Biomonitoring Exposures Study (BEST): Results for Urinary and Blood Metals

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BIOMONITORING CALIFORNIA

HISTORY

- Sample of adult Kaiser Permanente members
  - Sacramento
  - San Joaquin
  - Stanislaus
  - Merced
  - Madera
  - Fresno
  - Yolo
- Pilot (2011-2012)
  - N=112 participants
    - 110 blood samples; 108 urine samples
- Expanded (2013)
  - Oversampled Hispanics; Asian/Pacific Islanders (API)
  - N=315 blood samples; 218 urine samples

CHARACTERISTICS OF PARTICIPANTS

Characteristic	Pilot	Expanded
Age (mean/sd)*	56.3(15.2)	48.2 (17.2)
% Male	55	47
% Rural*	8.3	32
% Prefer Spanish language*	3.6	17
Race/Ethnicity *		
% Black	29	13
% API	18	33
% Hispanic	18	41
% White	36	14
% High school graduates	89.5	90.6

BIOMONITORING EXPOSURES STUDY

- Part I:
  - Geometric Mean levels in Pilot and Expanded phases of BEST
  - Comparison with National Health and Nutrition Examination Survey (NHANES)
- Part II
  - Predictors of urinary and blood metal concentrations in Expanded BEST

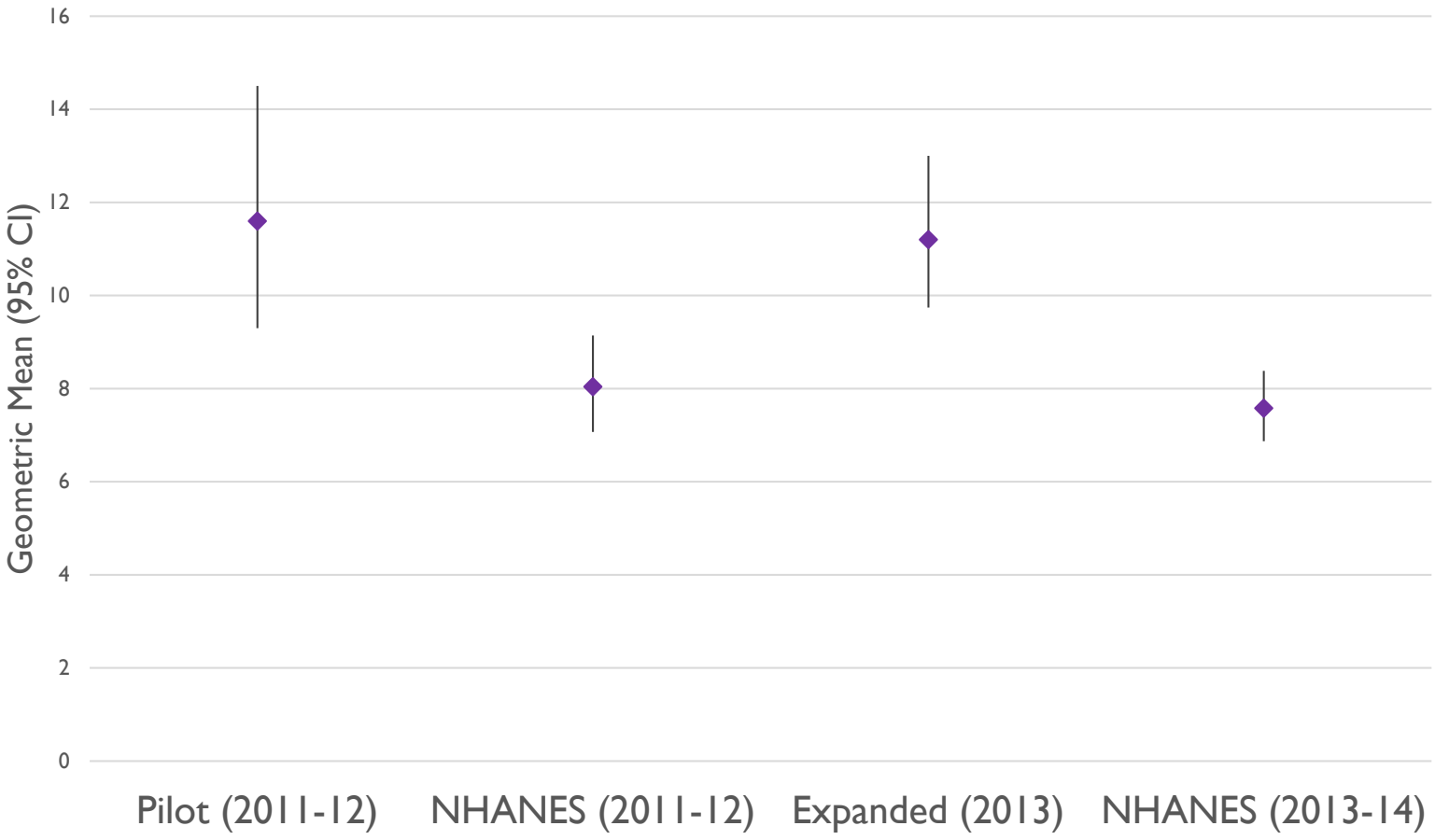
METALS ANALYZED

- Urinary Metals
  - Arsenic
  - Cadmium
  - Mercury
  - Cobalt
  - Manganese
  - Molybdenum
  - Thallium
  - Tungsten
  - Uranium

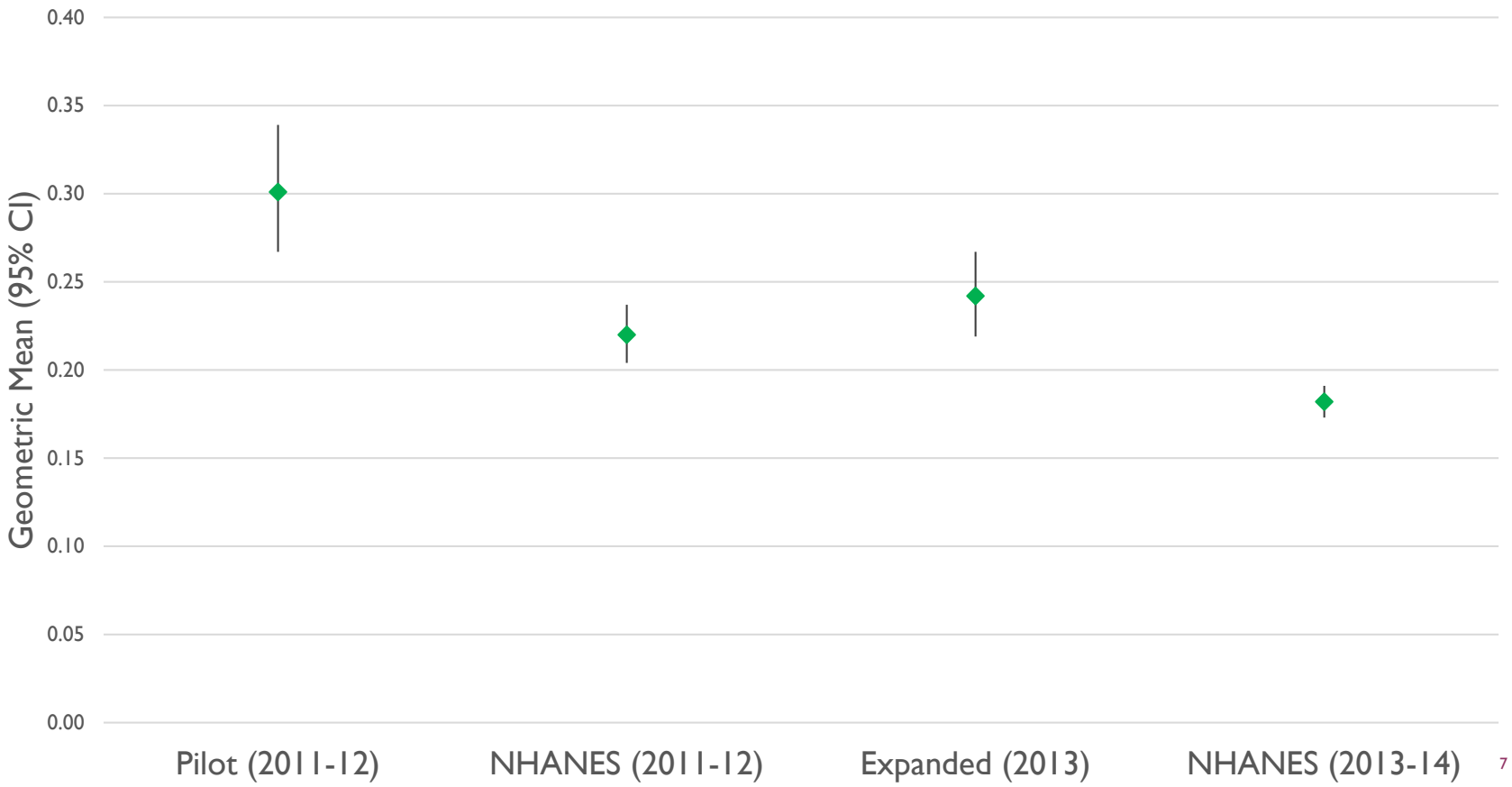
- Blood Metals
  - Cadmium
  - Lead
  - Manganese
  - Mercury

