



Pollution



Chemicals



Science



Human Health

ATSDR EXPOSURE INVESTIGATION

ASARCO Hayden Smelter Site Hayden and Winkelman, Arizona

2017 Urine Arsenic Exposure
Investigation

December 19, 2019



U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Table of Contents

Table of Contents	2
Summary	3
About the Site	4
Timeline of Recent ATSDR Activities	6
Community Concerns	7
Exposure Investigation Overview	8
Results	9
Findings and Next Steps	21
Limitations of this Exposure Investigation	23
For More Information	24
Authors	24
Documents Cited	25
Appendices	27
Appendix A: ATSDR’s methods for this investigation	28
Appendix B: Results tables	31
Appendix C: Map of air monitoring stations	34
Appendix D: Boxplots of arsenic levels in Hayden air	35
Appendix E: Summary of ATSDR’s 2017 arsenic exposure investigation	36
Appendix F: Resumen de la investigación de la ATSDR del 2017 sobre la exposición a arsénico	37



About ATSDR

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency of the U.S. Department of Health and Human Services (HHS). ATSDR works with other agencies and tribal, state, and local governments to study possible health risks in communities where people could come in contact with dangerous chemicals. For more information about ATSDR, visit our website at <https://www.atsdr.cdc.gov/>

Summary

In Hayden and Winkelman, Arizona, historic and ongoing copper smelting and processing operations have released contaminants to the air, soil, and surface water (EPA 2018). The U.S. Environmental Protection Agency (EPA) cleaned up residential soils between 2008 and 2014 (EPA 2015). However, residents may continue to be exposed to lead, arsenic, and copper in non-residential soil and air and sulfur dioxide in air (ADHS 2018).

In 2015, ATSDR provided voluntary lead and arsenic testing to Hayden and Winkelman residents most at risk for health effects from arsenic and lead exposure (ATSDR 2017). ATSDR tried to determine whether participants have higher levels of lead and arsenic in their bodies than the U.S. population. ATSDR's report on the 2015 lead and arsenic testing concluded:

- Some children had been exposed to lead at levels that could harm their health.
- Overall, children and adolescent participants had more lead in their bodies than children and adolescents from across the United States.
- We needed more information to determine how much arsenic participants have in their bodies when air pollution levels are typical for the community.¹

During the 2015 testing, the smelter was shut down for maintenance, reducing the level of lead and arsenic in air that participants breathed. Decreased exposure to arsenic in air could have reduced the amount of arsenic in participants' urine.

In 2017, ATSDR offered follow-up urine arsenic testing to residents of households that participated in our 2015 investigation – 33 residents participated. We did this follow-up testing to learn if residents have higher urine arsenic levels than the U.S. population when the smelter was operating normally. This report summarizes the 2017 follow-up urine arsenic test results.

The Bottom Line

- **Arsenic levels in the 33 Hayden and Winkelman residents ATSDR tested in 2017 were similar to U.S. population levels. We did not find elevated arsenic levels in participants.**
- **These test results tell us how much arsenic were in participants' bodies at the time of testing. The amount of arsenic in a person's body can change quickly.**
- **Residents remain at risk for exposure to arsenic and lead in non-residential soils, air, and other sources in the community.**
- **Organizations and community members should continue taking steps to reduce exposure to arsenic and lead.**

¹ ATSDR's report on the 2015 lead and arsenic testing is available at <https://www.atsdr.cdc.gov/sites/hwaz>.

An easy-to-read fact sheet summarizing this report is available in English and Spanish at <https://www.atsdr.cdc.gov/sites/HWAZ/> and in Appendix E (English) and Appendix F (Spanish). If you have questions, contact ATSDR's Region 9 Director, Libby Vianu, at 415-947-4319 or LVianu@cdc.gov or our toll-free number at 1-800-CDC-INFO and ask for information on the ASARCO Hayden Smelter site.

About the Site

Past and current contaminant releases

The ASARCO Hayden Smelter Plant Site is in rural Arizona, about 70 miles northeast of Tucson. The site includes several historic and current industrial areas and the small towns of Hayden and Winkelman (populations 662 and 353, respectively) (ATSDR 2017; EPA 2018). The area is dry, windy, and sparsely vegetated.

Historic and ongoing copper smelting and processing has caused environmental contamination in Hayden and Winkelman (EPA 2018). Active copper production in Hayden contributes to elevated levels of lead, arsenic, and copper in the air throughout the area (EPA 2018).

Arsenic is present in the air, mine waste piles, and soil at some non-residential locations because of past and present smelting operations (ATSDR 2017). In addition to smelter-related arsenic contamination, local drinking water supplies contain low levels of arsenic from naturally occurring sources in soil and bedrock, as is typical in the southwest United States (ATSDR 2017).

Partners work to clean up area

EPA, ADEQ, and ASARCO are working together to clean up the Hayden and Winkelman area through a Superfund alternative process (EPA 2018). EPA completed residential soil cleanup between 2008 and 2014 (EPA 2015). While residential soil has been cleaned up, residents may still be exposed to lead, arsenic, and copper in non-residential soil and air and sulfur dioxide in air (ADHS 2018).

Separate from the Superfund alternative process, EPA and ASARCO are implementing a 2015 Consent Decree (i.e., legal settlement) to resolve alleged Clean Air Act violations at ASARCO's Hayden facility (EPA 2015b). Under the settlement, the company is installing new equipment and pollution control technology at the Hayden smelter and funding local environmental health projects (including a home lead-based paint testing and abatement project) (EPA 2015b).

ATSDR tests residents' blood for lead and urine for arsenic

In response to community member requests, in 2014 EPA asked ATSDR to offer lead and arsenic testing to Hayden and Winkelman residents. In 2015, ATSDR conducted testing to determine how much lead and arsenic people at higher risk for health effects (e.g., young children and pregnant women) had in their blood and urine. Eighty-three residents from 29 households participated in the 2015 testing. All participants received lead testing and 58 participants

received arsenic testing. ATSDR's March 2017 report summarizes the testing results and ATSDR's health conclusions and recommendations (ATSDR 2017).

The 2015 test results showed that children and adolescent participants had more lead in their bodies than children and adolescents from across the United States (ATSDR 2017). But, ATSDR needed more information to determine how much arsenic participants have in their bodies when air pollution levels are typical for the community. Before and during ATSDR's 2015 testing, the smelter was shut down for maintenance, reducing the level of arsenic in air that participants breathed (ATSDR 2017). Because arsenic is typically excreted from the body within several days of exposure, the lower level of arsenic in air in the days before testing could have led to a lower amount of arsenic in participants' urine. Since lead stays in blood longer than arsenic stays in urine, ATSDR does not expect that the shutdown had a significant effect on participants' blood lead results.

In October 2017, ATSDR offered another urine arsenic test to residents of Hayden and Winkelman households that participated in the 2015 testing. According to ASARCO, the smelter was operating normally during this time (personal communications with Joe Wilhelm, General Manager, ASARCO Hayden Operations, July 14, 2017, August 25, 2017, and October 24, 2017).

Between 2014 – 2017, ATSDR visited the community seven times. Throughout this process, ATSDR has worked closely with EPA, the Arizona Department of Health Services (ADHS), and the Arizona Department of Environmental Quality (ADEQ).

Other ATSDR and Arizona Department of Health Services (ADHS) reports address lead, copper, and sulfur dioxide exposures in this community (ADHS 2002, ATSDR 2017, ADHS 2018).

Timeline of Recent ATSDR Activities

2014: EPA asked ATSDR to offer blood lead and urine arsenic testing in Hayden and Winkelman.

2015: ATSDR recruited participants for lead and arsenic testing. ATSDR collected blood and urine samples. ATSDR sent a letter to each participant with their result(s).

March 2017: ATSDR published a report on the 2015 blood lead and urine arsenic testing. ATSDR noted plans to offer participants another arsenic test.

October 2017: ATSDR recruited participants and collected urine samples for follow-up arsenic testing. Community leaders asked ATSDR to help them stay informed about local environmental health work.

December 2017: ATSDR sent a letter to each participant with their urine arsenic retest result.

February 2018: ATSDR and other organizations began sending community leaders regular emails with updates on each organization's local environmental health work.

Community Concerns

Health concerns from exposure to mine-related contaminants

Community members have expressed concerns to EPA, ATSDR, and other agencies about historic and ongoing exposure to lead, arsenic, and other mining-related contaminants in the Hayden and Winkelman area. Community requests for biological testing prompted ATSDR's exposure investigation.

Keeping track of local environmental and health work

Community leaders explained that it is difficult to keep track of the environmental and health work in Hayden and Winkelman, in part because of the many organizations involved (Box 1). In 2017, ATSDR, EPA, and the University of Arizona met with community leaders to discuss how to facilitate more communication between the organizations and them. Community leaders requested that the multi-organization group

- send quarterly emails to them with a short update on each organization's work, and
- provide up-to-date contact information for each organization.

In 2018, the multi-organization group began sending quarterly email updates to community leaders along with a contact list (University of Arizona 2018).

Box 1: Organizations working on environmental and health issues in Hayden and Winkelman

- Agency for Toxic Substances and Disease Registry
- U.S. Environmental Protection Agency
- Arizona Department of Environmental Quality
- Arizona Department of Health Services
- Central Arizona Governments
- Gila County Division of Health and Emergency Management
- University of Arizona Superfund Research Program

(University of Arizona 2018)

Reviving the local economy

Community leaders expressed to ATSDR that ongoing environmental health concerns challenge their efforts to revive the local economy. ATSDR recognizes that there is a long history of copper production in this area and that the smelter is an important part of the local economy. Our goal is to work cooperatively with the community to help protect their health.

