Article title: Exposure to Lead, Cadmium, Mercury and Arsenic Among Asian and Non-Asian Children and Adolescents in the United States: NHANES 2015-2018

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Authors:

Lanxin Song<sup>1</sup> and Ondine S. von Ehrenstein<sup>1,2</sup>

<sup>1</sup> Department of Epidemiology, Fielding School of Public Health, University of California, Los Angeles, CA, United States

<sup>2</sup> Department of Community Health Sciences, Fielding School of Public Health, University of California, Los Angeles, CA, United States

Address correspondence to:

Lanxin Song, University of California, Los Angeles, PO Box 951772, Los Angeles, CA 90095-1772, ORCID: 0000-0002-7869-2700, <u>lsong07@g.ucla.edu</u>

Dr. Ondine von Ehrenstein, University of California, Los Angeles, PO Box 951772, Los Angeles, CA 90095-1772, <u>ovehren@ucla.edu</u>

Description: This supplementary material contains supplementary tables and figures in the order referenced in the text.

	Asian		non-Asian	
	<high school<="" th=""><th>High School-Some College</th><th><high school<="" th=""><th>High School-Some College</th></high></th></high>	High School-Some College	<high school<="" th=""><th>High School-Some College</th></high>	High School-Some College
Pb	0.25 (0.00, 0.50)	-0.09 (-0.30, 0.12)	0.18 (0.01, 0.35)	0.16 (0.07, 0.24)
Cd	0.37 (0.04, 0.70)	-0.01 (-0.17, 0.16)	0.01 (-0.06, 0.08)	-0.03 (-0.09, 0.03)
Hg	0.26 (-0.19, 0.71)	0.05 (-0.25, 0.36)	-0.10 (-0.22, 0.01)	-0.10 (-0.21, 0.00)
MeHg	0.37 (-0.15, 0.88)	0.08 (-0.27, 0.44)	-0.18 (-0.31, -0.05)	-0.14 (-0.26, -0.01)
As	0.29 (-0.86, 1.44)	0.39 (-0.08, 0.85)	0.04 (-0.13, 0.2)	0.03 (-0.12, 0.18)
As(OH)3	0.03 (-0.61, 0.67)	-0.08 (-0.52, 0.36)	-0.08 (-0.29, 0.12)	-0.12 (-0.27, 0.04)
DMA	0.10 (-0.57, 0.77)	0.21 (-0.08, 0.49)	0.01 (-0.10, 0.13)	0.00 (-0.10, 0.09)
MMA	-0.15 (-0.51, 0.22)	-0.2 (-0.50, 0.11)	-0.08 (-0.21, 0.05)	-0.02 (-0.12, 0.08)

Table S1. Differences in log-transformed metal concentrations comparing parental education levels in Asian and non-Asian subgroups.<sup>a</sup>

<sup>*a*</sup> Models are linear regression of log transformed metal concentrations ( $\ln(\mu g/L; \ln(\mu g/dL) \text{ for Pb})$ , adjusting for age, gender, income, US-born, BMI-Z and cycle, with sampling weighting applied; urinary measurements adjusted for creatinine; reference ="College+". Shown are  $\beta$ -coefficients (95% CI).

	Asian	non-Asian
	Foreign-born	Foreign-born
Pb	0.31(0.21, 0.41)	0.14 (0.01, 0.28)
Cd	0.14(-0.03, 0.32)	0.01 (-0.08, 0.09)
Hg	-0.11(-0.52, 0.31)	0.15 (-0.02, 0.32)
MeHg	-0.07(-0.54, 0.4)	0.27 (0.06, 0.49)
As	-0.04 (-0.57, 0.49)	0.3 (0.10, 0.49)
As(OH)3	0.12 (-0.48, 0.72)	0.41 (0.13, 0.7)
DMA	0.10 (-0.35, 0.55)	0.30 (0.1, 0.51)
MMA	0.18 (-0.21, 0.57)	0.33 (0.1, 0.55)

Table S2. Differences in log-transformed metal concentrations comparing foreign-born vs. US-born among Asian and non-Asian Participants.<sup>*a*</sup>

<sup>*a*</sup> Models are linear regression of log transformed metal concentrations (ln( $\mu$ g/L; ln( $\mu$ g/dL) for Pb), adjusting for age, gender, income, parental education, BMI-Z and cycle, with sampling weighting applied; urinary measurements adjusted for creatinine; reference="US-born". Shown are β-coefficients (95% CI).

