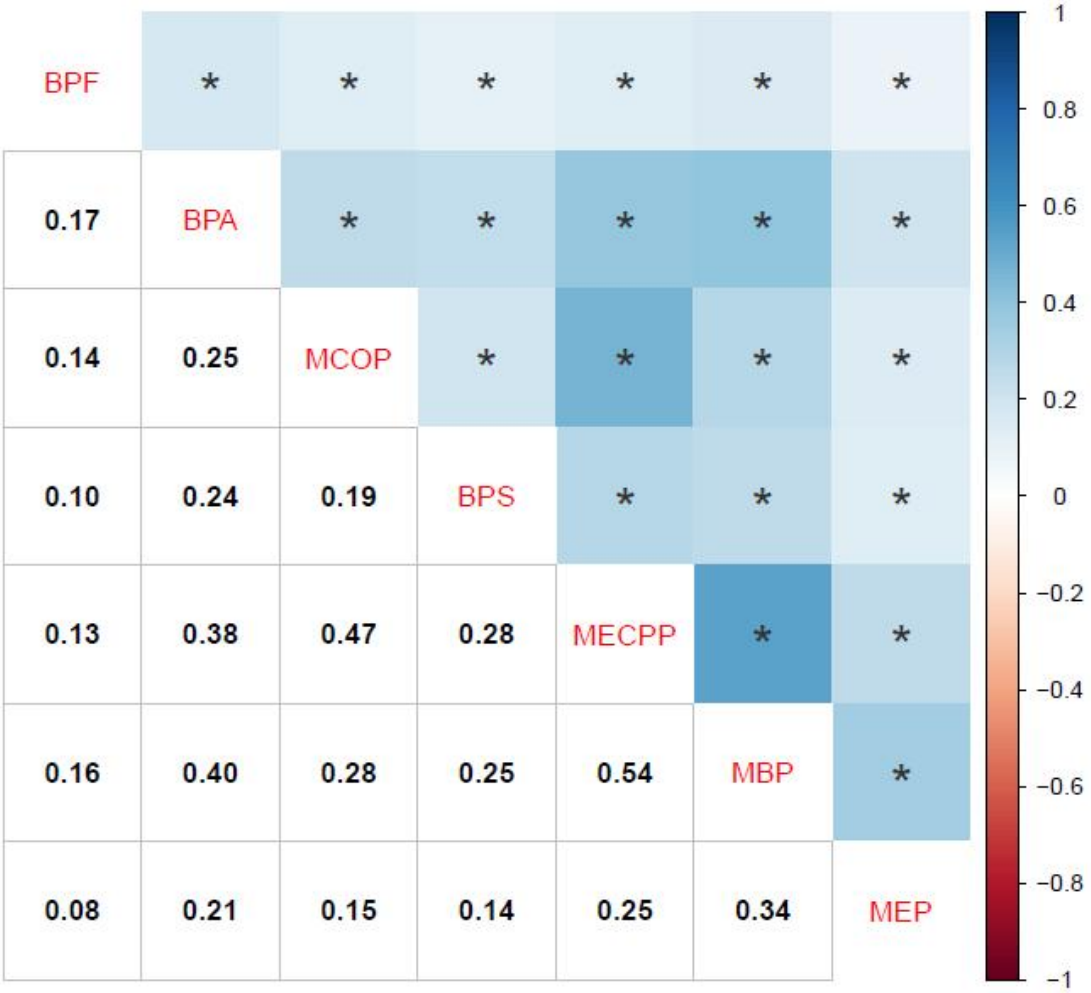
Supplementary Table S6. Estimated posterior inclusion probability (PIP) for all individual chemicals.

Chemicals	Obesity	General obesity	Central obesity
MBP	0.86	0.80	0.24
MCOP	1.00	0.98	0.56
MECPP	0.69	0.68	0.73
MEP	0.83	0.74	0.75
BPA	0.82	0.80	0.26
BPS	1.00	0.99	0.45