Exposure Investigation Overview

In recent years environmental agencies and ASARCO have taken steps to clean up residential soils and reduce air pollution in Hayden and Winkelman. Still, residents may be exposed to high levels of lead and arsenic in the local environment.

Residents may be exposed to lead and arsenic from smelting activities and other sources

Residents may be exposed to lead and arsenic from mining and smelting operations by breathing air and accidentally ingesting non-residential soil and household dust.

Companies have processed copper ore at several smelting operations and other facilities in the Hayden and Winkelman area for over 100 years (EPA 2014a). Past and present smelting activities released lead and arsenic into the air, some of which settled to indoor and outdoor surfaces throughout the community. Lead and arsenic are also left in mine waste areas. Wind-blown dust and current emissions contribute to arsenic and lead in local air. Additionally, some residents may be exposed to lead from paint in older housing (ATSDR 2017).

As is typical in the southwest and some other parts of the United States, residents likely also drink low levels of naturally occurring arsenic in drinking water (ATSDR 2017). Further, residents may consume low levels of arsenic in foods and drinks that often contain arsenic (e.g., seafood, rice, and apple juice). There are several types of arsenic that fall into two categories, organic and inorganic (Box 2).

ATSDR offers lead and arsenic tests for at risk community members

As noted in the “About the Site” section, in 2015, ATSDR conducted testing to determine how much lead and arsenic community members at higher risk for health effects had in their bodies. In October 2017, ATSDR offered another urine arsenic test to 2015-participant households when air quality was typical for the area. In both 2015 and 2017, ATSDR focused on testing children and women of childbearing age. This report summarizes the 2017 follow-up urine arsenic test results.

ATSDR focused on testing children and women of childbearing age for several reasons. Young children are more at risk for arsenic exposure and health effects than adults because they play in areas where soil and dust may be found and then put toys and hands in their mouths. Young children may also breathe and drink more arsenic in air and water than adults, relative to the size of their bodies. In addition, pregnant women, or women who may become pregnant, could expose their unborn child to arsenic, potentially harming the child’s health.

Who participated in ATSDR’s 2017 arsenic testing?

In 2017, ATSDR recruited participants from Hayden and Winkelman households that participated in ATSDR’s 2015 lead and arsenic testing. ATSDR offered arsenic tests to residents at higher risk for health effects from arsenic exposure:

- Children and adolescents ages 6 years to 17 years

- Pregnant women of any age
- Women of childbearing age (up to age 44)

In addition, ATSDR agreed to test several residents who did not meet these eligibility criteria but were concerned about exposure.

Box 2: Arsenic Sources and Types

Arsenic is an element that is widely distributed in the earth's surface. Arsenic is released into the environment from both human activities (e.g., mining, commercial use) and natural processes (e.g., weathering of arsenic-containing minerals in soil and groundwater).

There are two basic types of arsenic:

Organic arsenic exposure doesn't usually cause health problems. It is often found in fish and seafood, so eating fish or seafood before arsenic testing may increase a person's organic and total arsenic level.

Inorganic arsenic exposure may cause health problems. It is found in many places in the environment, like in soil and water, and in some foods, such as some types of rice.

In this report, we analyze participants' exposures to total arsenic (i.e., all types) and seven individual arsenic forms (or "species"). Following CDC guidance, we divided the seven species into three organic and four "inorganic-related" arsenic species (CDC 2017). Two of the inorganic-related arsenic species, monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA), have organic chemical structures. People can be exposed to them from eating seafood. They are also indicators of inorganic arsenic exposure because our bodies process inorganic arsenic into MMA and DMA (CDC 2017).

Results

Key Findings:

ATSDR tested 33 Hayden and Winkelman residents from 13 households. As explained below, ATSDR found

- All participants had total arsenic levels below ATSDR's follow-up level.
- Total arsenic levels for each age group were similar to U.S. population levels.
- Many participants had no detectable levels of some inorganic-related arsenic species.
- Individual participants' arsenic levels were generally lower in 2017 than 2015.
- Arsenic levels in air were typical for the community before and during the 2017 testing.

While ATSDR did not find elevated levels of arsenic among participants, residents remain at risk for exposure to arsenic and lead in the community. ATSDR recommends organizations and community members continue efforts to clean up contamination, reduce emissions, and prevent exposure to lead, arsenic, and other contaminants.

ATSDR’s investigation had limitations that affect what we can learn from the results. Urine arsenic tests only tell us how much arsenic was in participants’ bodies at the time of testing. The amount of arsenic in a person’s body can change quickly depending on their behaviors and environment. Further, the test results might not represent the overall community. For instance, residents with the most exposure to arsenic might not have volunteered for testing.

Box 3: The methods ATSDR used to conduct this investigation

Appendix A describes the scientific methods ATSDR used for this investigation, including participant recruitment, sample collection, laboratory methods, urine and air data and analysis.

33 residents from 13 households participated in the 2017 investigation

In 2017, ATSDR tested 33 Hayden and Winkelman residents from 13 households (Table 1). ATSDR sent results letters to each participant in December 2017.

All but one participant in the 2017 investigation self-reported their race or ethnicity as Hispanic (n=28) or non-Hispanic white (n=4). Just over half (17 of 33 or 52%) of 2017 participants received arsenic testing during ATSDR’s 2015 exposure investigation. Fifteen of the residents who volunteered for arsenic testing in 2017 did not participate in 2015.

Table 1. Number of participants tested for urine arsenic in 2017 by age group, gender, and participation in 2015 urine arsenic testing*

Age group	Total N=33	Female n=23	Male n=10	Also 2015 participant n=17
1–5 yrs	1 3%	1 4%	0 0%	0 0%
6–11 yrs	19 58%	13 57%	6 60%	8 47%
12–19 yrs	6 18%	3 13%	3 30%	6 35%
20–44 yrs	4 12%	4 17%	0 0%	3 18%
75 yrs and older^	3 9%	2 9%	1 10%	0 0%

* Percentages are based on column totals.

^ Excluded from analysis in this report.

In response to community interest during the 2017 investigation, ATSDR completed urinary arsenic testing for five residents who did not meet the predefined ATSDR eligibility criteria (described in the Exposure Investigation Overview):

- One 4-year-old female
- One 19-year-old male
- Three adults aged 75 years and older

The analyses that follow do not include the three adults aged 75 years and older because this age group is not considered highly vulnerable to arsenic, and an age-appropriate comparison population is not available in nationally representative data. However, ATSDR included the 4

and 19-year-old participants' results because they were at the threshold of age-based inclusion criteria (6 – 17 years) and thus assumed to have similar absorption, metabolism, excretion, and vulnerability to arsenic as compared to their 6 – 17-year-old peers.

All participants had total arsenic levels below ATSDR's follow-up level

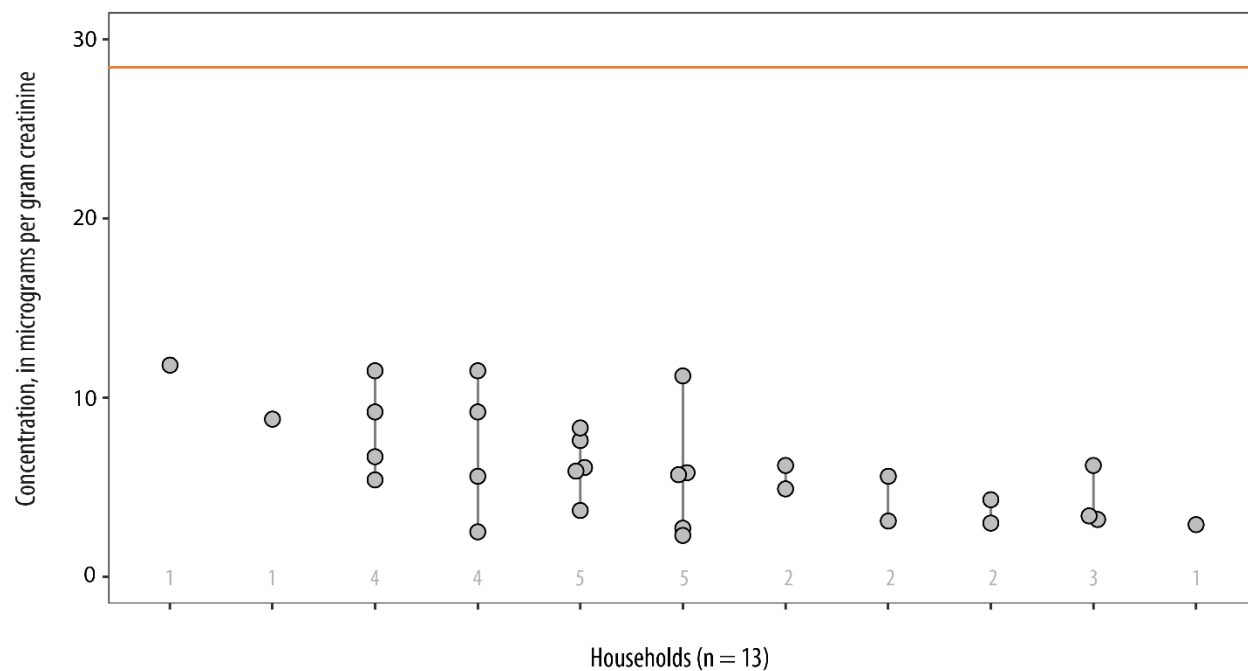
Figure 1 shows creatinine-corrected urinary total arsenic results for the 30 participants included in ATSDR's analysis, organized by household.² All results were below the predetermined follow-up level of 28.4 micrograms arsenic per gram creatinine (mcg/g Cr or $\mu\text{g/g Cr}$), denoted by the horizontal gold line (Box 4 explains the follow-up level). Participant total arsenic values ranged from 2.3 to 11.8 mcg/g Cr. Urine arsenic levels varied within and between household groups.

