Preliminary Results of Arsenic Found in Drinking Water Among Arizonan and Sonoran Residents

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Study Goals of the Binational Arsenic Exposure Survey (BAsES)

- To evaluate associations between elevated arsenic exposure and selected genetic polymorphisms
- Determine arsenic exposure in well defined populations consuming water at varying As levels

Design

- Cross-sectional study
- Recruit individuals from Arizona & Sonora
  - Random selection of households from selected communities or neighborhoods
  - Adults = age 18, men and women
  - 350 households
- Questionnaires and biological data

Participant Recruitment

- Arizona (152 households)
  - Ajo (n=25)
  - San Manuel (n=31)
  - N. & S. Tucson (n=47)
  - New River (n=49)
- Gender (225 people)
  - Males 99
  - Females 126
- Sonora
  - Hermosillo (n=100)
  - Communities in Yaqui Valley (n=100)
As levels - Ciudad Obregón

- Wells Sampled in the Yaqui Valley:
  - 73 wells sampled

As levels - Hermosillo

- Water towers sampled in Hermosillo:
  - 41 wells sampled

Procedures

- **Samples**
  - Blood
  - DNA
  - Serum
  - Buccal cells
  - First morning urine void
  - Toenail clippings
  - Anthropometric:
    - Height, weight, waist and hip circumference
  - Water samples from drinking and cooking sources

- **Measurements**
  - Urine analysis and water screen
  - 14 Metals
  - Arsenic Speciation
  - Store for subsequent analysis
  - Toenail samples for As levels
  - Serum, buccal cells, urine, water

Questionnaires

- **Individual questionnaire**
  - Demographics
  - Residential history
  - Smoking history
  - Alcohol use
  - Occupation and hobbies
  - Health
  - Physical activity

- **Household questionnaire**
  - Year the house was built, phones in the home, running water, etc.

- **24 hour diet recall**

- **Food frequency questionnaire**
  - ~50 foods known to have elevated arsenic levels
  - How often have you eaten the foods in the past year?
  - Have you eaten the foods in the past 3 days?

- **Water Consumption Sheet**
  - How often do you drink or cook using the water from each water source in the home?
Water samples

- Samples were taken from every drinking source in the home: fridge, water filtered through R.O., sink, etc.
- If a water softener was used on the house then water was collected from the spigot outside or from the well.
- The following preliminary results are from the unfiltered water source coming into the home

Water consumption of 143 primary respondents

<table>
<thead>
<tr>
<th>Water consumption</th>
<th>Unfiltered water</th>
<th>Reverse Osmosis</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of samples</td>
<td>143</td>
<td>140</td>
<td>283</td>
</tr>
<tr>
<td>Number of samples with non-detectable As level</td>
<td>83</td>
<td>20</td>
<td>103</td>
</tr>
<tr>
<td>Number of samples &gt;10 ppb of As range</td>
<td>60</td>
<td>44</td>
<td>104</td>
</tr>
<tr>
<td>Median</td>
<td>3.80 ppb</td>
<td>12.55 ppb</td>
<td>7.55 ppb</td>
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<td>Interquartile range</td>
<td>11.60 ppb</td>
<td>14.00 ppb</td>
<td>20.10 ppb</td>
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A primary respondent may report more than one drinking and/or drinking/cooking and/or cooking source.

Estimated water arsenic consumption per person per day

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Estimated arsenic concentration per person = \left( \sum_{i=1}^{n} \text{frequency} \times \text{As concentration} \right) / \text{number of drinking water samples}

- Frequency (frequency of consumption): frequently = 0.70, occasionally = 0.25, rarely = 0.05
- non-detectable = 1.75 ppb, this is half the detection limit (3.5 ppb)
Mexico Results

- Sampling is completed
- Sample testing and data entry are ongoing
- Expect to have all of the samples analyzed by the end of March

ADHS Public Health Laboratory

State Capitol Complex:
- Van Buren & 17th Ave
Chemistry Sections:
- Inorganic
- Organic
- Hazmat
- Food Emergency Response Network (FERN)
- Chemical Emergency Response (CT)

Chemical Emergency Response

Program Responsibilities
- LRN-C Lab for Arizona (CDC)
  - Chemical Terrorism (CT) preparedness & response
  - Chemical Unknown Identification
    - Suspicious powders and samples of interest to law enforcement & County Health Departments
- Biomonitoring
  - Rocky Mountain Biomonitoring Consortium (RMBC)
  - Collaborations with Arizona’s Universities

Instrumentation

- Organic
  - Liquid Chromatograph - Tandem Mass Spectrometer (LC/MS/MS): Applied Biosystems API 4000
  - Gas Chromatograph - Mass Spectrometer (GC/MS): Agilent 6890/5973
- Inorganic
  - Inductively Coupled Plasma - Mass Spectrometer (ICP-DRC-MS): PerkinElmer ELAN DRCII
Instrument Used for Project

- ICP-DRC-MS
- PerkinElmer ELAN DRCII
- High Performance Liquid Chromatography (HPLC) Front End
- Arsenic Speciation
  - arsenite (valence III)
  - arsenate (valence IV)
  - monomethylarsonic acid (MMA)
  - dimethylarsinic acid (DMA)
  - arsenobetaine (AsB)

Analytical Methods Used

- The urine samples were analyzed according to LRN-C metals method for toxic elements
- The water samples were screened using a modified toxic metals LRN-C method for urine and is not EPA compliant for drinking water
- 14 Metals: Antimony, Arsenic, Barium, Beryllium, Cadmium, Cesium, Cobalt, Lead, Molybdenum, Platinum, Selenium, Thallium, Tungsten, & Uranium

Implications of Biomonitoring Study

Arizona Public Health Perspective
- Arsenic is a problematic metal for households serviced by well water
- Many people do not know how to contact private laboratories for testing of drinking water

Laboratory Perspective
- ADHS has the instrumentation and expertise available to assist future biomonitoring projects

Future of Biomonitoring in Arizona

Collaborative Effort
- This project between UofA and ADHS is a pilot project that worked
- Brain power and legwork of the university system coupled with the analytical capacity of ADHS is a powerful combination
- One that ultimately benefits the children of Arizona and border states
Research Team

- University of Arizona
  - Robin Harris, PhD
  - Jason Roberge, MPH
  - Clark Lantz, PhD
  - Jeff Burgess, MD
  - Walt Klimeski, PhD
  - Mary Kay O’Rourke, PhD
  - Elena Martinez, PhD
  - Julia Gerace
  - Andrew Abalos
  - Roberta Kline

- ADHS
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  - Patricia Adler
  - Marcus Castle

- ITSON
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  - Fernando Lares Villa
  - Anacleto Felix Fuentes
  - Guadalupe Aguilar

- UNISON
  - Luis Gutiérrez, PhD
  - Maria Burboa Zazueta

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