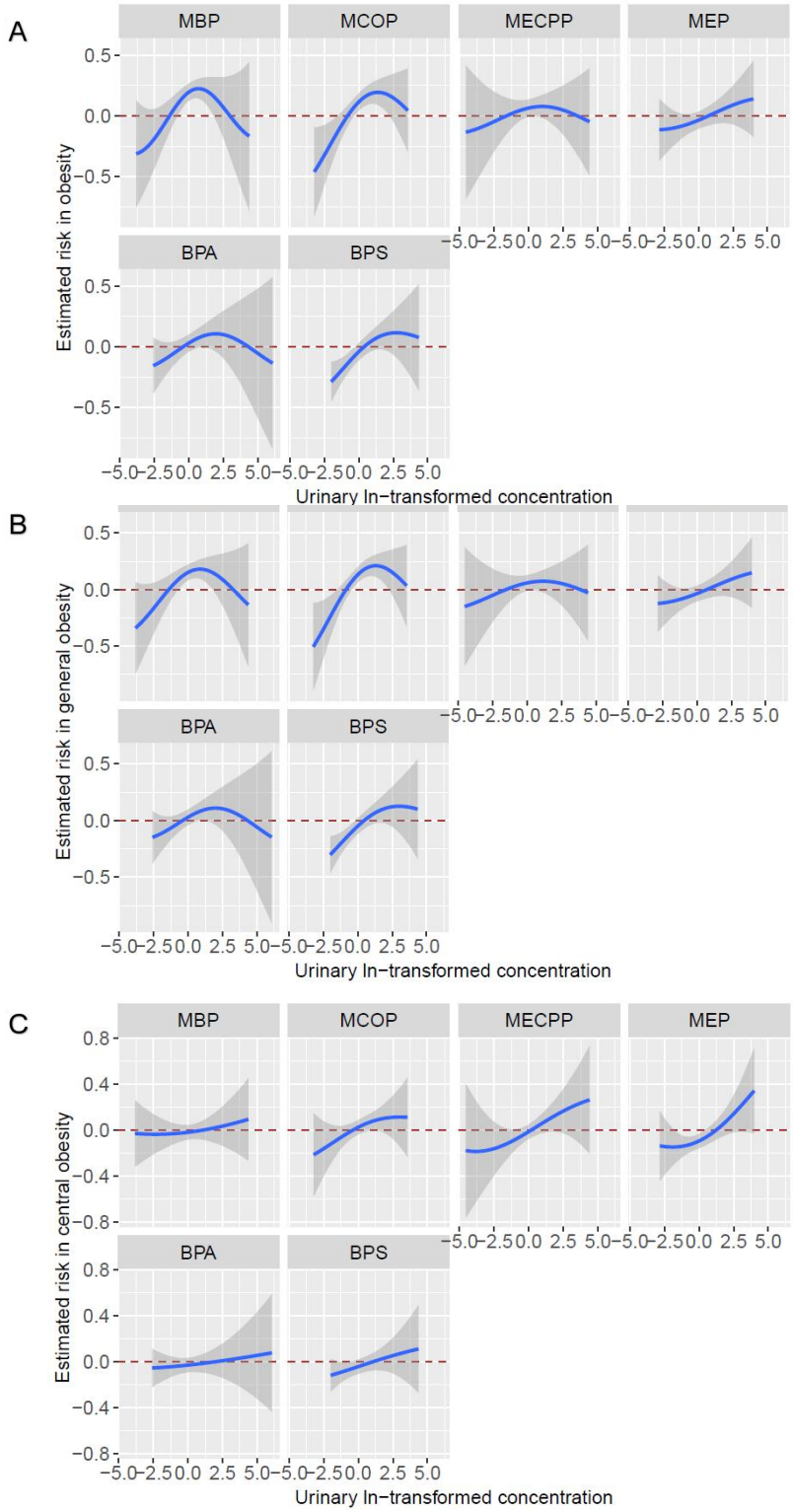
Note. Models were adjusted for age, gender, race, education, family income-to-poverty ratio, smoking status, alcohol use, physical activity, and total energy intake; MBP, mono-n-butyl phthalate; MEP, mono-ethyl phthalate; MCOP, mono (carboxyoctyl) phthalate; MECPP, mono (2-ethyl-5-carboxypentyl) phthalate; BPA, bisphenol A; BPS, bisphenol S.



Supplementary Figure S1. Flowchart of participant selection from NHANES 2013–2016.