Box 4: The urine arsenic follow-up level ATSDR used

In this investigation (and in 2015) ATSDR used a follow up level to identify participants with potentially elevated urine arsenic levels. ATSDR compared each participant's urine arsenic result to the follow-up level of 28.4 mcg/g creatinine. This follow-up level was the lowest 95th percentile level for any age group in the 2009–10 National Health and Nutrition Examination Survey (the 12–19 year age group). Read Appendix A to learn more about ATSDR's methods.

² ATSDR used participant creatinine levels to adjust urine arsenic results for urine dilution. ATSDR used creatinine-corrected arsenic results to compare arsenic results between participants. Read Appendix A to learn more about ATSDR's methods.

Figure 1. Participant urinary total arsenic results (creatinine-corrected) by household



Explanation

- ATSDR Exposure Investigation follow-up level (28.4 micrograms per gram creatinine)
- Total urinary arsenic (creatinine-corrected) results for an individual participant
- | Vertical tie line indicating results are from the same household
- 2 Number of participants in the household

Creatinine levels for 2017 participant age groups were similar to U.S. population levels (Appendix B, Table B-3). Using data from working adults, the World Health Organization developed guidelines for expected creatinine concentrations in urine samples (30 – 300 mg/dL) (WHO 1996 and Barr et al. 2005).³ Two participants (a 15-year-old male and 7-year-old female) had urine creatinine values outside this range; however, their uncorrected urine arsenic levels were below U.S. population age-specific 90th percentile [2013 – 2014 National Health and Nutrition Examination Survey (NHANES)], indicating that their levels were not above the exposure investigation follow-up level. Further, given that the WHO reference levels were not developed with pediatric populations, they may not be applicable to children and adolescent age groups.

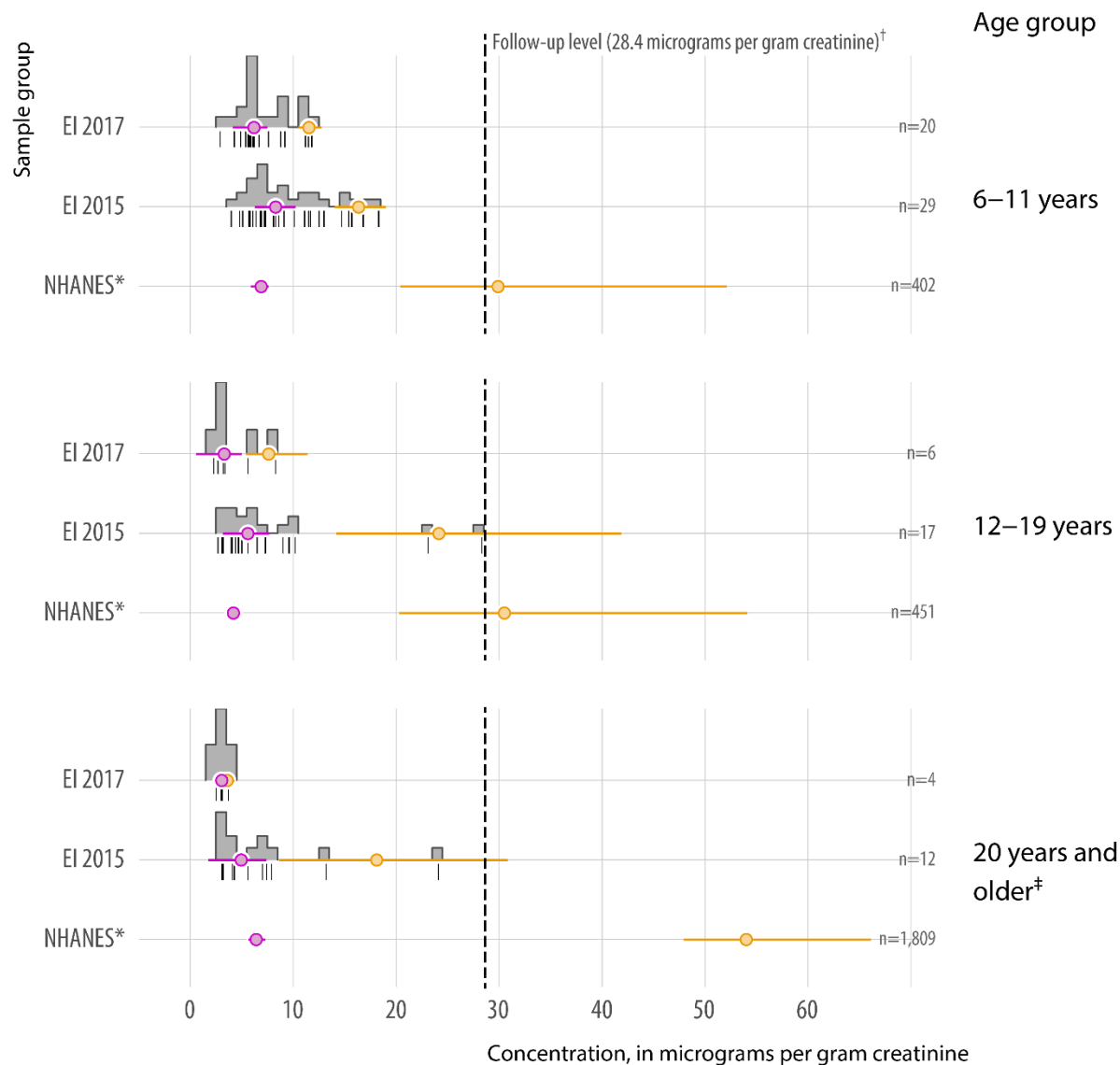
³ Creatinine correction for a target chemical (e.g., arsenic) measured in a highly concentrated urine sample (i.e., elevated creatinine) tends to underestimate the concentration of the target chemical. Conversely, creatinine correction for a target chemical measured in a very dilute urine sample (i.e., low creatinine) tends to overestimate the concentration of the chemical.

Total arsenic summary values for each age group were similar to U.S. population levels

Figure 2 shows summary statistics for creatinine-corrected urinary total arsenic for participants in the 2017 investigation, with comparison to the 2015 investigation and nationally representative data (NHANES). Median and 95th percentiles are reported for three age groups.

Median and 95th percentile values for children, adolescents, and adults in 2017 were similar to those from the U.S. population (Figure 2 and Appendix B: Results tables: Results Tables). Because different members of the community participated in the 2015 and 2017 investigations, comparisons of 2015 and 2017 results won't tell us whether levels of arsenic in this community changed over time. Though results from 2015 and 2017 come from two different groups and cannot be directly compared, it seems that overall results from 2017 do not appear significantly different from those in 2015.

Figure 2. Urinary total arsenic (creatinine-corrected) results for 2015 and 2017 exposure investigation participants and the U.S. population by age groups



Explanation



Probability density (scaled histogram) of sample results

Individual sample results

Median (50th percentile) and estimated extent of confidence interval

95th percentile and estimated extent of confidence interval

EI 2017 ATSDR Exposure Investigation (EI) results from 2017

EI 2015 ATSDR EI results from 2015

NHANES National Health and Nutrition Examination Survey (NHANES) 2013–2014 data (CDC 2018)

* Only the median and 95th percentile for the NHANES results are shown; the individual sample results and probability density are not shown because of the large size of the underlying sample results data set.

[†] The ATSDR Exposure Investigation follow-up level is based on the lowest age-specific 95th percentile value for the U.S. population from 2010-2011 (CDC 2018).