Pilot and Expanded BEST
Expanded BEST

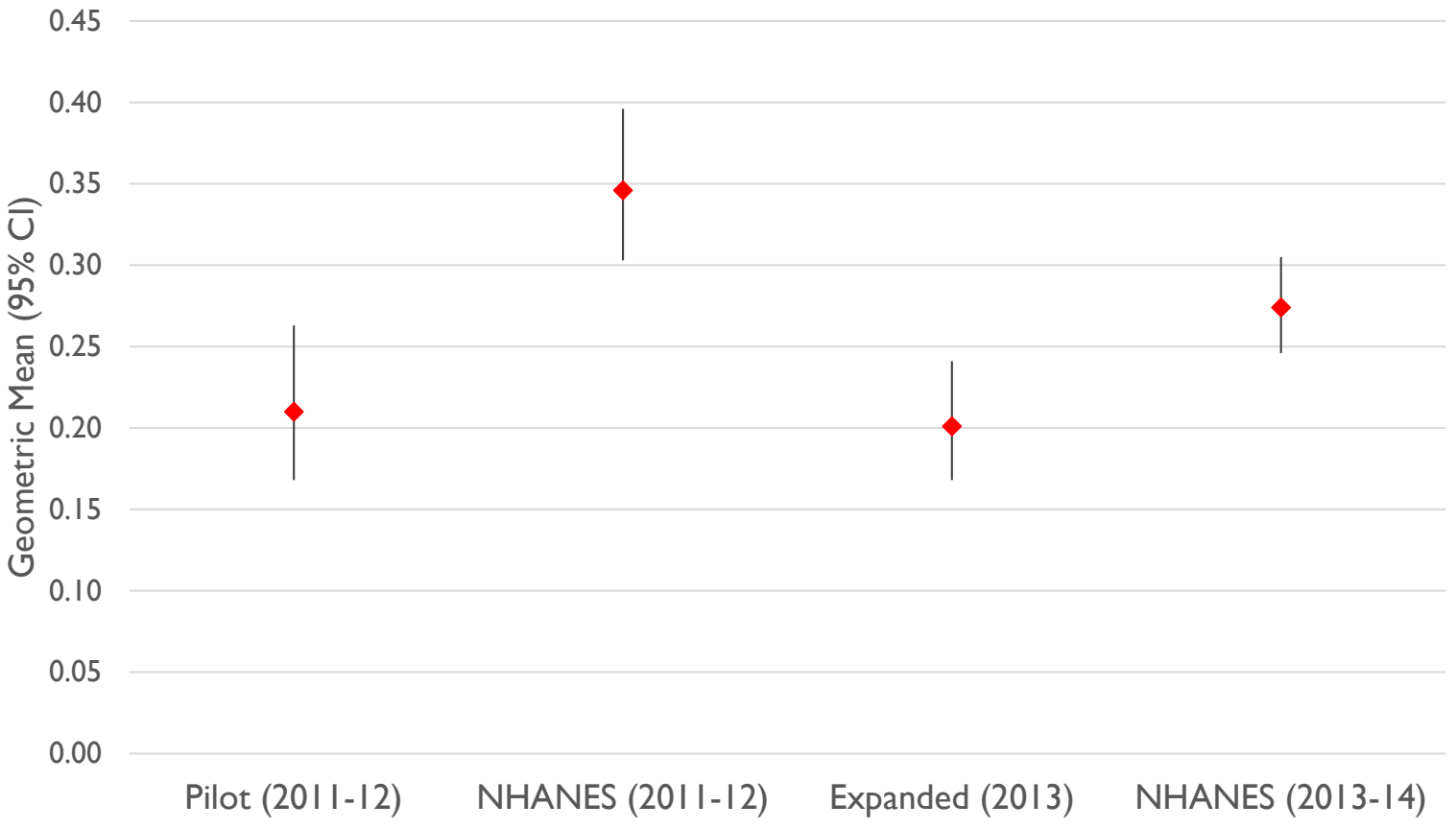
Total Urinary Arsenic (µg/L)



