731 **Supplemental Information**

732 **Predictors of Urinary and Blood Metal(loid) Concentrations among Pregnant Women in**

733 **Northern Puerto Rico**

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736 **Table of Contents:**

737　Table S1. Demographic characteristics of n = 1,040 pregnant women from Puerto Rico (2011– 2017)

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variable	Mean (SD)	
maternal age	26.7 (5.5)	
parity (# live births)	0.7 (0.8)	
characteristic	**category**	**count (percent)**
Insurance type	private	607 (58.4%)
	public (mi salud)	351 (33.8%)
	missing	82 (7.9%)
maternal education	<=high school/ged	214 (22.5%)
	some college or technical school	359 (37.8%)
	college degree	312 (32.8%)
	master's degree or higher	36 (3.8%)
	missing	29 (3.1%)
household income	<$10,000	266 (25.6%)
	≥$10,000 to <$30,000	287 (27.6%)
	≥$30,000 to <$50,000	207 (19.9%)
	≥$50,000	117 (11.3%)
	missing	163 (15.7%)
marital status	single	206 (19.8%)
	married or living together	801 (77%)
	missing	33 (3.2%)
gravidity (# pregnancies)	0	415 (39.9%)
	1	363 (34.9%)
	>1	229 (22%)
	missing	33 (3.2%)
prepregnancy BMI (kg m−2)	≤25	535 (51.4%)
	>25 to ≤30	309 (29.7%)
	>30	166 (16%)

	missing	30 (2.9%)
smoke during pregnancy	yes	9 (1.1%)
	no	787 (98.6%)
employment status	unemployed	626 (62.6%)
	employed	337 (33.7%)
	missing	37 (3.7%)
smoking	never	852 (81.9%)
	ever	144 (13.8%)
	current	12 (1.2%)
	missing	32 (3.1%)
exposure to second hand smoking	none	860 (82.7%)
	up to 1 hour	43(4.1%)
	more than 1 hour	66(6.3%)
	missing	71(6.8%)
alcohol consumption	none	511(49.1%)
	before pregnancy	434(41.7%)
	within the last few months	59(5.7%)
	missing	36(3.5%)

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752 Table S2. Uncorrected urinary biomarker concentrations (ng/ml) in n = 660 pregnant women from Puerto Rico[a] in 2011– 2017 and
753 comparison with U.S. population-based samples of women ages 18– 40 from NHANES.[b,c]
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	Cohort	N (Sample)	LOD	% >LOD	GM	GSD	25%	50%	75%	95%	P value[d]
As	PROTECT	1285	0.3	100	10.9	2.5	6.1	10.8	19.0	46.4	<0.01**
	NHANES	1562	0.26-1.25	97.6	7.3	3.2	3.3	6.4	13.3	62.3	
Ba	PROTECT	1285	0.1	99.3	2.5	2.9	1.3	2.5	5.0	12.9	<0.01**
	NHANES	1561	0.06-0.12	99.5	1.1	2.8	0.58	1.1	2.3	5.6	
Cd	PROTECT	1285	0.06	74.5	0.12	2.3	0.06	0.12	0.20	0.58	<0.01**
	NHANES	1561	0.036-0.056	85.7	0.14	2.8	0.06	0.15	0.28	0.75	
Co	PROTECT	1285	0.05	100	1.0	1.9	0.70	1.0	1.5	2.8	<0.01**
	NHANES	1561	0.023-0.048	99.6	0.44	2.5	0.25	0.41	0.81	1.8	
Cs	PROTECT	1285	0.01	100	4.9	1.7	3.7	5.3	7.1	10.7	<0.01**
	NHANES	1561	0.066-0.12	100	3.8	2.1	2.3	4.1	6.4	11.4	
Cu	PROTECT	1285	2.5	99.3	14.0	1.8	10.0	14.2	19.5	34.5	
	NHANES										
Hg	PROTECT	1285	0.05	98.6	0.60	2.9	0.30	0.59	1.2	3.6	<0.01**
	NHANES	1565	0.05-0.13	69.7	0.28	2.9	<LOD	0.25	0.55	1.8	
Mn	PROTECT	1285	0.08	100	1.2	1.6	0.95	1.2	1.6	2.3	<0.01**
	NHANES	1131	0.08-0.13	42.8	0.12	1.8	<LOD	<LOD	0.16	0.34	
Mo	PROTECT	1285	0.3	100	58.9	2.0	38.9	62.9	92.2	166	<0.01**
	NHANES	1560	0.8-0.99	100	36.1	2.5	19.6	39.4	69.8	139	
Ni	PROTECT	1285	0.8	98.9	5.4	2.0	3.5	5.5	8.5	15.5	
	NHANES										
Pb	PROTECT	1285	0.1	72.1	0.25	2.7	<LOD	0.27	0.51	1.2	0.11
	NHANES	1561	0.03-0.10	96.2	0.27	2.5	0.15	0.27	0.48	1.2	
Sb	PROTECT	1285	0.04	90	0.09	1.9	0.06	0.08	0.12	0.22	<0.01**