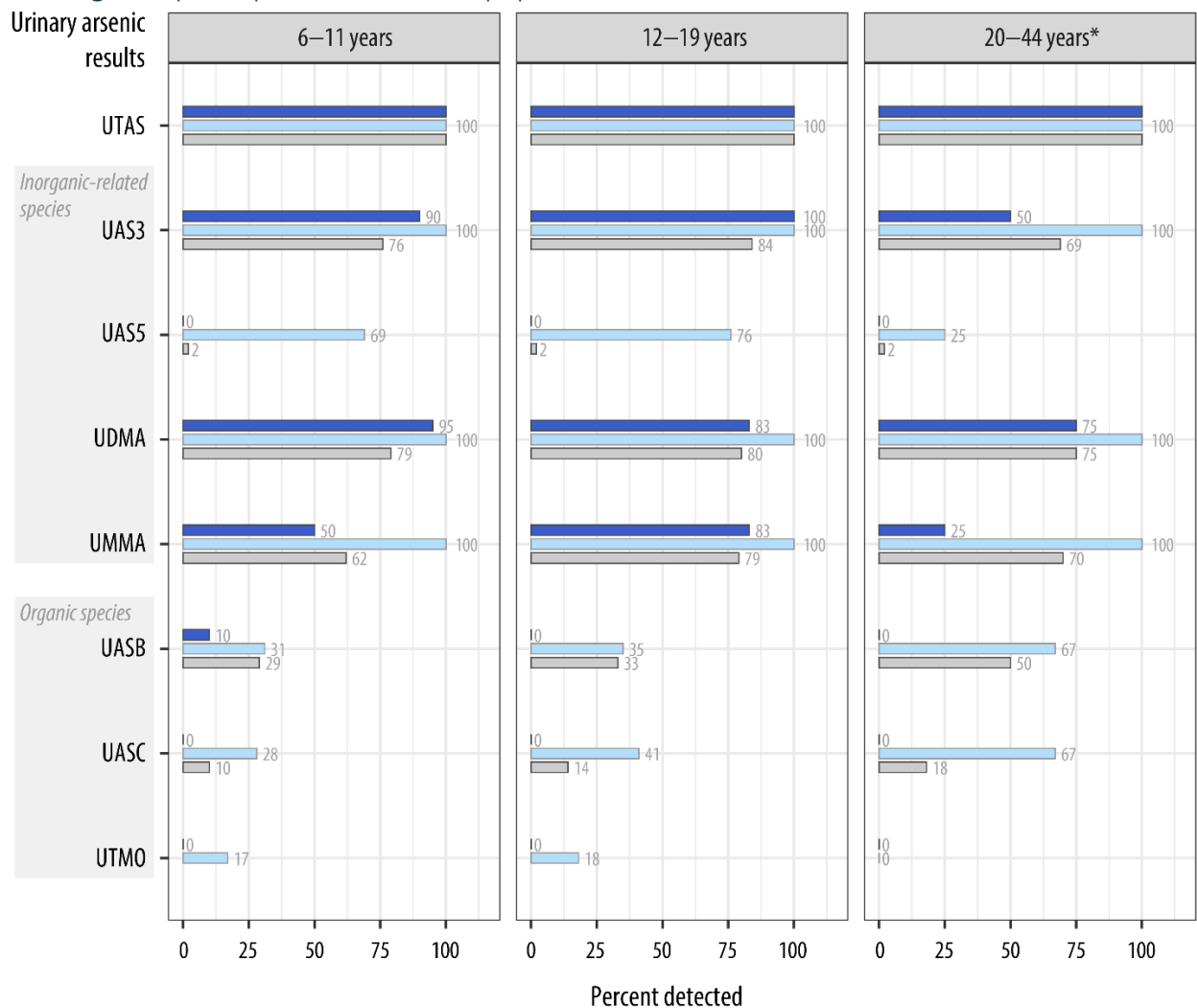
[‡] The Exposure Investigation age group is 20–44 years, but the corresponding NHANES age group is 20 years and older.

Many participants had no detectable levels of some inorganic-related arsenic species

Figure 3 shows the rate of detection of total arsenic and individual arsenic species (i.e., types) in urine among participants in the 2017 investigation, the 2015 investigation, and U.S. population (NHANES), organized by age group. The laboratory's limit of detection for each arsenic species was unchanged across these three investigations. Among 2017 testing participants, the rates of detection for most arsenic species was close to or lower than the rates of detection among 2015 participants and the U.S. population.

Though ATSDR calculated summary values for inorganic-related arsenic for two age groups in 2015, we were unable to do so using 2017 data because of the low rate of detection for some inorganic arsenic species. A summary value for inorganic-related arsenic is calculated by adding results for four arsenic species: arsenic (V) acid, arsenous (III) acid, dimethylarsinic acid (DMA), and monomethylarsonic acid (MMA) (CDC 2015). As CDC notes, summed inorganic-related arsenic "may be a more toxicologically and health relevant measure than total urinary arsenic, which includes non-toxic organic arsenic species" (CDC 2015). However, because the age-group specific rate of detection for several species in 2017 data was less than 60%, ATSDR was unable to calculate inorganic-related arsenic summary values.

Figure 3. Percentage of detected results for each arsenic species among 2017 and 2015 exposure investigation participants and the U.S. population



Explanation

- ATSDR Exposure Investigation (EI) results from 2017
- ATSDR EI results from 2015
- National Health and Nutrition Examination Survey (NHANES) 2013–2014 (CDC 2018)

* The Exposure Investigation age group is 20-44 years, but the corresponding NHANES age group is 20 years and older.

Abbreviations: UTAS urinary total arsenic (laboratory measurement of all arsenic species)

Inorganic-related species

- UAS3 urinary arsenous (III) acid
- UAS5 urinary arsenic (V) acid
- UDMA urinary dimethylarsinic acid
- UMMA urinary monomethylarsonic acid

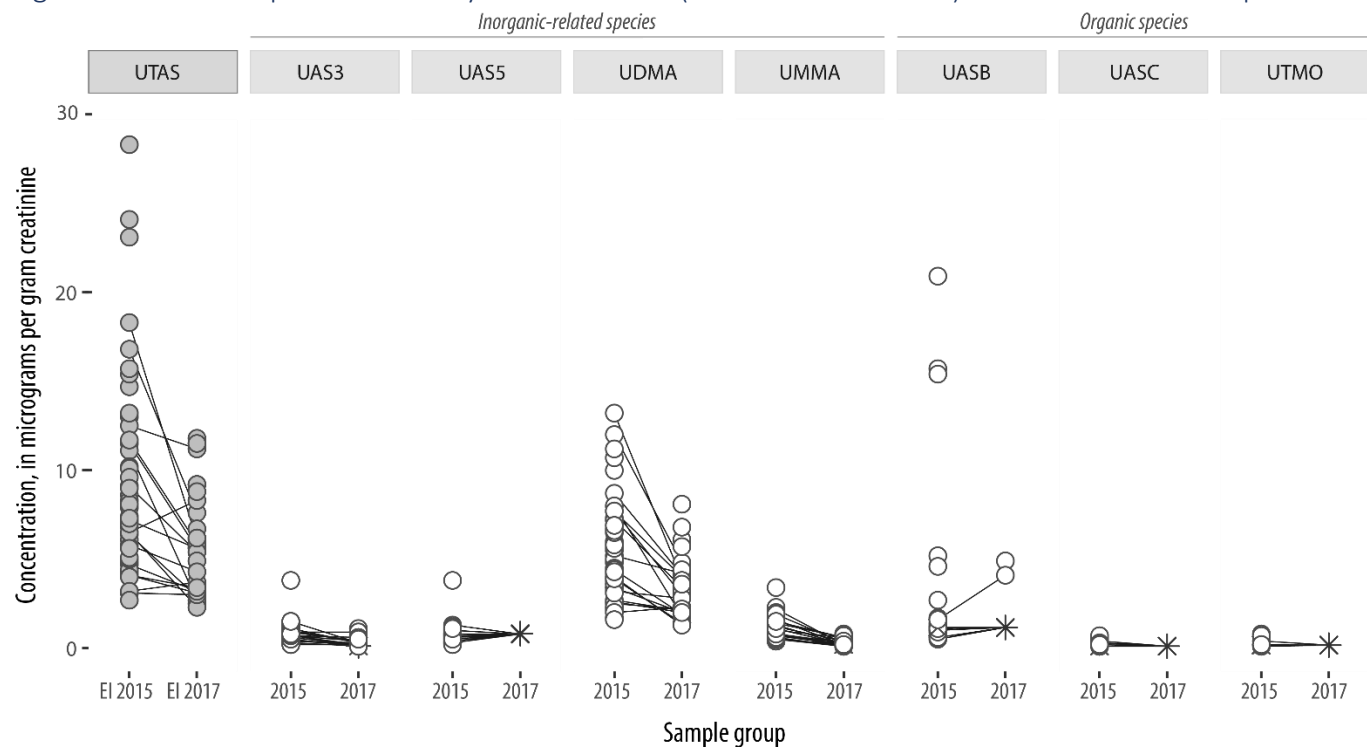
Organic species

- UASB urinary arsenobetaine
- UASC urinary arsenocholine
- UTMO urinary trimethylarsine oxide

Individual participants' arsenic levels were generally lower in 2017 than 2015

Figure 4 shows individual creatinine-corrected total and speciated urinary arsenic results for those who participated in either or both of the 2015 and 2017 exposure investigations. With few exceptions, among those who participated in both investigations, individual participants' arsenic levels were lower in 2017 than 2015. None of the individual arsenic results in 2017 exceeded age-specific 95th percentile levels based on nationally representative data for the U.S. population. ATSDR cannot draw conclusions about long-term trends in individual participant's or the Hayden and Winkelman community's arsenic exposure based on these individual-level results.

Figure 4. Total and speciated urinary arsenic results (creatinine-corrected) for 2015 and 2017 exposure investigation participants



Explanation

● 2015 participant result
 ○ 2017 participant result
 — tie line is present for participants involved in both 2015 and 2017

* Result is below reporting limit (nondetect).