Subgroup	Metal	Family income level		
		<\$20,000	\$20,000-\$45,000	\$45000-\$75,000
	Pb	0.46 (0.08, 0.84)	0.11(-0.07, 0.30)	-0.07 (-0.27, 0.12)
	Cd	0.20 (-0.06, 0.47)	-0.06 (-0.3, 0.17)	-0.15 (-0.33, 0.02)
	Hg	0.11(-0.53, 0.76)	0.03 (-0.44, 0.5)	0.14 (-0.31, 0.58)
Asian	MeHg	-0.04 (-0.73, 0.66)	0.01 (-0.51, 0.52)	0.07 (-0.47, 0.6)
Asian	As	-0.38 (-1.65, 0.89)	-0.31 (-0.85, 0.23)	0.12 (-0.46, 0.69)
	As(OH)3	-0.36 (-0.96, 0.24)	0.00 (-0.47, 0.47)	0.11 (-0.24, 0.45)
	DMA	-0.34 (-1.03, 0.35)	-0.13 (-0.52, 0.27)	-0.11 (-0.49, 0.27)
	MMA	-0.31 (-0.66, 0.05)	0.16 (-0.14, 0.46)	0.04 (-0.34, 0.43)
	Pb	0.19 (0.07, 0.30)	0.06 (-0.04, 0.17)	0.07 (-0.04, 0.17)
	Cd	0.04 (-0.02, 0.10)	0.02 (-0.05, 0.08)	0.02 (-0.05, 0.10)
	Hg	0.07 (-0.04, 0.18)	0.03 (-0.06, 0.12)	-0.04 (-0.15, 0.06)
non Asian	MeHg	0.02 (-0.08, 0.13)	0.00 (-0.11, 0.11)	-0.10 (-0.21, 0.00)
non-Asian	As	-0.06 (-0.19, 0.06)	-0.13 (-0.24, -0.01)	-0.04 (-0.20, 0.12)
	As(OH)3	0.06 (-0.17, 0.29)	0.03 (-0.13, 0.18)	0.02 (-0.16, 0.19)
	DMA	-0.06 (-0.17, 0.06)	-0.11 (-0.2, -0.01)	-0.07 (-0.19, 0.04)
	MMA	-0.10 (-0.24, 0.05)	-0.14 (-0.27, -0.02)	-0.10 (-0.23, 0.04)

Table S3. Differences in log-transformed metal concentrations comparing family income levels in Asian and non-Asian subgroups.<sup>*a*</sup>

<sup>*a*</sup> Models are linear regression of log transformed metal concentrations ( $\ln(\mu g/L; \ln(\mu g/dL))$  for Pb), adjusting for age, gender, US-born, parental education, BMI-Z and cycle, with sampling weighting applied; urinary measurements adjusted for creatinine; reference income="\$75,000+". Shown are  $\beta$ -coefficients (95% CI).

		Fish	Shellfish	
Metal	Estimator	Asians (n=358) vs. non-Asians (n=4197)	Asians (n=359) vs. non-Asians (n=4208)	
Pb	ACME	-0.001 (-0.008, 0.006)	-0.002 (-0.008, 0.003)	
	PM	-0.002 (-0.033, 0.025)	-0.006 (-0.034, 0.011)	
	TE	0.248 (0.157, 0.333)	0.251 (0.167, 0.342)	
Cd	ACME	0.000 (-0.007, 0.005)	-0.001 (-0.005, 0.004)	
	PM	-0.001 (-0.023, 0.018)	-0.002 (-0.020, 0.011)	
	TE	0.302 (0.209, 0.391)	0.306 (0.215, 0.398)	
Hg	ACME	0.055 (0.015, 0.094)	0.033 (0.003, 0.065)	
	PM	0.091 (0.026, 0.173)	0.057 (0.005, 0.120)	
	TE	0.584 (0.412, 0.737)	0.581 (0.420, 0.742)	
MeHg	ACME	0.064 (0.016, 0.115)	0.039 (0.006, 0.079)	
	PM	0.090 (0.025, 0.157)	0.053 (0.008, 0.113)	
	TE	0.713 (0.538, 0.887)	0.709 (0.534, 0.882)	
As	ACME	0.056 (-0.004, 0.122)	0.042 (-0.013, 0.108)	
	PM	0.093 (-0.007, 0.199)	0.063 (-0.024, 0.178)	
	TE	0.592 (0.372, 0.814)	0.622 (0.412, 0.829)	
As(OH)3	ACME	-0.003 (-0.018, 0.011)	-0.001 (-0.015, 0.012)	
	PM	-0.015 (-0.309, 0.201)	-0.004 (-0.297, 0.312)	
	TE	0.127 (-0.022, 0.281)	0.118 (-0.036, 0.276)	
DMA	ACME	0.017 (-0.002, 0.04)	0.017 (-0.003, 0.043)	
	PM	0.033 (-0.005, 0.084)	0.035 (-0.007, 0.092)	
	TE	0.481 (0.358, 0.611)	0.486 (0.37, 0.604)	
MMA	ACME	0.004 (-0.006, 0.019)	-0.002 (-0.017, 0.009)	
	PM	0.013 (-0.022, 0.158)	-0.006 (-0.096, 0.05)	
	TE	0.207 (0.077, 0.335)	0.202 (0.076, 0.333)	

Table S4. Estimated Average Causal Mediation Effect (ACME), Proportion Mediated (PM), and Total Effects (TE) with 95% Confidence Intervals of Fish and Shellfish Consumption, Among Asian vs. non-Asian, Respectively.