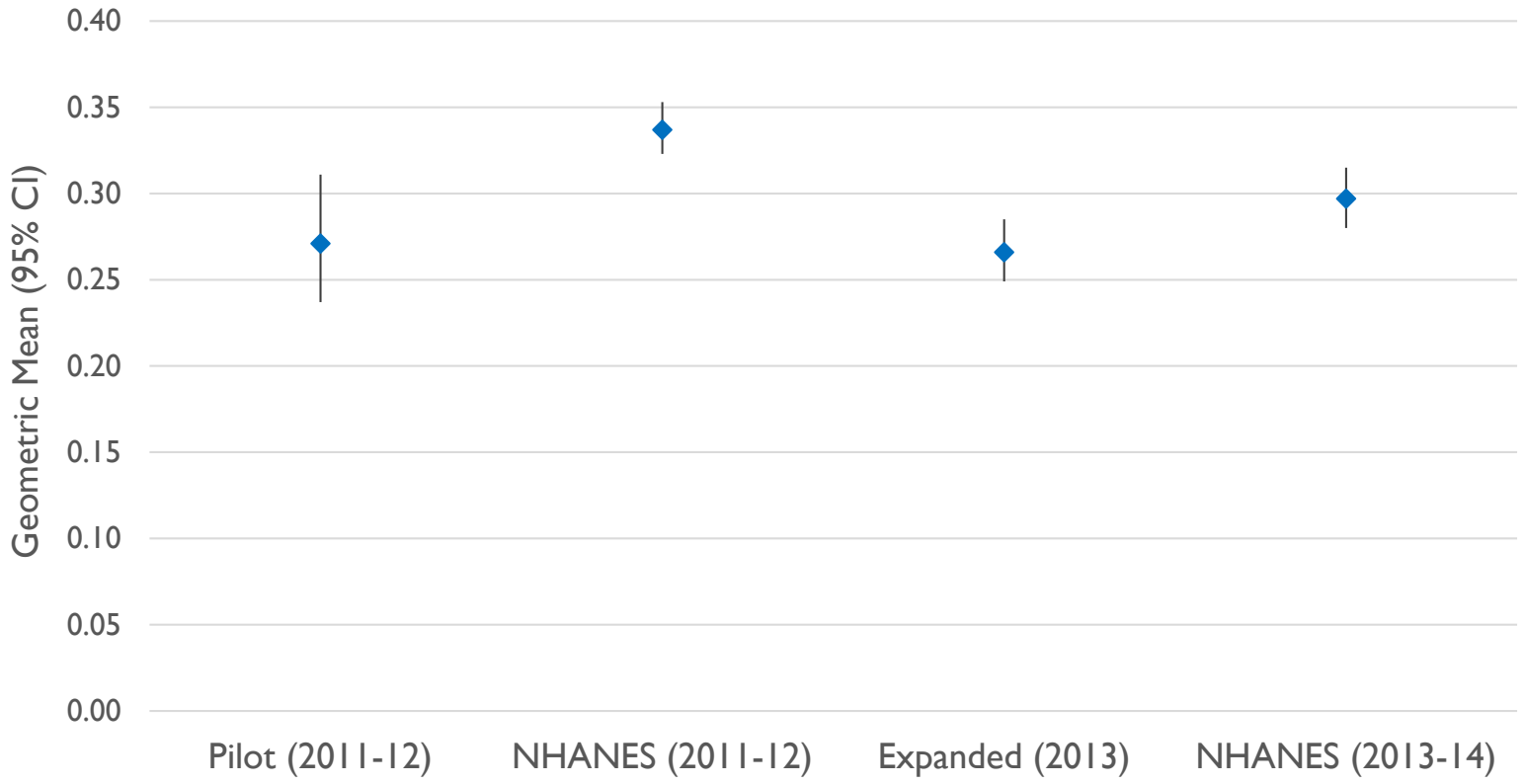
Urinary Cadmium (creatinine-adjusted) µg/g