EI 2015 ATSDR Exposure Investigation (EI) results from 2015 (n=58 participants)
 EI 2017 ATSDR EI results from 2017 (n= 30 participants)

UTAS Urinary total arsenic (laboratory measurement of all arsenic species)

Inorganic-related species included in the laboratory analyses

UAS3 urinary arsenous (III) acid

UAS5 urinary arsenic (V) acid

UDMA urinary dimethylarsinic acid

UMMA urinary monomethylarsonic acid

Organic species included in the laboratory analyses

UASB urinary arsenobetaine

UASC urinary arsenocholine

UTMO urinary trimethylarsine oxide

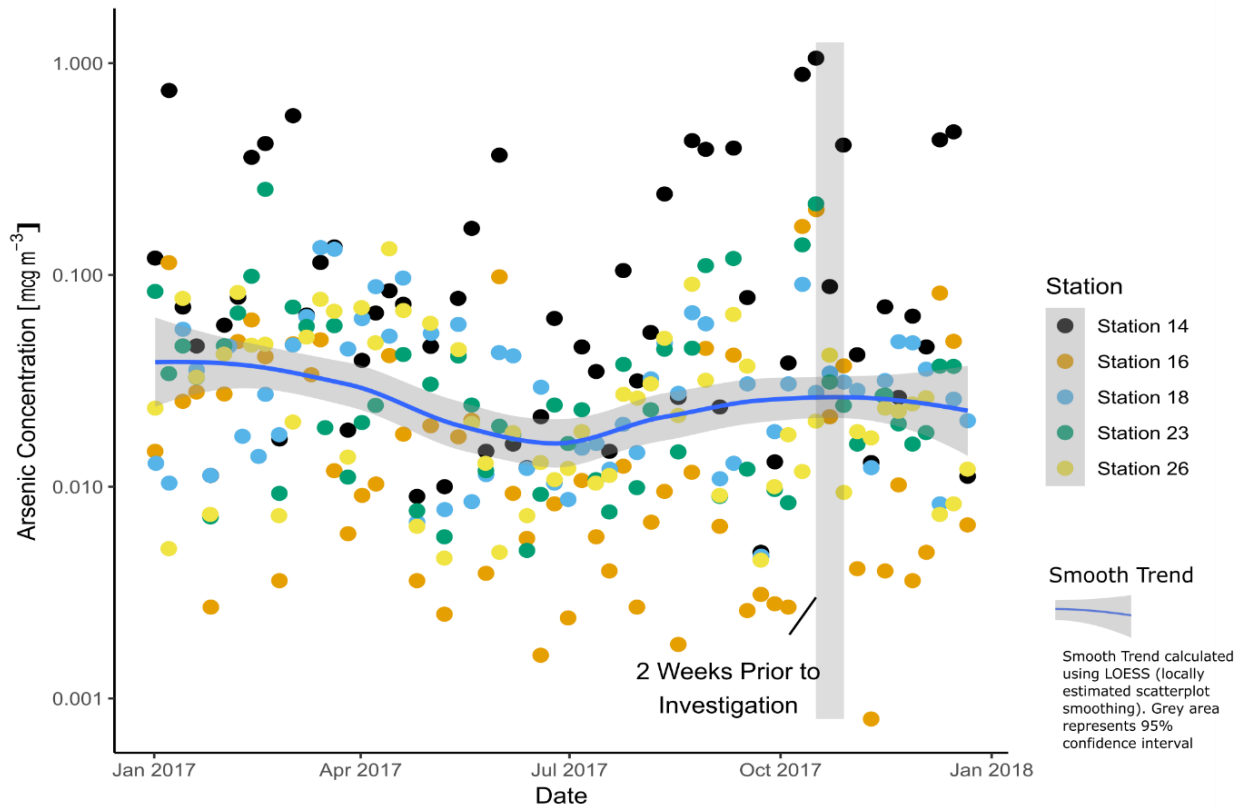
Arsenic levels in air were typical for the community before and during the 2017 testing

In the days before ATSDR's 2015 testing, the smelter was shut down for maintenance, reducing the levels of arsenic and lead in the air (ATSDR 2017). This could have lowered the amount of arsenic ATSDR measured in participants' urine in 2015. ATSDR conducted the 2017 arsenic testing to determine how much arsenic Hayden and Winkelman community members have in their bodies when air pollution levels are typical for the community (i.e., unaffected by a smelter shutdown).

ATSDR compared arsenic levels in Hayden's air during the two weeks before ATSDR completed the 2017 urine sampling (October 14 – 28, 2017) with the rest of 2017.⁴ Figure 5 shows that arsenic levels in air during the two weeks before ATSDR collected urine samples were similar to or higher than other times in 2017. Combining measurements from all five stations, the median arsenic levels for the two weeks before ATSDR collected urine samples and other times in 2017 were 0.03 mcg/m³ and 0.02 mcg/m³ respectively (Appendix D: Boxplots of arsenic levels in Hayden air : Boxplots of arsenic levels in Hayden air). Average concentrations for the two weeks prior to urine sampling at each of the five stations were either higher than (station 14) or not markedly different from (stations 16, 18, 23, and 26) the rest of 2017 (Appendix B, Table B-4: Arsenic air concentrations, Hayden, Arizona). Appendix C: Map of air monitoring stations includes a map of air monitoring sites.

⁴ As noted in Appendix A, ATSDR used several methods for this comparison. The result of the nonparametric multivariate analysis of variance indicated that there was less than a 2% probability of seeing such changes if these changes were due to random chance alone. This suggests that there was a significant change in at least one of the station averages prior to the exposure investigation. The results of examining each station's data using the Wilcoxon rank sum test (Hollander and Wolfe 1973) showed that station 14 had a 4% probability of seeing such a large shift during the two-week window if the shift was due to random chance alone (Appendix B, Table B-4). Other stations did not have significant differences, but with limited samples (three per station) only large differences would likely be detected with the Wilcoxon rank sum test.

Figure 5. Arsenic levels in air measured at five locations in Hayden in 2017



Findings and Next Steps

Finding 1: Arsenic levels in the 33 Hayden and Winkelman residents ATSDR tested in 2017 were similar to U.S. population levels.

- All participants had total arsenic levels below ATSDR's follow-up level 28.4 mcg/g creatinine. Results ranged from 2.3 to 11.8 mcg/g creatinine.
- Total arsenic levels for each age group were similar to U.S. population levels.
- Many participants had no detectable levels of some inorganic-related arsenic species.
- Individual participants' arsenic levels were generally lower in 2017 than 2015.
- Arsenic levels in air were typical for the community before and during the 2017 testing.
- These tests only tell us how much arsenic was in participants' bodies at the time of testing. The amount of arsenic in a person's body can change quickly.

Finding 2: Residents remain at risk for exposure to arsenic and lead in the community.

- People in Hayden and Winkelman might be exposed to lead and arsenic in outdoor air, in mine waste piles, and in soil in some non-residential locations. Additionally, they may be exposed to lead from paint in older housing (ATSDR 2017).
- The Hayden and Winkelman children and adolescents ATSDR tested in 2015 had higher levels of lead in their bodies than children and adolescents from across the U.S. (ATSDR 2017).

Next Steps

ATSDR recommends that organizations and community members continue taking steps to reduce exposure to lead and arsenic in the community.

ATSDR recommends that EPA, ADEQ, and ASARCO take the following steps to protect the health of the community.

- Continue implementing the 2015 EPA/ASARCO consent decree that requires the company to install new equipment and pollution control technology at the Hayden smelter and fund local environmental health projects (including a home lead-based paint testing and abatement project), among other actions (EPA 2015b).
- Continue environmental sampling and clean-up efforts in Hayden and Winkelman.

ATSDR recommends that community members continue taking steps to reduce their exposure to arsenic and lead in the community.

- Follow the tips in Box 5 to keep dirt and dust from getting into your body at home, at work, and at play.
- Sign up for the free home lead-based paint testing and abatement project with Central Arizona Governments. Contact Alan Urban at 480-474-9300 or aurban@cagaz.org.

- Parents and caregivers should make sure their children have regular follow-up blood lead testing, as recommended by their health care provider or state and local health departments. Yearly or more frequent testing may be necessary for children under six years old or children who have previously had a confirmed blood lead level greater than or equal to 5 micrograms per deciliter ($\mu\text{g}/\text{dL}$).
- Maintain healthy eating habits for your family; people who eat healthy diets rich in iron, calcium, zinc, and vitamin C absorb less lead.

ATSDR has:

- Sent participants their 2017 arsenic test results and tips for reducing exposure to arsenic.
- Provided updates on our work in Hayden and Winkelman to interested organizations, community members, and local leaders.

ATSDR will:

- Brief other organizations working on environmental and health issues in Hayden and Winkelman on the 2017 arsenic testing results.
- Meet with the Mayors of Hayden and Winkelman to discuss the 2017 arsenic testing results.
- Hold a community event to discuss the 2017 arsenic testing results with Hayden and Winkelman residents.
- Remain available to answer questions about our Hayden and Winkelman activities.

Box 5: Community members can keep dirt and dust from getting into their bodies by following these tips

Outside

- Don't play in arroyos or on waste piles.
- Stay away from railroad tracks in Hayden.
- Do not trespass on mine or smelter property.

At Home

- Wipe shoes on a doormat and remove shoes before entering your house.
- Wet-mop or wet-wipe floors, windowsills, counters and hard-surface furniture every 2 – 3 weeks.
- Make sure your child does not chew on surfaces painted with lead-based paint.
- Wash pets that spend time outside and inside your home at least every 2-3 weeks.

Keep things clean

- Wash things children put into their mouths, such as pacifiers, bottles, and toys whenever they fall on the floor or ground.
- Wash your hands and your children's hands before eating and after being outside.
- Wash fruits, vegetables, and root crops (like potatoes) before preparing them to eat.

At work

- If you could be exposed to lead or arsenic in your workplace, change your clothes at work before returning home or immediately after arriving home.
- Wash your work clothes separately from the clothes of other family members.

Limitations of this Exposure Investigation

- Exposure investigation results are applicable only to the individuals tested and cannot be generalized to other individuals or areas.
- Urine arsenic tests cannot be used to determine the sources of arsenic exposures.
- Single urinary arsenic tests are snapshots of exposure and may not accurately represent a person's past or long-term arsenic exposures. Arsenic is excreted within several days of exposure.
- Some residents who participated in urine arsenic testing in ATSDR's 2015 investigation were unavailable or chose not to participate in the 2017 testing opportunity.
- The results of ATSDR's 2015 and 2017 urine arsenic tests for Hayden and Winkelman residents are snapshots in time and cannot be used to draw conclusions about arsenic exposure trends in the community.
- Comparisons between adult participants (women 20–40 years old) and U.S. population adults (men and women 20 years and older) should be interpreted with caution due to sex and age differences.