*Note.* 'non-Asian' includes all non-Hispanic White, Black, Mexican, other Hispanic and other non-Hispanic participants. Mediation models of metal measurements adjusted for age, sex/gender, income, US-born, BMI-Z score, cycle, parental education level, with sampling weighting applied; urinary measurements further adjusted for creatinine.



Figure S1. Flowchart derivation of study sample.

*Note*. NHANES = National Health and Nutrition Examination Survey. SES = socioeconomic status. Pb = lead. Cd = cadmium. Hg = mercury. MeHg = methylmercury. As = arsenic. As(OH)3 = arsenous acid. MMA = monomethylarsonic acid. DMA = dimethylarsinic acid.

Supplementary information for the study population: We calculated BMI z-scores (BMIz) for children and teens using the CDC 2000 growth charts (aged 2-19 years) and WHO growth standards (aged 12-24 months) by the LMS method [1–3]. Blood collection eligibility varied: in 2015-2016, ages 1-11 and half of those 12+ were eligible; in 2017-2018, ages 6+ were eligible for lead, while ages 1+ were eligible for other metals. For urine, ages 3-5 and a third of ages 6+ were eligible in both cycles. About 85% of this group had data on fish (n=4555) and shellfish (n=4567) consumption in the month prior to the MEC examination, used for mediation analysis (Figure S1).

#### Metals concentrations by Asian Race



Labeled with the geometric mean. Yellow error bars show ±1 geometric SD, and grey error bars show ±2 geometric SD.

Figure S2. Distribution of metal concentrations for non-Asian and Asian participants aged 1-19 years in NHANES 2015-2018.

*Note.* NHANES = National Health and Nutrition Examination Survey. Figures are labeled with geometric means and error bars ( $\pm 1$  and  $\pm 2$  geometric standard deviations).

Labeled with the geometric mean. Yellow error bars show ±1 geometric SD, and grey error bars show ±2 geometric SD. Figure S3. Boxplots of metal concentrations by race/ethnicity for participants aged 1-19 years in NHANES 2015-2018.

0.7

6 -

4

0.53

0.24

0.23

Note. NHANES = National Health and Nutrition Examination Survey. Figures are labeled with geometric means and error bars (±1 and ±2 geometric standard deviations).

Other Non-His Other Workthe Other Hispanic herwonthis White Black Asian Other Hispanic White Black Asian OtherHispanic Asian Mexican Mexican Mexican white Black



## Metals concentrations by Race/Ethnicity

0.15

0.1 0.1 0.1

0.5

0.4

0.3

0.65 0.6

offer North

Black

white

0.56

2.0

1.5

48 0.48

Blood lead (ug/dL)

125 -100 -75 -50 -

25

.63

Other Hispanic

Mexican

Urinary arsenic, total (ug/L)

3 6 0.6 2 0.4 Blood mercury, total (ug/L) Blood cadmium (ug/L) Mercury, methyl (ug/L) Blood lead (ug/dL) 0.79 0.19 0.57 0.63 0.72 0.52 0.7 0.6 0.53 0.14 0.13 0.45 0.31 0.1 0.34 0.21 Non-Asian Non Asian Non-Asian Asian Non-Asian Asian Asian Asian 125 -100 -75 -30 3 2 Urinary Dimethylarsinic acid (ug/L) Urinary Monomethylarsonic acid (ug/L) 50 -Urinary Arsenous acid (ug/L) Urinary arsenic, total (ug/L) 25 4.78 8.87 4.67 0.29 8.47 0.42 0.42 0.26 3.89 0.37 6.49 0.22 0.2 0.28 4.73 2.84 Asian Non Asian Asian NonAsian Non Asian Non Asian Asian Asian

Labeled with the geometric mean. Box limits show ±1 geometric SD, and error bars show ±2 geometric SD. Figure S4. Boxplots of metal concentrations by country of birth for Asians and non-Asians aged 1-19 years in NHANES 2015-2018. Note. NHANES = National Health and Nutrition Examination Survey. Figures are labeled with geometric means and error bars (±1 and ±2 geometric standard deviations).

# Metals exposure by Birth Country & Asian Race Birth Country 🔂 US 🔝 Others

#### Metals exposure by Income & Asian Race

Family Income 🔁 <\$20,000 🔂 \$20,000-\$45,000 🔂 \$45000-\$75,000 🔂 \$75,000+



Labeled with the geometric mean. Box limits show ±1 geometric SD, and error bars show ±2 geometric SD.

Figure S5. Boxplots of metal concentrations by family income levels for Asians and non-Asians aged 1-19 years in NHANES 2015-2018.

*Note.* NHANES = National Health and Nutrition Examination Survey. Figures are labeled with geometric means and error bars ( $\pm 1$  and  $\pm 2$  geometric standard deviations).

### References

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