	NHANES	1561	0.022-0.041	69.4	0.05	2.3	<LOD	0.05	0.08	0.21	
Sn	PROTECT	1285	0.1	100.0	2.1	3.0	1.0	1.9	4.0	14.0	<0.01**
	NHANES	1130	0.09-0.22	86.2	0.43	3.2	0.18	0.38	0.88	3.3	
Zn	PROTECT	1285	2	100	266	2.5	155	300	498	947	
	NHANES										

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756 [a] Includes biomarker concentrations for up to 3 repeated samples per woman (n = 1,285 samples); [b] Females 18−40 years of age; n = 1,604 for
757 biomarkers measured in 2009-2010, 2011-2012, 2013-2014, and 2015-2016 NHANES; [c] NHANES, National Health and Nutrition Examination
758 Survey; LOD, limit of detection; GM, geometric mean, GSD, geometric standard deviation; [d] P value for two sample t-test comparing geometric
759 mean of chemical concentration in two cohorts; **P <0.01
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Table S3. Blood biomarker concentrations (ng/ml) in n = 842 pregnant women from Puerto Rico[a] in 2011– 2017 and comparison with U.S. population-based samples of women ages 18– 40 from NHANES.[b,c]

	Cohort	N (Sample)	LOD	% >LOD	GM	GSD	25%	50%	75%	95%	P value[d]
As	PROTECT	1183	0.3	48.9	0.34	1.8	0.21	0.21	0.48	1.0	
	NHANES										
Cd	PROTECT	1183	0.1	60.9	0.12	1.7	0.07	0.12	0.16	0.27	<0.01**
	NHANES	3393	0.1-0.16	83.0	0.31	2.2	0.17	0.28	0.48	1.4	
Co	PROTECT	1183	0.2	98.2	0.34	1.4	0.28	0.34	0.41	0.57	
	NHANES										
Cs	PROTECT	1183	0.04	99.9	1.1	1.4	0.94	1.2	1.4	1.9	
	NHANES										
Cu	PROTECT	1183	9	99.9	1552	1.3	1393	1562	1740	2096	
	NHANES										
Hg	PROTECT	1183	0.2	99.9	1.2	1.7	0.85	1.2	1.7	3.0	<0.01**
	NHANES	3393	0.16-0.28	87.9	0.74	2.5	0.37	0.67	1.4	4.0	
Mn	PROTECT	1183	2	99.9	11.3	1.4	9.0	11.3	14.0	19.4	<0.01**
	NHANES	2174	0.99-1.06	100.0	10.7	1.4	8.4	10.6	13.6	19.2	
Ni	PROTECT	1183	0.5	96.4	1.0	1.6	0.81	1.0	1.3	2.2	
	NHANES										
Pb	PROTECT	1183	0.02	99.9	3.3	1.6	2.5	3.3	4.3	6.4	<0.01**
	NHANES	3393	0.7-2.5	98.8	6.4	1.8	4.4	6.1	9.0	16.9	
Zn	PROTECT	1183	24	99.9	4682	1.3	4248	4752	5252	6055	
	NHANES										

[a] Includes biomarker concentrations for up to 2 repeated samples per woman (n = 1,183 samples); [b] Females 18−40 years of age; n = 3,585 for biomarkers measured in 2009-2010, 2011-2012, 2013-2014, and 2015-2016 NHANES; [c] NHANES, National Health and Nutrition Examination Survey; LOD, limit of detection; GM, geometric mean, GSD, geometric standard deviation; [d] P value for two sample t-test comparing geometric mean of chemical concentration in two cohorts; **P <0.01

Table S4. Geometric means of urinary (SG-corrected) and blood concentrations of metal(loid)s according to demographic, and maternal factors[a,b].

Variable	Urinary metal(loid)s						Blood metal(loid)s					
	As	Cd	Co	Cs	Mo	Sb	Cd	Cu	Hg	Mn	Pb	Zn
overall	10.9	0.12	1.0	4.9	1.2	0.09	0.12	1552	1.2	11.3	3.3	4682
maternal age (years)												
<25		0.11		5.0		0.10	0.11		1.1			
25-30		0.13		5.4		0.09	0.11		1.3			
>30		0.17		5.8		0.09	0.13		1.3			
p value		**<0.001****		**<0.001****		**<0.001****	**0.02****		**<0.001****			
maternal education												
<=high school/ged				4.8		0.10			1.1	11.7	4.05	
some college or technical school				5.3		0.10			1.2	11.4	3.20	
college degree				5.6		0.08			1.3	10.9	2.99	
master's degree or higher				5.7		0.08			1.5	11.0	3.28	
p value				**<0.001****		**<0.001****			**<0.001****	**0.01****	**<0.001****	
parity (# pregnancies)												
0		0.12					0.11	1516		10.8	3.09	
1		0.13					0.11	1589		11.3	3.34	
>1		0.14					0.13	1560		12.2	3.75	
p value		**0.003****					**0.01****	**0.03****		**<0.001****	**<0.001****	
prepregnancy BMI (kg /m^2)												
≤25		0.12					0.12	1477		10.9		4585
>25 to ≤30		0.14					0.12	1603		11.7		4759
>30		0.14					0.10	1684		11.6		4825
p value		**0.004****					**<0.001****	**<0.001****		**0.01****		**0.005****
smoking												
never			1.1				0.11				3.23	
ever			1.2				0.13				3.75	
current			0.9				0.25				4.21	
p value (ever vs never)			**<0.001****				**<0.001****				**0.001****	
p value (current vs never)							**<0.001****					