- The 12 – 19 and 20 – 40 year-old participant age groups had just 6 and 4 participants, respectively, so ATSDR is less confident in summary statistics (e.g., median levels) for those age groups.
- For this analysis, ATSDR relied on 2017 air monitoring data for Hayden only. The levels of arsenic in air in Winkelman may have differed.

For More Information

If you have questions, contact ATSDR's region 9 director, Libby Vianu, at 415-947-4319 or LVianu@cdc.gov or our toll-free number at 1-800-CDC-INFO and ask for information on the ASARCO Hayden Smelter site.

Authors

Ben Gerhardstein, MPH
Environmental Health Scientist, Region 9, Division of Community Health Investigations

Matt Karwowski, MD, MPH
Senior Medical Officer, Science Support Branch, Division of Community Health Investigations

Jamie Rayman, MPH
Health Educator & Community Involvement Specialist, Region 9, Division of Community Health Investigations

Barbara Anderson, PE, MSEnvE
Environmental Health Scientist, Science Support Branch, Division of Community Health Investigations

James Durant, MSPH, CIH
Environmental Health Scientist, Science Support Branch, Division of Community Health Investigations

Documents Cited

[ADHS 2002] Arizona Department of Health Services (2002). Public Health Assessment, ASARCO Hayden Smelter Site. Available at <https://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/environmental-toxicology/asarco-hayden.pdf>. Accessed June 18, 2018.

[ADHS 2018] Arizona Department of Health Services (2018). Health Consultation. Evaluation of Community Exposure to Lead and Sulfur Dioxide in Air. Hayden and Winkelman Communities. Available at <https://azdhs.gov/documents/preparedness/epidemiology-disease-control/environmental-toxicology/hayden-winkelman-2018.pdf>. Accessed June 18, 2018.

[ATSDR 2017] Agency for Toxic Substances and Disease Registry (2017). Health Consultation. Exposure Investigation. Biological Testing for Exposure to Lead and Arsenic near ASARCO Hayden Smelter Site. Hayden and Winkelman, Arizona. Available at https://www.atsdr.cdc.gov/HAC/pha/AsarcoHaydenSmelterSite/AsarcoHaydenSmelterSite_HC_EI_03272017_508.pdf. Accessed June 18, 2018.

Barr DB, Wilder LC, Caudill SP, Gonzalez AJ, Needham LL, Pirkle JL (2005). Urinary Creatinine Concentrations in the U.S. Population: Implications for Urinary Biologic Monitoring Measurements. *Environmental Health Perspectives*. 113(2): 192–200. Available at: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1277864/>. Last visited October 15, 2018.

[CDC 2015] Centers for Disease Control and Prevention. Fourth Report on Human Exposure to Environmental Chemicals, Updated Tables (February, 2015). Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. https://www.cdc.gov/exposurereport/pdf/archives/exposurereport_wnd_feb2015.pdf.

[CDC 2016] Centers for Disease Control and Prevention (2016). Laboratory Procedure Manual. Urine Arsenic Speciation. Method DLS 3000.15. Available at https://wwwn.cdc.gov/nchs/data/nhanes/2015-2016/labmethods/UAS_UASS_I_MET.pdf. Accessed October 15, 2018.

[CDC 2017] Centers for Disease Control and Prevention (2017). Biomonitoring Summary: Arsenic. Available at: https://www.cdc.gov/biomonitoring/Arsenic_BiomonitoringSummary.html.

[CDC 2018] Centers for Disease Control and Prevention. Fourth Report on Human Exposure to Environmental Chemicals, Updated Tables, (March 2018). Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. <https://www.cdc.gov/exposurereport/>.

Cleveland WS, Grosse E. and Shyu WM (1992) Local regression models. Chapter 8 of Statistical Models in S eds J.M. Chambers and T.J. Hastie, Wadsworth & Brooks/Cole.

[EPA 2015] Environmental Protection Agency (2015). Residential Soil Removal Action Report, Towns of Hayden and Winkelman, Arizona.

[EPA 2015b] Environmental Protection Agency (2015). ASARCO LLC Settlement. Available at <http://www.epa.gov/enforcement/asarco-llc-settlement>. Accessed September 19, 2018.

[EPA 2016] Environmental Protection Agency (2016). List of Designated Reference and Equivalent Methods. Available at <https://www3.epa.gov/ttnamti1/files/ambient/criteria/AMTIC%20List%20Dec%202016-2.pdf>. Accessed October 16, 2018.

[EPA 2018] Environmental Protection Agency (2018). Asarco Hayden Plant. Available at <https://cumulis.epa.gov/superpad/cursites/csitinfo.cfm?id=0900497>. Accessed June 18, 2018.

Hollander M. and Wolfe D. (1973). Nonparametric Statistical Methods. New York: John Wiley & Sons. Pages 27–33 (one-sample), 68–75 (two-sample).

Jones DR, Wallon, KL, Jarrett JM, Caldwell KL, Jones RL (2016). A Combined Method for Detecting Cr, Ni, and As in Human Urine by Inductively Coupled Plasma Universal Cell Technology Mass Spectrometry. Winter Conference on Plasma Spectrochemistry, Florida, ICP Information Newsletter.

Manly, BFJ. (2007). Randomization, Bootstrap and Monte Carlo Methods in Biology, Third Edition. Boca Raton, FL, Chapman & Hall/CRC.

University of Arizona (2018). Contact List: Organizations Working on Environmental and Health Issues in Hayden and Winkelman, AZ. Available at <https://superfund.arizona.edu/sites/superfund.arizona.edu/files/u68/v17-organizations-in-h-w-handout-logos.pdf>. Accessed September 11, 2018.

[WHO 1996] World Health Organization. 1996. Biological Monitoring of Chemical Exposure in the Workplace. Vol 1. Geneva.

Appendices

Appendix A: ATSDR's methods for this investigation

Eligibility and Recruitment

For the 2017 arsenic testing, ATSDR focused on recruiting people who lived in households that participated in the 2015 lead and arsenic testing. In 2017, ATSDR used the same eligibility criteria as the 2015 arsenic testing when recruiting participants (Box A-1). ATSDR did not recruit children younger than 6 years old because there were no national comparison statistics for this age group at the time, making it difficult to interpret the results.

Box A-1: Eligibility Criteria for 2015 and 2017 Arsenic Testing Participants

Hayden and Winkelman residents who met the following criteria were eligible to participate:

- children and adolescents ages 6 years to 17 years,
- pregnant women of any age,
- women of childbearing age,

As noted in the body of the report, in 2017 ATSDR agreed to test several community members who did not meet these eligibility criteria but were concerned about exposure.

ATSDR took several steps to recruit 2017 urine arsenic test participants:

- sent postcards to each household that participated in the 2015 arsenic testing;
- visited each household that participated in 2015 arsenic testing or had a child who did not meet the age criteria for arsenic testing in 2015 (i.e., younger than age 6) but was eligible in 2017; and
- called each household that staff could not reach in person.

ATSDR staff visited and called each 2015 participant household multiple times during the week of the 2017 testing opportunity. In several cases, ATSDR determined that 2015 participants had moved away from the area or were unavailable to participate. In addition, some 2015 participants declined the opportunity for another urine arsenic test.

Participant consent and questionnaire

ATSDR administered consent, assent, and parental permission forms for collecting urine samples. ATSDR also collected information from the head of each household using an Office of Management and Budget (OMB) approved questionnaire (OMB Control Number 0923-0048). The household questionnaire included questions on demographics, characteristics of the residence, and activities that might result in exposure to arsenic. ATSDR collected information on participant race and ethnicity as part of the questionnaire. This information helped ATSDR understand differences between the participant population and the U.S. population. It also allowed ATSDR to compare individual and aggregate participant results to appropriate U.S. subpopulations, when necessary.

Sample Collection and Analytic Methods

Urine Arsenic Data & Analysis

ATSDR collected spot urine samples (generally first morning void) during the week of October 23, 2017. Participants used collection cups supplied by the CDC laboratory. Most participants collected their urine sample at home on the day of their appointment, froze the sample, and then brought it to the collection location, where they completed the questionnaire. To maintain privacy, the samples were labeled with a unique identification number. Urine samples were kept frozen on dry ice and shipped to the CDC laboratory.

The CDC laboratory performed urinary arsenic analyses (total and speciated arsenic for all participants) using the following methods: DLS 30131.1 for urine total arsenic (Jones et al., 2016), and DLS 3000.15 for arsenic speciation (CDC 2016). The lab also measured creatinine levels in urine samples.

ATSDR used participant creatinine levels to adjust urine arsenic results for urine dilution. Creatinine-corrected arsenic results allowed ATSDR to compare arsenic results between participants and gauge the validity of a urine sample (Barr et al. 2005). Creatinine-corrected arsenic results are reported as microgram of arsenic per gram creatinine (mcg/g creatinine).

ATSDR interpreted the 2017 urine arsenic values by:

- Comparing participants' individual and age group specific corrected and uncorrected urine arsenic results with those from the U.S. population (CDC's NHANES 2013-2014) (Appendix B, Tables B-1 and B-2).
- Comparing participants' individual results to the follow-up level of 28.4 mcg/g creatinine. The arsenic exposure investigation follow-up level was the lowest 95th percentile level for any age group in the 2009–10 NHANES (the 12–19 year age group).
- ATSDR calculated statistics to compare age group specific participant and U.S. population arsenic levels. ATSDR estimated median (i.e., 50th percentile) and 95th percentile levels for participants (Box A-1 defines these statistics).
- ATSDR also used percentile bootstrap methods (n = 2,000) to calculate the upper and lower bounds of the 95% confidence interval for arsenic median and 95th percentile levels (Manly 2007).