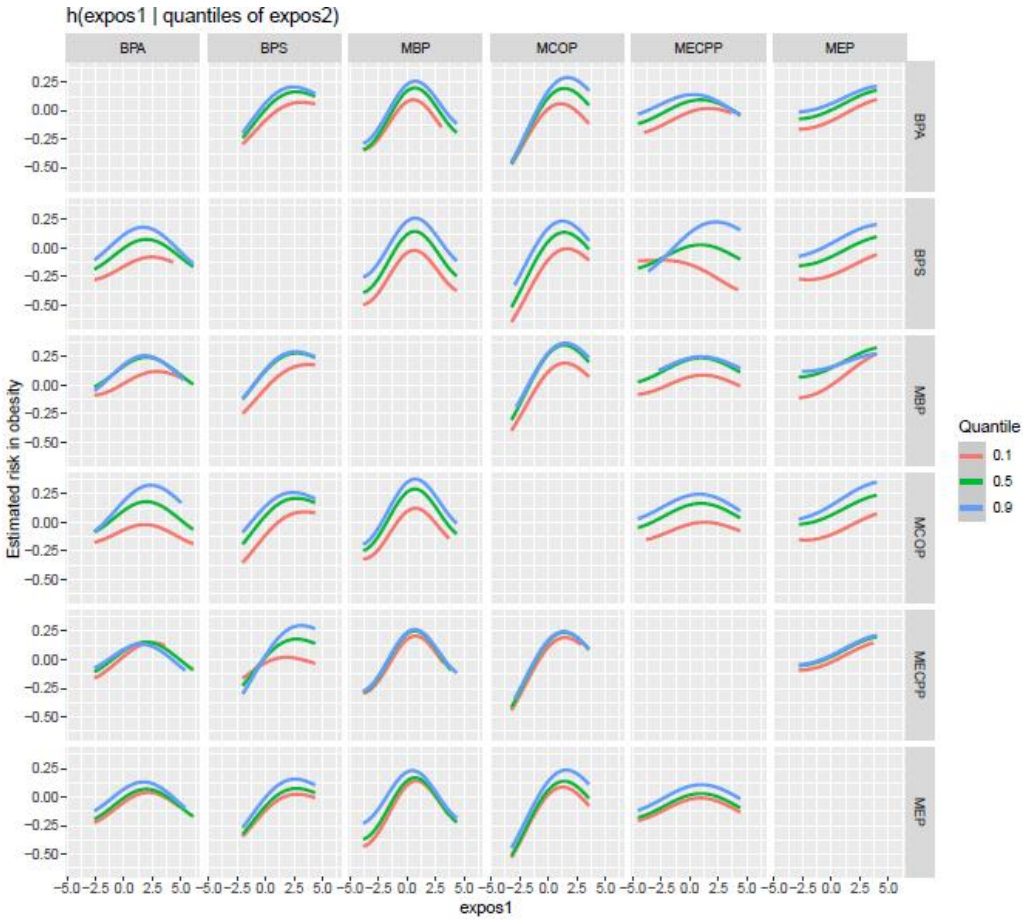


Supplementary Figure S2. Pairwise Pearson correlations among urinary concentrations of seven urinary chemical metabolites in the population (N=2392), NHANES, USA, 2013–2016. *, statistical significance (p < 0.05). MBP, mono-n-butyl phthalate; MEP, mono-ethyl phthalate; MCOP, mono (carboxyoctyl) phthalate; MECPP, mono (2-ethyl-5-carboxypentyl) phthalate; BPA, bisphenol A; BPS, bisphenol S; BPF, bisphenol F.