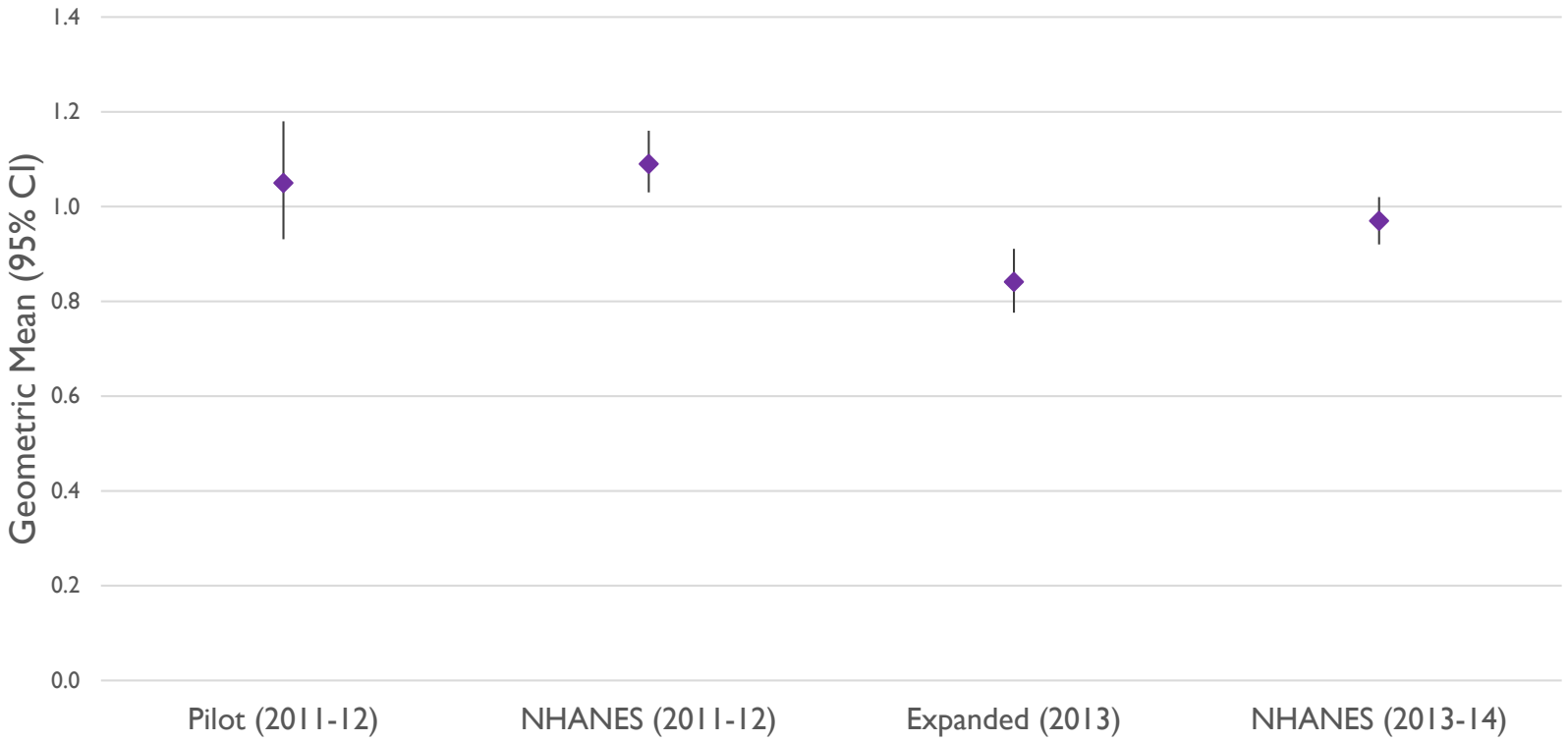
Urinary Mercury (µg/L)