[a] Results shown for food items with association detected; [b] p-values from linear mixed effects models accounting for within-person correlations;
*P from 0.1 to 0.05, **P <0.05

796 Table S5. Frequencies of product use, dietary supplement intake, food consumption, and water use and sources in the 48-h recall questionnaire and
797 geometric mean urinary (SG-corrected) and blood concentrations of metal(loid)s (ng/mL) associated with self-reported use or non-use[ab].
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		Urinary metal(loid)s								Blood metal(loid)s							
Variable	Use	n[c]=660	N[d]=1285	As	Cd	Co	Cs	Mo	Sb	n[c]=842	N[d]=1183	Cd	Cu	Hg	Mn	Pb	Zn
Products																	
cosmetic	yes	435	845						0.09	568	787		1531	1.3	11.0	3.2	
	no	146	308						0.10	185	259		1604	1.1	11.7	3.6	
	p value								**0.01****				**0.01****	**0.02****	**0.01****	**0.01****	
perfume	yes	484	965	11.5	**0.13**	1.1		62.7		628	868						
	no	97	188	13.1	**0.12**	1.2		69.9		124	176						
	p value			**0.05***	**0.05***	**0.04****		**0.02****									
shaving cream	yes	48	94			1.1	5.5			67	90		1471	1.2			
	no	533	1060			1.1	5.4			687	957		1556	1.2			
	p value					0.77	0.93						0.16	0.23			
shampoo	yes	409	815							541	743				11.0		
	no	172	338							213	302				11.6		
	p value														0.10		
hairspray	yes	196	395						0.10	243	337						
	no	384	759						0.09	507	705						
	p value								0.12								
other hair product	yes	81	81	10.2		1.0				109	112		1457		10.1	3.1	4366
	no	499	1073	11.9		1.1				645	934		1560		11.3	3.3	4716
	p value			0.21		**0.06***							**0.01****		**<0.001****	**0.01****	**0.002****
store pesticide	yes	342	668	11.1						467	643				10.9	3.1	
	no	238	483	12.7						285	401				11.5	3.6	
	p value			**0.01****											**0.004****	**<0.001****	
Food items																	
milk	yes	485	979			**1.1**	**5.5**			622	873						
	no	96	174			**1.0**	**4.7**			133	175						
	p value					**0.02****	**<0.001****										
meat	yes	360	729							470	654	0.12					
	no	221	424							285	394	0.11					

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p value												**0.01**		
fish	yes	106	211	**14.99**				59.3		144	182	1485	1.5	
	no	475	942	**11.11**				64.8		611	866	1563	1.2	
p value				**<0.001*****				**0.03****				**0.03****	**<0.001*****	
cold cuts	yes	360	719	11.2	0.13					476	663			11.2
	no	221	433	12.7	0.14					279	385			11.0
p value				**0.04****	**0.05***									0.46
peanut butter	yes	45	101			**1.2**		69.1		64	90			
	no	535	1051			**1.1**		63.3		690	957			
p value						**0.04****		0.10						
can foods	yes	303	601							393	557		1.3	
	no	277	551							362	491		1.1	
p value													**<0.001*****	
spinach	yes	35	69				6.1			46	57			
	no	545	1083				5.3			709	991			
p value							**0.01****							
tomatoes	yes	218	442							293	409	0.12	1.3	
	no	362	710							462	639	0.11	1.2	
p value												**0.02****	**0.01****	
collard	yes	42	72							31	40	0.14		
	no	538	1080							724	1008	0.12		
p value												**0.01****		
Supplements														
folic acid	yes	172	344			1.2	5.7	67.4	0.10	213	298			
	no	434	864			1.1	5.2	62.3	0.09	606	856			
p value						**0.05***	**<0.001****	**0.03****	**0.001****					
multi-vitamin	yes	570	1145	0.13						775	1089	0.12		
	no	38	68	0.15						45	66	0.13		
p value				0.27								0.19		
iron supplement	yes	36	64					73.07		36	48			
	no	569	1142					63.19		779	1101			
p value								**0.06***						
Water usage														
water source	bottled	236	479				5.7			361	507			3.0

for drinking [a]	public	382	742		5.2		446	629	3.6
p value					**0.001****				**<0.001****
water treatment	yes	147	299				162	231	10.7
	no	471	923				650	913	11.3
p value									**0.04****
water filtration frequency [b]	~ never	235	469			65.7	289	398	
	~ 1/4 of the time	51	97			61.2	60	86	
	~ 1/2 of the time	51	93			60.3	66	99	
	~ 3/4 of the time	22	42			63.3	59	80	
	always	247	496			62.6	327	465	
p value (yes/no)						0.13			
cistern material [c]	plastic	193	370	0.12			211	307	
	metal	10	18	0.16			12	18	
	other	13	32	0.13			14	21	
p value				**0.02****					

[a] Results shown for food items with association detected; [b] p-values are from linear mixed effects models accounting for within-person correlations: *P from 0.1 to 0.05, **P <0.05; [c] number of participants; [d] N number of samples