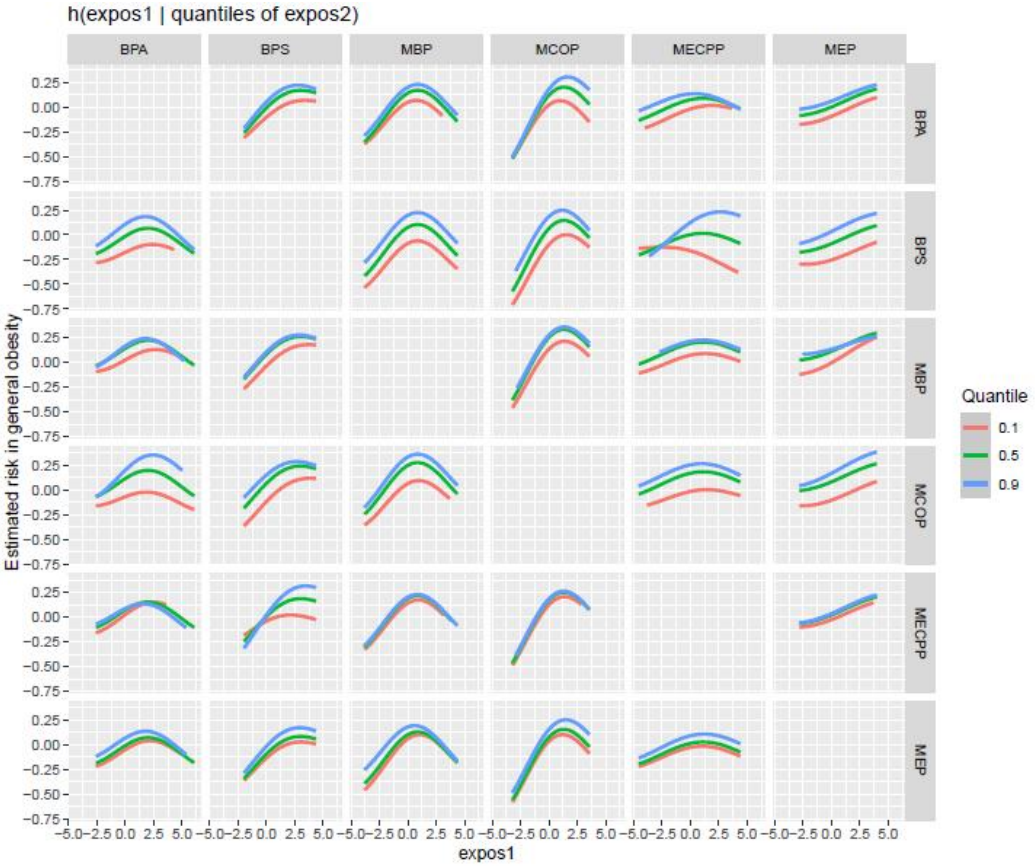


Supplementary Figure S3. Univariate exposure-response functions (95% CI) for obesity (A), general obesity (B) and central obesity (C) with a single ln-transformed urinary chemical, while the other six ln-transformed urinary chemicals are fixed at the median. Models were adjusted for age, gender, race, education, family income-to-poverty ratio, smoking status, alcohol use, physical activity, and total energy intake.

A


h(expos1 | quantiles of expos2)
BPA
BPS
MBP
MCOP
MECPP
MEP
Estimated risk in obesity
expos1
Quantile
0.1
0.5
0.9

B


h(expos1 | quantiles of expos2)
BPA
BPS
MBP
MCOP
MECPP
MEP
Estimated risk in general obesity
expos1
Quantile
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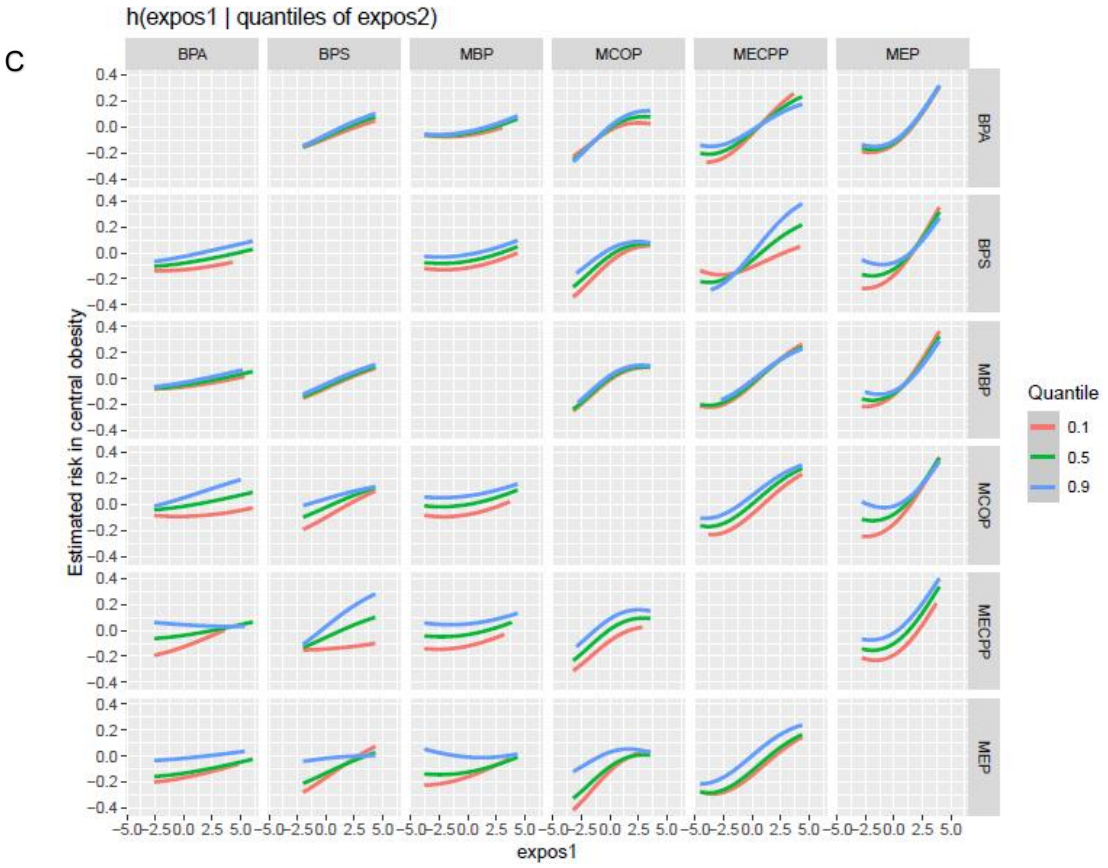
0.5
0.9



Supplementary Figure S4. Mean difference in obesity (A), general obesity (B) and central obesity (C) as bivariate exposure-response functions for each of the exposure1 chemicals when exposure2 chemicals were at their 10th, 50th and 90th percentiles, and other chemicals were fixed at their median levels. Models were adjusted for age, gender, race, education, family income-to-poverty ratio, smoking status, alcohol use, physical activity, and total energy intake.