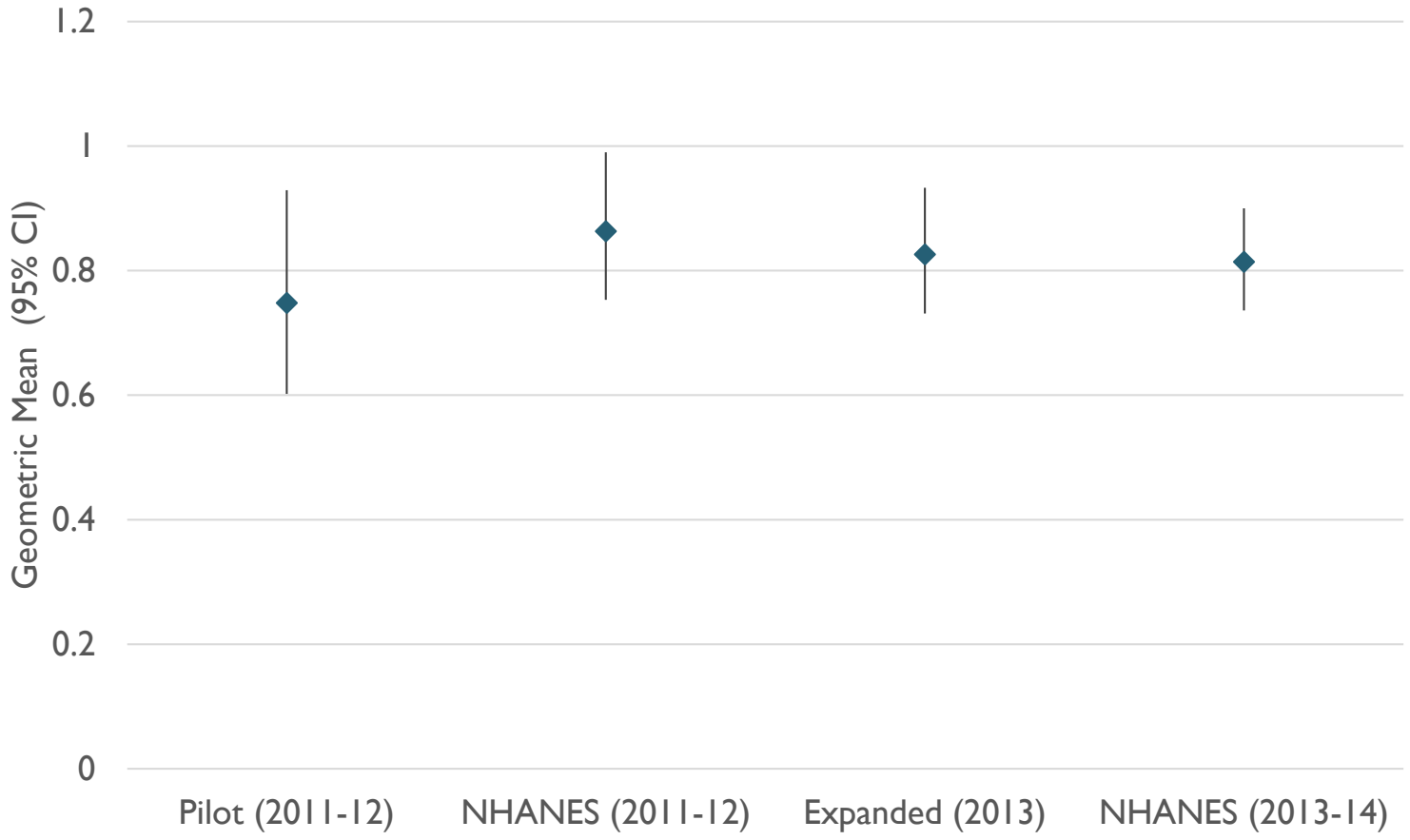
Blood Cadmium (µg/L)