819 Table S6. Frequencies of selected food type consumption reported in second visit and sg-corrected urinary geometric mean concentrations of
820 metal(loid) biomarkers (ng/ml) associated with self-reported frequency[a].
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Food Item	Frequency category	n[c]	As	Ba	Cd	Co	Cs	Cu	Hg	Mn	Mo	Ni	Pb	Sb	Sn	Zn
fish	Never	22	11.3	2.9	0.22	1.3	5.2	14.8	0.63	1.2	76.9	5.9	0.34	0.10	2.0	349
	<1 per month	46	11.7	2.8	0.13	1.1	5.5	14.7	0.66	1.4	73.0	6.5	0.29	0.09	2.5	272
	1 per month	44	10.5	3.0	0.14	1.3	5.6	15.2	0.60	1.3	65.9	6.6	0.25	0.09	2.6	236
	2–3 per month	55	11.6	2.5	0.12	1.1	5.2	13.5	0.59	1.3	57.4	5.9	0.26	0.09	1.9	245
	1 per week	12	12.3	3.0	0.08	1.1	5.7	18.8	0.94	1.3	67.5	8.8	0.18	0.08	4.3	248
	3–4 per week and more	13	16.6	2.5	0.1	1.0	5.4	14.6	0.44	1.2	76.2	5.4	0.20	0.09	1.9	400
P value[b]			0.20	0.61	**0.02****	**0.06***	0.96	0.95	0.51	0.62	0.37	0.90	**0.04****	0.52	0.89	0.90
rice	2–3 per month or less	19	8.7	2.9	0.12	1.1	4.9	13.9	0.72	1.4	60.6	5.6	0.29	0.09	2.1	257
	1 per week	11	10.5	2.2	0.08	1.1	5.3	12.0	0.49	1.3	57.3	5.4	0.23	0.09	1.9	185
	2 per week	25	11.2	3.3	0.23	1.3	5.7	14.6	0.73	1.2	67.3	6.2	0.20	0.07	2.0	240
	3–4 per week	65	10.5	2.6	0.12	1.2	5.9	15.7	0.52	1.4	65.4	7.4	0.23	0.10	2.5	288
	5-6 per week	30	15.2	2.7	0.14	1.0	5.4	15.0	0.80	1.3	74.1	5.6	0.30	0.09	2.6	253
	1 per day and more	37	13.4	3.5	0.15	1.2	4.8	14.5	0.58	1.2	69.3	6.4	0.37	0.10	2.6	332
P value[b]			**0.02****	0.50	0.55	0.77	0.65	0.51	0.83	0.35	0.25	0.57	**0.09***	0.20	0.27	**0.09***

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823 [a] Results shown for food items with association detected; [b] p-values are from linear mixed effects models accounting for within-person correlations: *P from 0.1 to
824 0.05, **P <0.05; [c] n=449 for total number of participants in second visit
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836 Table S7. Frequencies of selected food type consumption reported in second visit and blood geometric mean concentrations of metal(loid)
837 biomarkers (ng/ml) measured in third visit associated with self-reported frequency[a]
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Food item	Frequency category	n[c]	As	Cd	Co	Cs	Cu	Hg	Mn	Ni	Pb	Zn
	<1 per month	40	0.40	0.11	0.38	1.0	1614	1.3	12.3	1.1	3.3	4638
	1 per month	41	0.31	0.12	0.36	1.1	1623	1.2	12.6	1.1	3.2	4815
	2–3 per month	89	0.31	0.11	0.39	1.1	1613	1.1	12.7	1.0	3.4	4776
Meat	1 per week	32	0.32	0.14	0.36	1.1	1489	1.2	11.5	0.94	3.3	4698
	2 per week	29	0.31	0.13	0.38	1.2	1571	1.2	11.6	1.0	3.3	4681
	3–4 per week and more	26	0.31	0.14	0.43	1.0	1669	1.1	11.9	1.2	3.2	4628
P value[b]			0.16	**0.02****	0.27	0.35	0.78	0.26	0.26	0.80	0.76	0.69
	Never	51	0.29	0.11	0.40	1.0	1635	0.9	12.5	1.0	3.3	4856
	<1 per month	46	0.35	0.12	0.38	1.0	1596	1.1	12.3	1.1	3.4	4726
	1 per month	62	0.30	0.13	0.38	1.1	1667	1.2	12.7	1.0	3.3	4780
fish	2–3 per month	69	0.32	0.12	0.36	1.1	1547	1.3	11.6	1.0	3.1	4561
	1 per week	14	0.43	0.12	0.35	1.2	1525	1.3	12.6	1.0	3.4	4717
	3–4 per week and more	18	0.43	0.11	0.45	1.4	1514	1.4	13.5	0.94	3.8	4925
P value[b]			**0.02****	0.54	0.71	**<0.01****	0.06	**<0.01****	0.91	0.20	0.73	0.60