ATSDR intended to estimate the sum of inorganic-related arsenic species [arsenic (V) acid, arsenous (III) acid, dimethylarsinic acid (DMA), and monomethylarsonic acid (MMA)] for 2017 participants, as we did for 2015 participants (see Box 2). However, as explained in the results section, certain inorganic arsenic species results were below the laboratory's limit of detection for many 2017 participants, so ATSDR could not estimate the sum of inorganic-related arsenic

species for 2017 participant age groups because the high number of non-detects would affect the accuracy of the results.

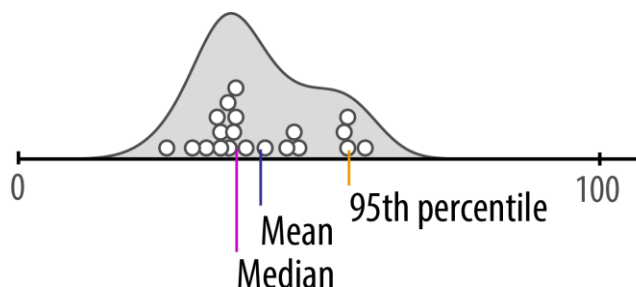
Box A-1: What are the median, mean, and 95th percentile?

The median and mean are different ways of measuring the center of a collection of numbers.

- The **median** is the middle value in a list of numbers. In a set of numbers, it separates the higher half from the lower half.
- The **mean** (or average) is the sum of a set of numbers divided by the number of numbers in the set.

The **95th percentile** is the value below which 95 percent of the values in a data set are found.

These three statistics are illustrated in this figure:



Explanation: In this figure the white dots are a hypothetical set of numbers (or data set) organized on a number line. Numbers in the set that are close together are stacked to show how many there are. The gray curve shows the shape of the distribution of the data. The peak of the curve is where most of the numbers are. In this number set, the median (middle value) is less than the mean (average). The 95th percentile value is higher than both the median and mean.

Arsenic Air Data & Analysis

ATSDR used arsenic air monitoring data that ASARCO collected (with EPA oversight) at five monitoring stations located throughout Hayden (Appendix C: Map of air monitoring stations provides a map). ATSDR used these data to assess levels of arsenic in outdoor air in the area. Specifically, ATSDR used measurements of arsenic in particulate matter with an aerodynamic diameter of 10 micrometers or less (PM₁₀) from samples collected every six days at each monitoring station. ASARCO used Thermo Scientific Partisol Plus 2025i Federal Reference Method sequential air samplers configured with PM₁₀ inlets (personal communication with Mathew Plate, Environmental Protection Agency, Region 9, October 16, 2018 & EPA 2016).

We compared arsenic air monitoring data for the two-week period before ATSDR completed the 2017 urine sampling (October 14 – 28, 2017) with other times in 2017 using locally estimated scatterplot smoothing (LOESS), boxplots, nonparametric multivariate analysis of variance, and the Wilcoxon rank sum test (Cleveland, Grosse and Shyu 1992, Anderson 2001, Hollander and Wolfe 1973).

Appendix B: Results tables

Table B-1. Creatinine-corrected total urine arsenic concentrations among exposure investigation participants and the U.S. population by age group

Age group	Number of ATSDR EI participants	Number of NHANES participants	ATSDR EI median total urinary arsenic and upper and lower bounds of 95 th confidence interval* (mcg/g creatinine)	NHANES median total urinary arsenic and upper and lower bounds of 95 th confidence interval* (mcg/g creatinine)	ATSDR EI 95 th percentile total urinary arsenic and upper and lower bounds of 95 th confidence interval* (mcg/g creatinine)	NHANES 95 th percentile total urinary arsenic and upper and lower bounds of 95 th confidence interval* (mcg/g creatinine)
6–11 yrs [‡]	20	401	6.2 (4.2-7.5)	6.9 (5.9-7.7)	11.5 (10.4-12.8)	29.9 (20.4–52.1)
12–19 yrs	6	451	3.3 (0.6-5.0)	4.2 (3.6-4.6)	7.6 (5.5-11.5)	30.5 (20.3–54.1)
≥20 yrs [†]	4	1,808	3.1 (2.5-3.6)	6.4 (5.7-7.3)	3.6 (3.2-4.3)	54.0 (47.9–66.1)

* The upper and lower bounds of the 95% confidence interval calculated using the percentile bootstrap method with 2,000 repetitions.

[‡] This group includes the exposure investigation participant who was between 1-5 years of age.

[†] This group excludes the three participants who are 75 years and older. Comparisons between the adult participant age group (women 20–44 years old) and NHANES adults (men and women 20 years and older) should be interpreted with caution due to sex and age differences.

Abbreviations: ATSDR, Agency for Toxic Substances and Disease Registry; EI, Exposure Investigation; NHANES, National Health and Nutrition Examination Survey (2013–14 data) (CDC 2018).

Table B-2. Total urine arsenic concentrations among exposure investigation participants and the U.S. population by age group

Age group	Number of ATSDR EI participants	Number of NHANES participants	ATSDR EI median total urinary arsenic and upper and lower bounds of 95 th confidence interval* (mcg/L)	NHANES median total urinary arsenic and upper and lower bounds of 95 th confidence interval* (mcg/L)	ATSDR EI 95 th percentile total urinary arsenic and upper and lower bounds of 95 th confidence interval* (mcg/L)	NHANES 95 th percentile total urinary arsenic and upper and lower bounds of 95 th confidence interval* (mcg/L)
6–11 yrs [‡]	20	402	7.1 (4.3-9.6)	4.8 (4.3-5.6)	13.5 (2.6-20.3)	29.0 (17.9-47.7)
12–19 yrs	6	451	7.0 (5.1-9.6)	5.3 (4.8-5.9)	9.3 (7.5-12.1)	44.1 (27.0-90.8)
≥20 yrs [†]	4	1,809	3.7 (1.1-6.1)	6.1 (5.2-7.0)	6.0 (4.5-8.7)	48.0 (37.5–57.5)

* The upper and lower bounds of the 95% confidence interval calculated using the percentile bootstrap method with 2,000 repetitions.

[‡] This group includes the exposure investigation participant who is between 1-5 years of age.

[†] This group excludes the three participants who are 75 years and older. Comparisons between the adult participant age group (women 20–44 years old) and NHANES adults (men and women 20 years and older) should be interpreted with caution due to sex and age differences.

Abbreviations: ATSDR, Agency for Toxic Substances and Disease Registry; EI, Exposure Investigation; NHANES, National Health and Nutrition Examination Survey (2013–14 data) (CDC 2018).

Table B-3. Exposure investigation participant and U.S. population median urinary creatinine levels by age group

Age group	Number of ATSDR EI participants	Number of NHANES participants	ATSDR EI median urinary creatinine and upper and lower bounds of 95 th confidence interval* (mcg/L)	NHANES median urinary creatinine and upper and lower bounds of 95 th confidence interval* (mcg/L)
6–11 yrs [‡]	20	401	93 (72-113)	73 (68-79)
12–19 yrs	6	392	191 (123-257)	126 (103-151)
≥20 yrs [†]	4	1723	108 (33-172)	95 (90-99)

* The upper and lower bounds of the 95% confidence interval calculated using the percentile bootstrap method with 2,000 repetitions.

[‡] This group includes the exposure investigation participant who is between 1-5 years of age.

[†] This group excludes the three participants who are 75 years and older. Comparisons between the adult participant age group (women 20–44 years old) and NHANES adults (men and women 20 years and older) should be interpreted with caution due to sex and age differences.

Abbreviations: ATSDR, Agency for Toxic Substances and Disease Registry; EI, Exposure Investigation; NHANES, National Health and Nutrition Examination Survey (2013–14 data) (CDC 2018).

Table B-4. Arsenic air concentrations, Hayden, Arizona

Air Monitor Station	Average air concentration (mcg/m ³) during 2017, excluding October 14 - 28	Average air concentration (mcg/m ³) during two weeks before urine sample collection	Wilcoxon Rank Sum Test p-value
Station 14	0.14	0.52	0.04
Station 16	0.02	0.09	0.065
Station 18	0.04	0.03	0.79
Station 23	0.04	0.09	0.253
Station 26	0.03	0.02	0.840

Abbreviations: mcg/m³, microgram per cubic meter of air

Appendix C: Map of air monitoring stations

EPA FACILITY ID AZD008397127

Air monitoring stations where arsenic was measured in 2017

INTRODUCTORY MAP SERIES

Hayden, AZ



Data Sources: ¹ATSDR GRASP Hazardous Waste Site Boundary Database; ²ATSDR GRASP; ³Tom Tom International BV (2012), Digital Globe.
 Note: ASARCO conducted air monitoring with EPA oversight.
 Projection: NAD 1983 StatePlane Arizona East FIPS 0201 Feet