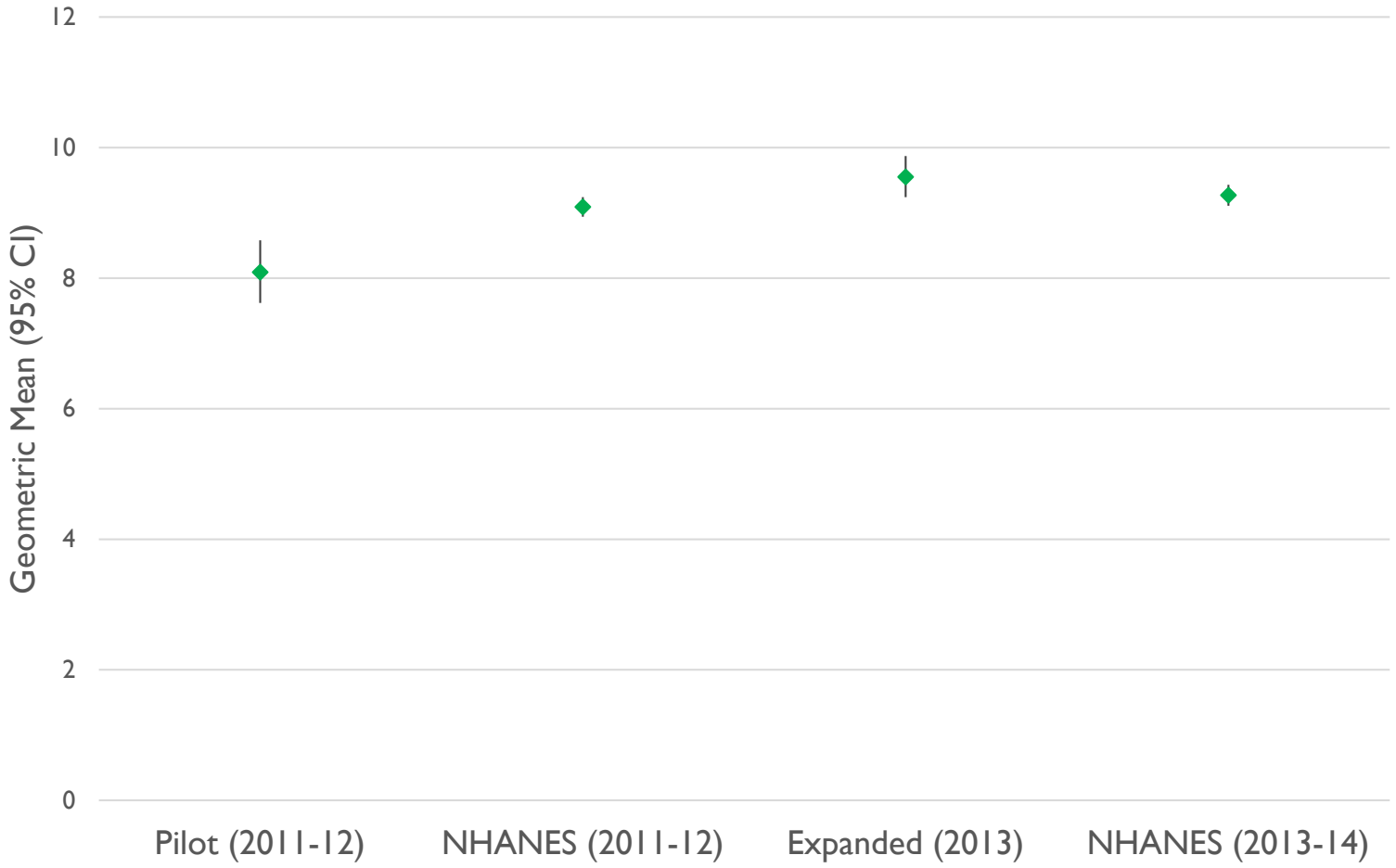
Blood Lead (µg/dL)



Blood Mercury (µg/L)



Blood Manganese (µg/L)



PREDICTION MODELS FOR URINARY AND BLOOD METALS

EXPANDED BEST

EXPANDED BEST: URINARY METALS (N=218)

Metal	Detection Frequency	GM# Expanded BEST (µg/L)	GM NHANES 2013-2014 (µg/L)
Arsenic	100%	11.2*	7.58
Cadmium^	93%	0.24*	0.18
Cobalt	99%	0.19	0.37*
Manganese	60%	ND	ND
Mercury	94%	0.20	0.27*
Molybdenum	100%	46.7*	30.8
Thallium	99%	0.18*	0.14
Tungsten	96%	0.08*	0.05
Uranium	86%	0.008*	0.005