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841 [a] Results shown for food items with association detected; [b] p-values are from linear mixed effects models accounting for within-person correlations: **P <0.05; [c]
842 n=505 for total number of participants in third visit;
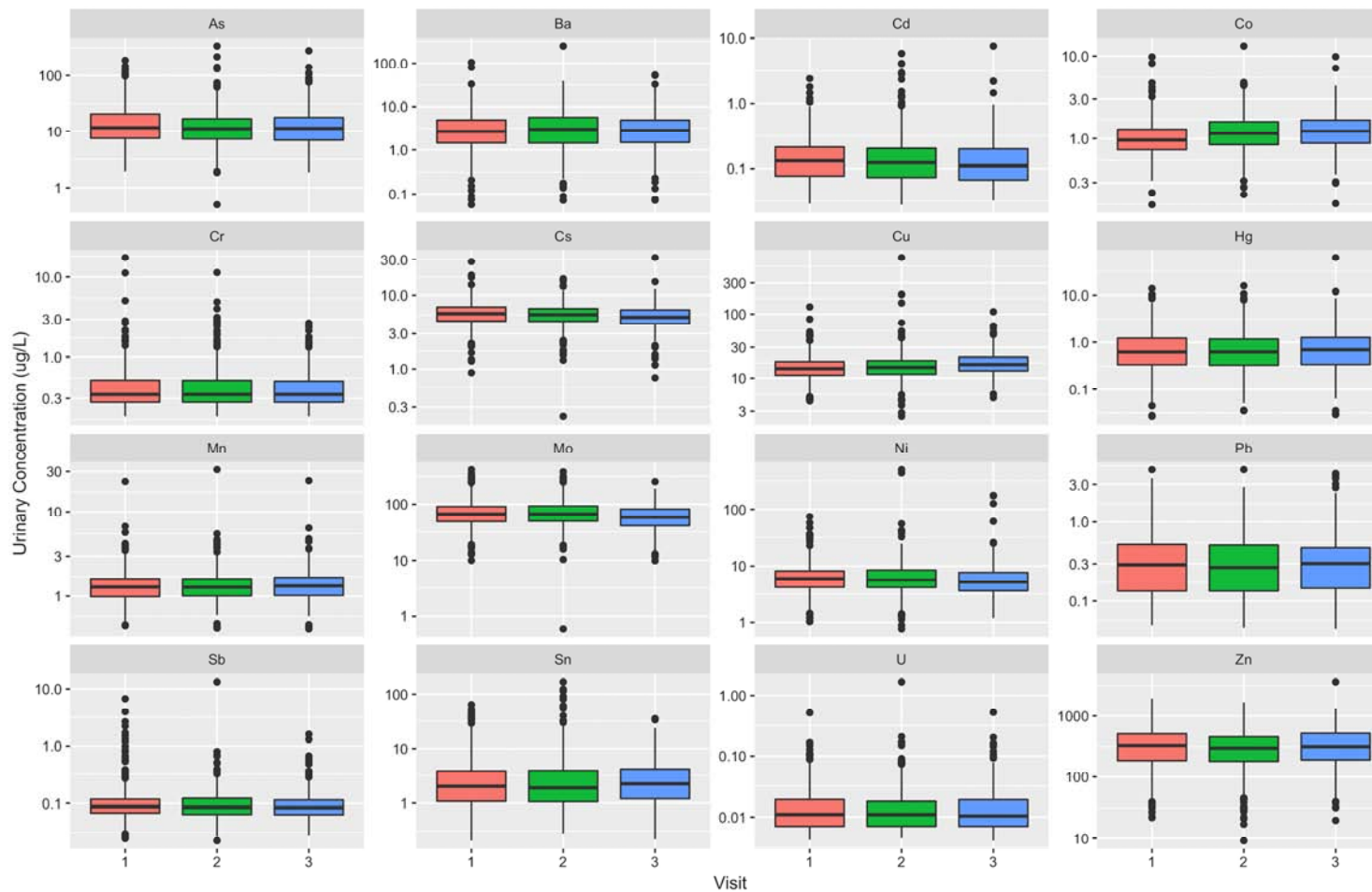843
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851   Figure S1. SG-corrected urinary concentrations (ng/mL) of metal(loid)s by study visit (n=1285)[a].
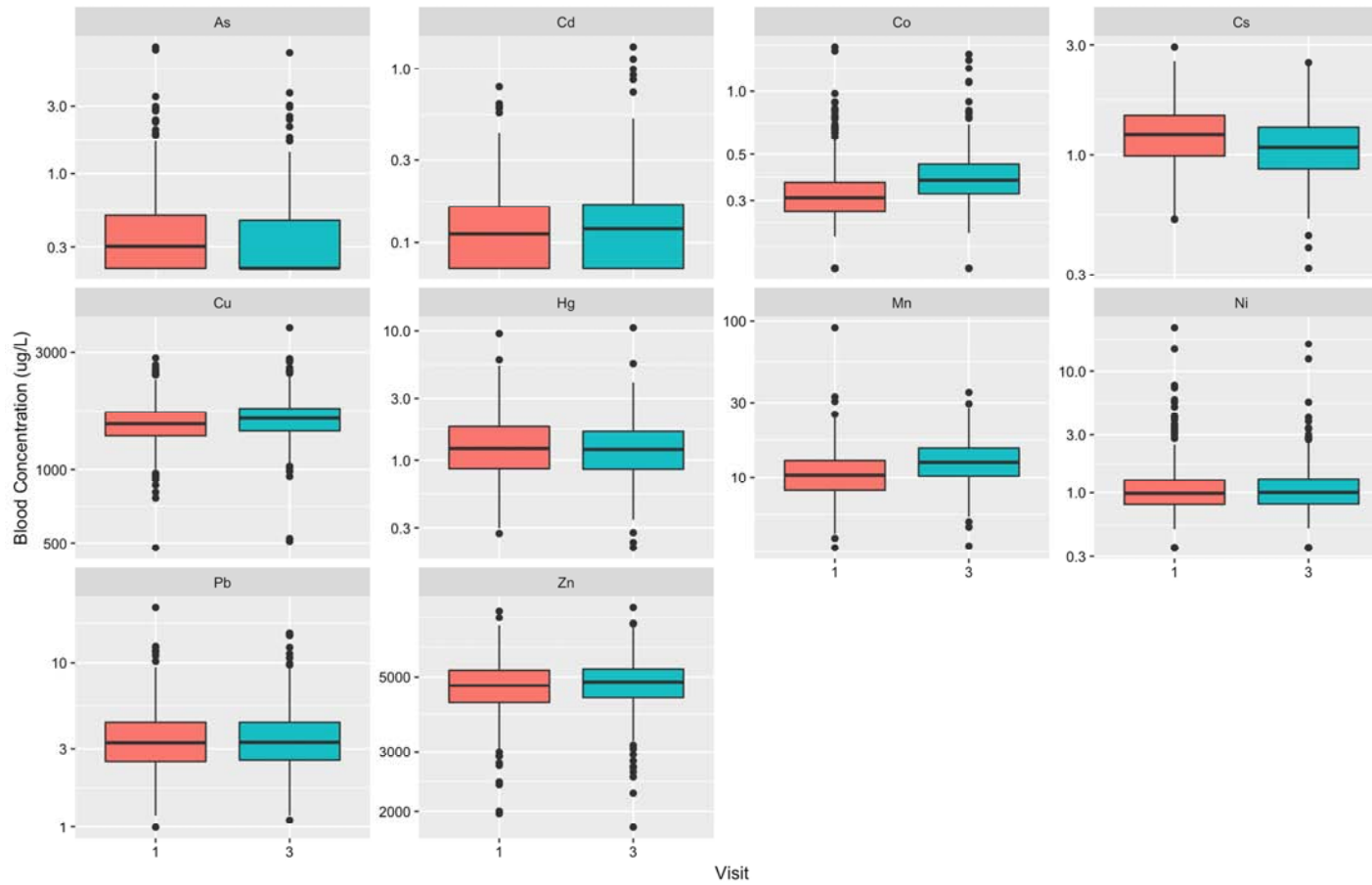

