Seumas P. Rogan, Mary Kay O'Rourke, Robin B. Harris, Michael D. Lebowitz.

Epidemiology Graduate Program, Mel & Enid Zuckerman Arizona College of Public Health, University of Arizona, Tucson, Arizona

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Variability in Sample Concentrations, Biomarkers and Total Exposures to Pb, Cd and As among Population Subgroups in the National Human Exposure Assessment Survey in Arizona

Research Problem

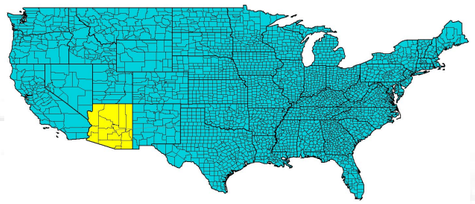
- Making Informed Decisions
  - Accurate and reliable human environmental exposure related data are essential to make informed decisions to protect and promote public health
  - These data must reflect the experience of the general population and specific at-risk population subgroups
  - Existing exposure-related data are insufficient to adequately characterize demographic, geographic and temporal variation in baseline human environmental exposures
  - Limited available data suggest that minority populations experience disproportionate exposures to environmental toxicants

Scientific Approach

- NHEXAS AZ
  - Phase I of NHEXAS was conducted as 3 studies in AZ, EPA Region V and Baltimore, MD.
  - These 3 projects were designed to test and implement exposure-assessment strategies for use in a national survey (Phase II) or special studies (Phase III)
  - NHEXAS AZ used a probability proportional to size (PPS) multi-stage cluster sampling design to represent the non-institutionalized population of the State of Arizona
  - Conducted from Dec. 1995 to Dec. 1997
  - Multi-media, multi-route, multi-pollutant
  - 1225 Households contacted: 78% Response Rate

Environmental Justice is a societal goal, defined as the provision of adequate protection from environmental toxicants for all people regardless of age, ethnicity, gender, health status, social class or race

Sexton, K. and Banks Anderson, Y. Foreword in Special Issue on "Equity in Environmental Health: Research Issues and Needs". Toxicology and Industrial Health 9(5): 1993



- Pb, Cd and As Health Effects
  - Pervasive pollutants with natural & anthropogenic sources
  - Acute and chronic effects on most organs including respiratory, circulatory, renal, digestive, reproductive & central nervous systems
  - As (known) and Cd (likely) are carcinogens

- Exposure Calculations
  - Air, soil, house dust, water, food, urine and blood samples were analyzed for 179/1225 intensively sampled households
  - Intake calculated in µg/day for all pollutants

Exposure	Calculation
Inhalation	$E_a\ \mu g/day = (T_i * B_c\ m^3/day * M_i\ \mu g/m^3/day) + (T_o * B_c\ m^3/day * M_o\ \mu g/m^3/day)$
Water	$E_w\ \mu g/day = (L_d\ /day * M_d\ \mu g/L) + (L_t\ /day * M_t\ \mu g/L)$
Food	$E_c\ \mu g/day = (I_w\ kg/day * M_f\ \mu g/kg/day) + (I_v\ kg/day * M_b\ \mu g/kg/day)$
Non-Food Ingestion	$E_e\ \mu g/day = \sum_{age\ j=1}^{n} [(T_i * C_j\ m^3/day * M_h\ \mu g/m^3/day) + (T_o * C_j\ m^3/day * M_s\ \mu g/m^3/day)]$
Total	$E_t = E_a + E_w + E_c + E_e$

Results

Intake (µg/day)									
		Weighted Exposures				Unweighted Exposures			
		Total	Hispanic	Non-Hispanic	sig[1]	Total	Hispanic	Non-Hispanic	sig[2]
	N =	4,936,270	1,284,049	3,652,221		179	53	126	
Inhalation									
	Cd	*	*	*	*	*	*	*	*
	Pb	*	*	*	*	*	*	*	*
	As	0.035	0.032	0.036	0.66	0.045	0.049	0.043	0.01
Ingestion									
	Cd	*	*	*	*	*	*	*	*
	Pb	18.636	33.775	13.313	0.25	18.585	24.447	16.119	0.60
	As	41.423	24.710	47.299	0.35	37.211	18.405	45.122	0.31
TOTAL									
	Cd	*	*	*	*	*	*	*	*
	Pb	*	*	*	*	*	*	*	*
	As	41.458	24.743	47.335	0.35	37.256	18.455	45.165	0.32
		Total	Adult	Child	sig[1]	Total	Adults	Child	sig[2]
	N =	4,936,270	4,034,243	902027		179	145	34	
Inhalation									
	Cd	*	*	*	*	*	*	*	*
	Pb	*	*	*	*	*	*	*	*
	As	0.0349	0.039	0.019	0.01	0.045	0.051	0.019	0.01
Ingestion									
	Cd	*	*	*	*	*	*	*	*
	Pb	18.636	19.746	13.671	0.97	18.585	19.582	14.337	0.98
	As	41.423	48.436	10.058	0.01	37.211	43.181	11.754	0.01
TOTAL									
	Cd	*	*	*	*	*	*	*	*
	Pb	*	*	*	*	*	*	*	*
	As	41.458	48.475	10.077	0.01	37.256	43.232	11.773	0.01

Conclusions

- In general, environmental concentrations were low with many samples below the analytical method detection limit
- Differences in sample concentrations observed between population subgroups (age, ethnicity, income, mining community status) were inconsistent with calculated exposures for some groups
- Personal behaviors, diet, use of consumer products, etc., significantly impact personal exposures
- These data do not consider subpopulation variability in susceptibility to environmental exposures
- Additional research is need to understand the relationship between sample concentrations, personal exposures, biomarkers and consequent health effects

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