#: GM=Geometric Mean; ^creatinine-adjusted (µg/g) * p<.05

BLOOD METALS (N=315)

	Detection Frequency	Expanded BEST GM	NHANES 13-14 GM
Cadmium (µg/L)	100	0.27	0.30
Lead (µg/dL)	100	0.84	0.97*
Manganese (µg/L)	100	9.55	9.27
Mercury (µg/L)	99.7	0.83	0.81

VARIABLES IN PREDICTION MODELS

Same variables in every model

- Sex
- Age Category (10-year)
- Race/Ethnicity
  - Asian/Pacific Islander
  - Hispanic
  - African-American
  - White (ref)
- Diet: grains, fresh and canned fish, vegetables and fruit
- Time in U.S.
- Educational Level
- Smoking Status
- Rural residence

STATISTICAL ANALYSIS

- Percent increase or decrease
  - Relative to reference group (categorical variables)
  - 1-day/wk increase in consumption (diet)
- Test for trend:
  - Age group
  - Smoking status
  - Time in U.S.
  - Educational level

EXPLANATORY POWER OF MODELS (R^2) (%)

	URINE (N=218)	BLOOD (N=315)
Total Arsenic	17	---
Cadmium (creatinine-adjusted)	52	36
Cobalt	16	---
Lead	---	42
Manganese	Low DF	23
Mercury	19	35
Molybdenum	19	---
Thallium	18	---
Tungsten	17	---
Uranium	22	---

RACE/ETHNICITY

% Difference (95% CI)

Metal	API	African-American	Hispanic
Blood Mercury	63% (13 to 136)	-14% (-14 to -3)	
Urinary Mercury	145% (134 to 350)	193% (41 to 507)	104% (108 to 286)
Total Arsenic	76% (7 to 188)	102% (12 to 265)	
Molybdenum			70% (2 to 185)
Tungsten			130% (16 to 345)

Reference group was white participants. Adjusted for sex, age group, education level, time in U.S., and smoking status. All items listed are statistically significant ($p<.05$).

DIET
% Difference (95% CI)

Metal	Fresh Fish	Canned Fish	Fresh Fruit	Canned Fruit
Blood Mercury	23% (13 to 34)	17% (4 to 32)		
Total Arsenic	12% (0.4 to 26)			
Thallium		-12% (-22 to 0)	19% (1 to 39)	
Cobalt				21% (5 to 64)

Adjusted for sex, age group, race/ethnicity, education level, time in U.S., and smoking status.
All items listed are statistically significant ($p<.05$)

- Relative concentration for an increase of 1 day/week
- Grains, fresh and canned vegetables and fresh fruit were not associated with increased levels of any of the metals in Expanded BEST
- The BEST study did not include a specific question about rice consumption

GENERATION/TIME IN U.S.

- Born in U.S. (Y/N). (Ref)
- If not born in U.S. , years lived here:
  - >=25 years
  - 16-25
  - 11-15 years
  - ≤10 years

- Uranium levels **decrease** with time in U.S. (test for trend, p=0.05)

URBAN OR RURAL ADDRESS

- Geocoded as rural or urban
  - Census definition: based on population density and/or land use designations
  - Possible proxy for private well water use

- Participants from rural areas were higher in :
  - Molybdenum 44% (8 to 92) p=0.04
  - Thallium 23% (-3 to 55) p=0.09
  - Uranium 60% (7 to 141) p=0.02
  - Blood Manganese 7% (0 to 15) p=0.06

SUMMARY / CONCLUSION

- Many of the metals added to the urinary panel for Expanded BEST were higher than in NHANES
- Elevated metal concentration in non-white groups even after adjustment for other predictors.
  - Asian/PI special group of interest
  - One motivation for Asian/Pacific Islander Community Exposures (ACE) Project
- Elevated levels of urinary molybdenum, thallium, uranium, and blood manganese in rural participants
  - Reason for higher levels still need to be explored

BEST: WORKS IN PROGRESS

- Journal articles:
  - Urinary and blood metals
  - Perfluorinated compounds

- New student project

ACKNOWLEDGEMENTS

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