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853   [a] Number of participants in each visit were 500, 449, and 336 respectively.

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857 Figure S2. Blood concentrations(ng/mL) of metal(loid)s by study visit (n=1183)[a].

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859 [a] Number of participants in 1st and 3rd visits were 678 and 505, respectively.
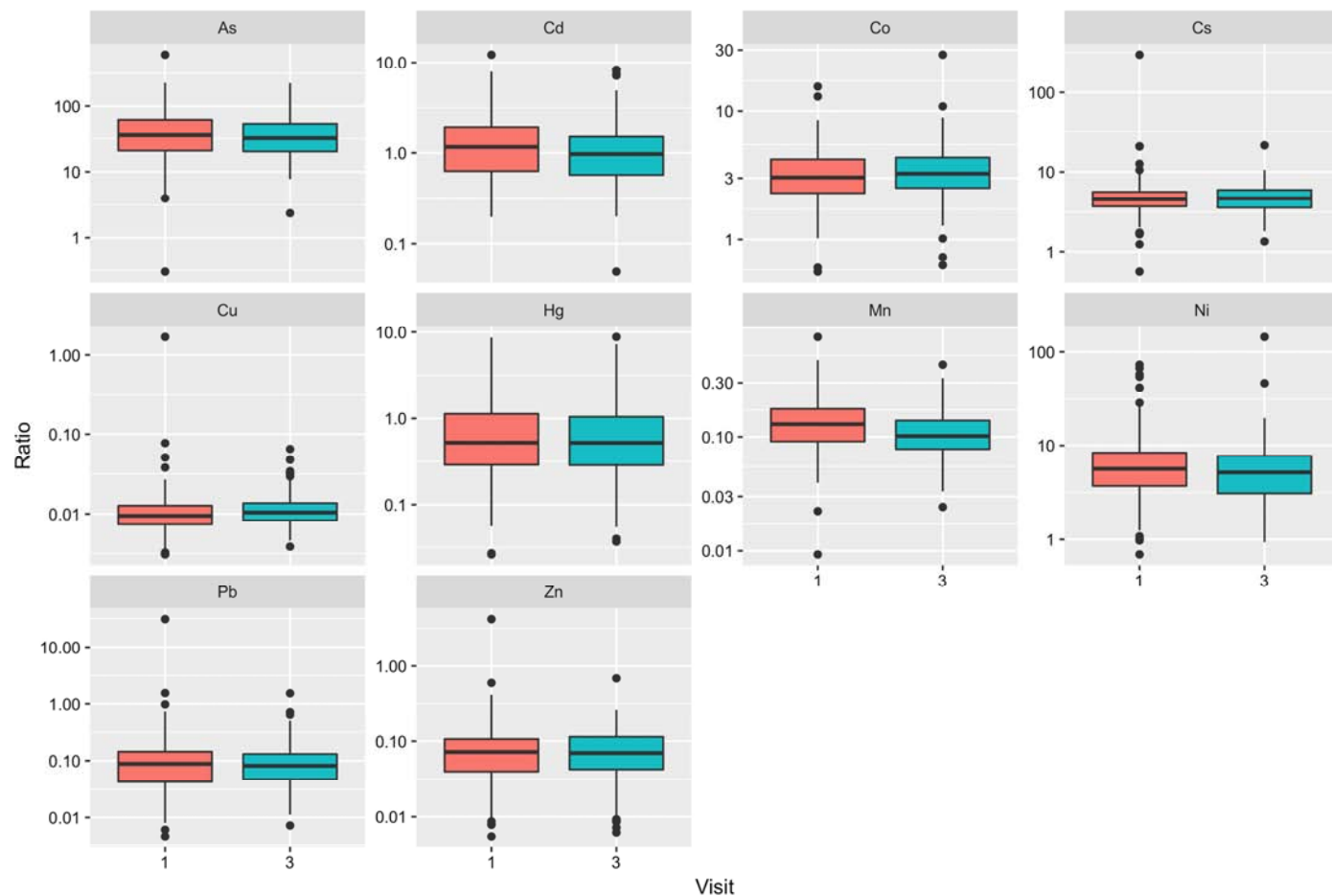
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864   Figure S3. Urine/blood ratio distribution by study visit (n=509)[a].
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867   [a] Number of participants in 1st and 3rd visits were 309 and 200, respectively.
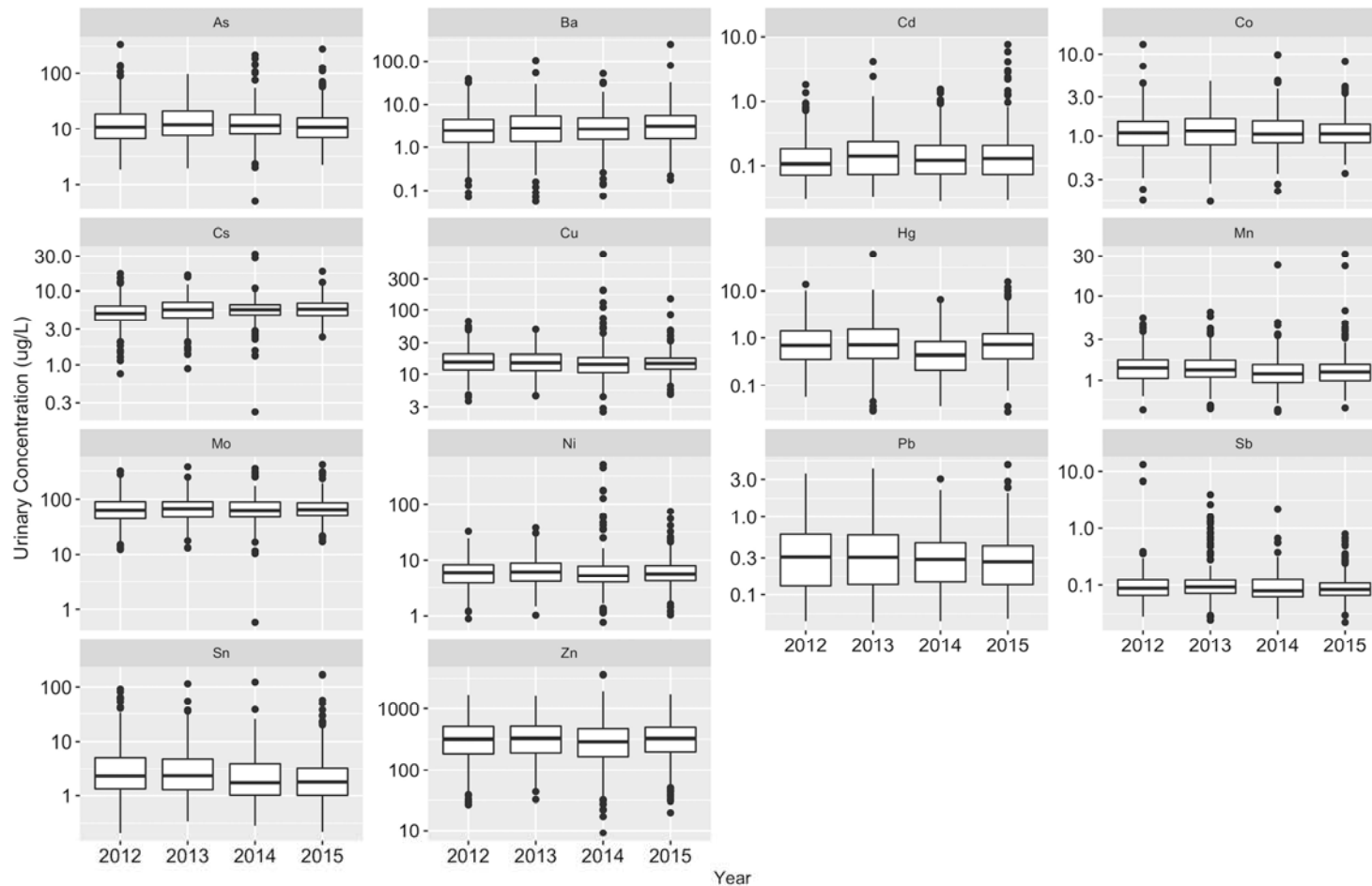
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875   Figure S4. Distribution of urinary biomarker concentrations (ng/mL) among 660 pregnant women in Puerto Rico over study years (2011–2017)[ab].
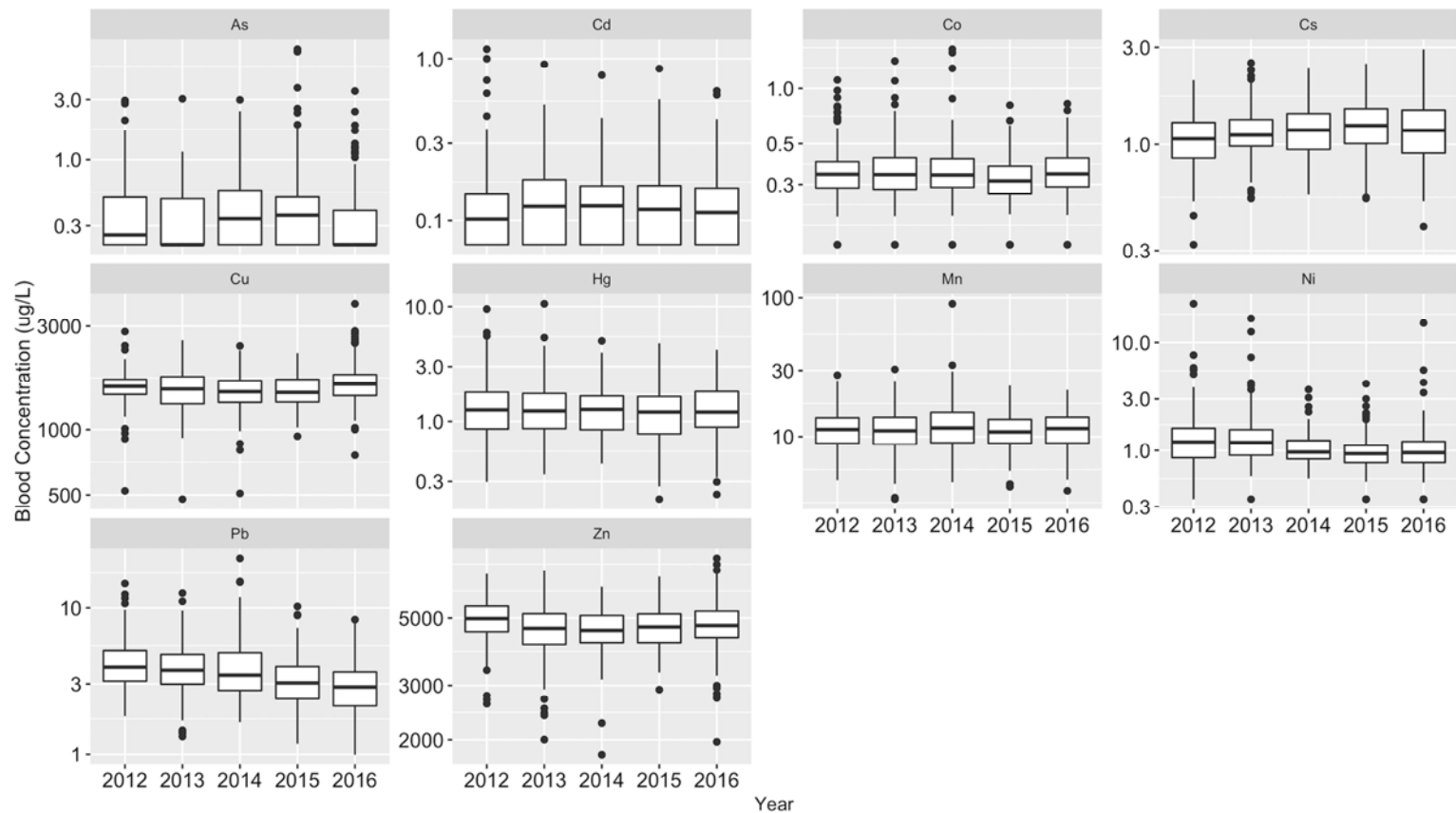876

877
878   [a] 2011 and 2012, 2015 and 2016 are combined to have even numbers of samples in each box; [b] Number of participants in each year during 2011–2012, 2013, 2014, 2015-2016
879   were 302, 273, 196, and 434, respectively.
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884   Figure S5. Distribution of blood biomarker concentrations (ng/mL) among 842 pregnant women in Puerto Rico over study years (2011–2017)[ab].
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887   [a] 2011 and 2012, 2016 and 2017 are combined to obtain a balanced number of samples in each box; [b] Number of participants in each year during 2011–2012, 2013, 2014, 2015,
888   and 2016-2017 were 212, 148, 147, 249, and 274, respectively.
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