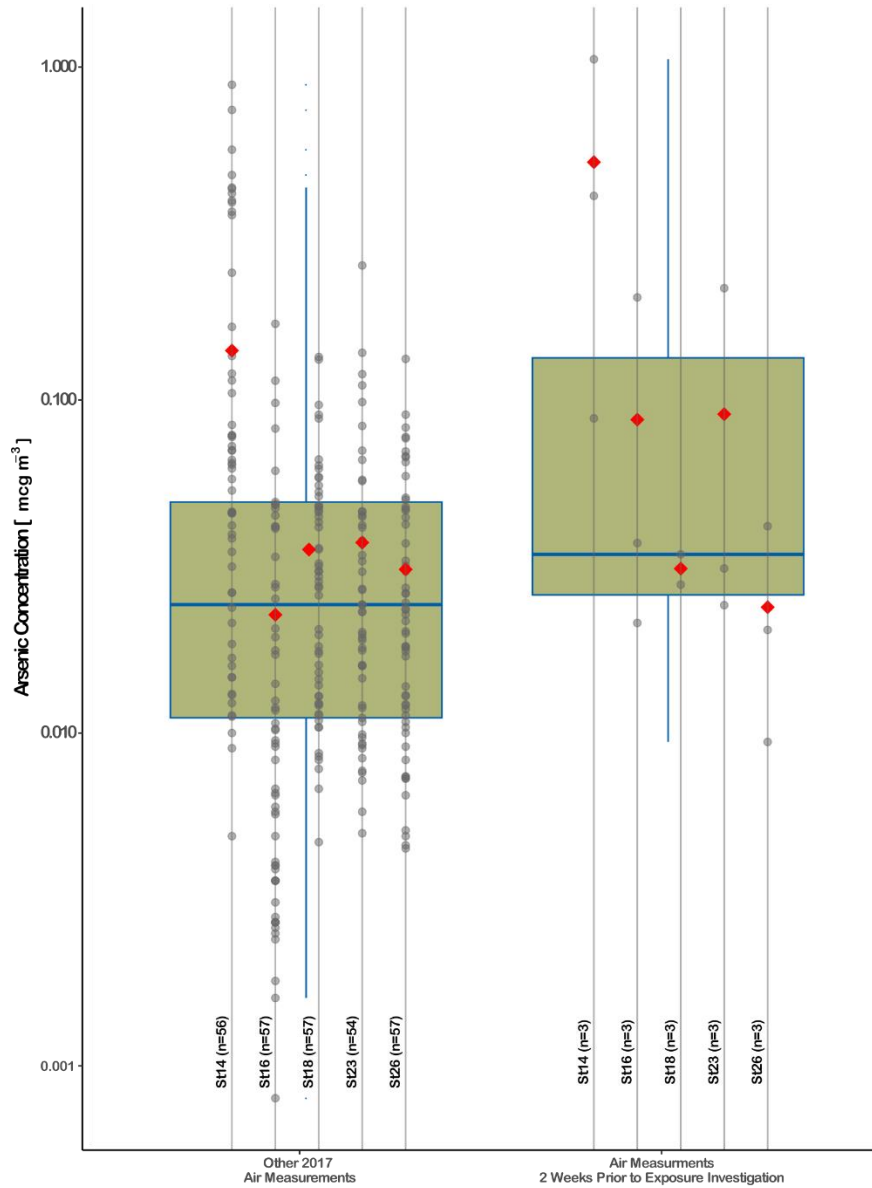
PRJ 05164 LLE0 11/29/17

Agency for Toxic Substances and Disease Registry
 Division of Toxicology and Human Health Sciences



FINAL - FOR PUBLIC RELEASE

Appendix D: Boxplots of arsenic levels in Hayden air

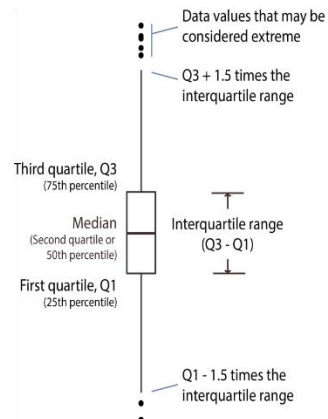


Explanation

Arsenic measurements are plotted vertically for each station. Measurements taken during the 2 weeks before ATSDR collected urine samples are grouped on the right. Measurements taken during other times in 2017 are grouped on the left.

The boxplots show the overall median (50th percentile), and the 25th and 75th percentiles of the data, as well possible extreme values in the data.

- Arsenic Air Concentration
- ◆ Station average
- St14 (n=56) Station Number (number of samples)



Appendix E: Summary of ATSDR's 2017 arsenic exposure investigation

ASARCO Hayden Smelter Site, Hayden and Winkelman, Arizona

Summary of ATSDR's 2017 Arsenic Exposure Investigation

December 2019

People in Hayden and Winkelman may be exposed to lead and arsenic from smelting activities and other sources in their environment. In 2015 ATSDR provided blood and urine testing for residents. In 2017 we offered follow-up urine arsenic testing to people in households that participated in 2015. Our goal in 2017 was to find out arsenic levels in participants' urine when air quality was typical for the community. This is a summary of the 2017 investigation report.

What are the community's concerns?

Community members have health concerns about historic and ongoing exposure to lead, arsenic, and other mine and smelter-related contaminants. Community leaders also have concerns about keeping track of environmental and health work in Hayden and Winkelman and reviving the local economy.

The Bottom Line

- Arsenic levels in the 33 Hayden and Winkelman residents ATSDR tested in 2017 were similar to U.S. population levels.
- Residents remain at risk for exposure to arsenic and lead in the community.
- Organizations and community members should continue taking steps to reduce exposure to lead and arsenic.



A playground next to the ASARCO Hayden Plant in Hayden, AZ.

About these tests and results

These tests tell us how much arsenic was in participants' bodies at the time of testing, but the amount of arsenic in a person's body can change quickly. Also, the results might not represent the overall community.

What did ATSDR do?

In October 2017 ATSDR offered follow-up urine arsenic testing to households that participated in the 2015 investigation. We focused on testing residents at higher risk for health effects from arsenic exposure: children, adolescents, and women of child-bearing age.

- We tested a total of 33 Hayden and Winkelman residents from 13 households.
- Just over half (17 of 33 or 52%) of 2017 participants received arsenic testing during the 2015 exposure investigation.
- ATSDR sent result letters to each participant in December 2017.

ATSDR used measurements of arsenic in Hayden's air from 2017 to find out if air quality was typical for the community during the testing.

In 2018, ATSDR helped a group of organizations working on environmental health issues in the community to begin sending regular email updates to community leaders.



**U.S. Department of
Health and Human Services**
Agency for Toxic Substances
and Disease Registry

What did ATSDR find?

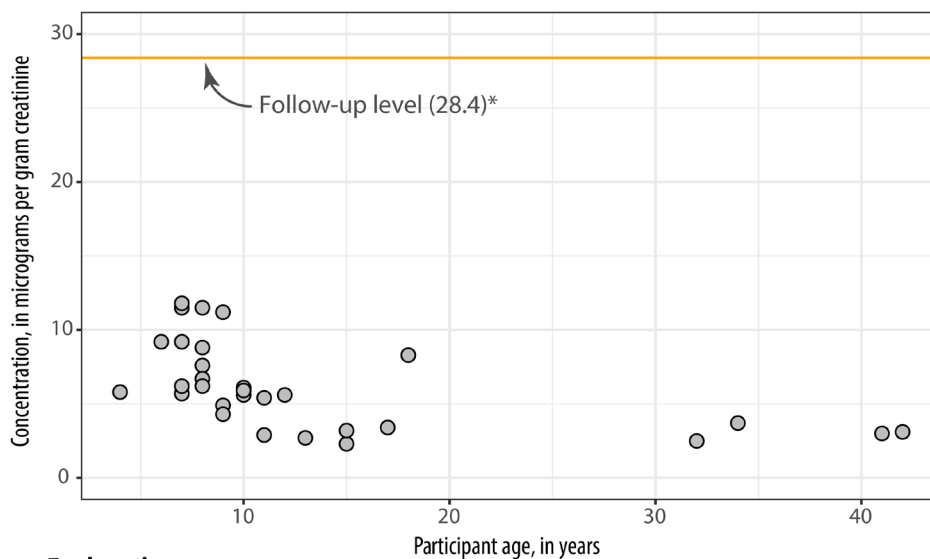
Arsenic levels in the Hayden and Winkelman residents ATSDR tested in 2017 were similar to levels found in the U.S. population.

- All participants had total arsenic levels below ATSDR's follow-up level (28.4 micrograms arsenic per gram creatinine, or mcg/g Cr). The highest value was 11.8 mcg/g Cr (Figure 1).
- Total arsenic summary values for child and adolescent participants were similar to U.S. population levels (Figure 2).
- Many participants had no detectable levels of some of the inorganic-related arsenic species measured.
- Individual participants' arsenic levels were generally lower in 2017 than 2015.
- Arsenic levels in air were typical for the community before and during the 2017 urine testing. In 2015, the smelter was shut down for maintenance during ATSDR's testing, reducing the levels of arsenic and lead levels in air.

Residents remain at risk for exposure to arsenic and lead in the community.

- People in Hayden and Winkelman might be exposed to lead and arsenic in outdoor air, in mine waste piles, and in soil in some non-residential locations. Also, they may be exposed to lead from paint in older housing.

Figure 1: Individual total arsenic in participants in ATSDR's Exposure Investigation



Explanation

- ATSDR Exposure Investigation follow-up level (28.4 micrograms per gram creatinine)
- Total urinary arsenic (creatinine-corrected) results for an individual participant

* The ATSDR Exposure Investigation follow-up level is based on the lowest age-specific 95th percentile value from reported values for the U.S. population from 2010-2011 (CDC 2018).

Next Steps

ATSDR recommends that organizations and community members continue taking steps to reduce exposure to lead and arsenic in the community.

ATSDR recommends that EPA, ADEQ, and ASARCO continue

- Implementing the 2015 EPA/ASARCO consent decree.
- Environmental sampling and clean-up efforts in Hayden and Winkelman.

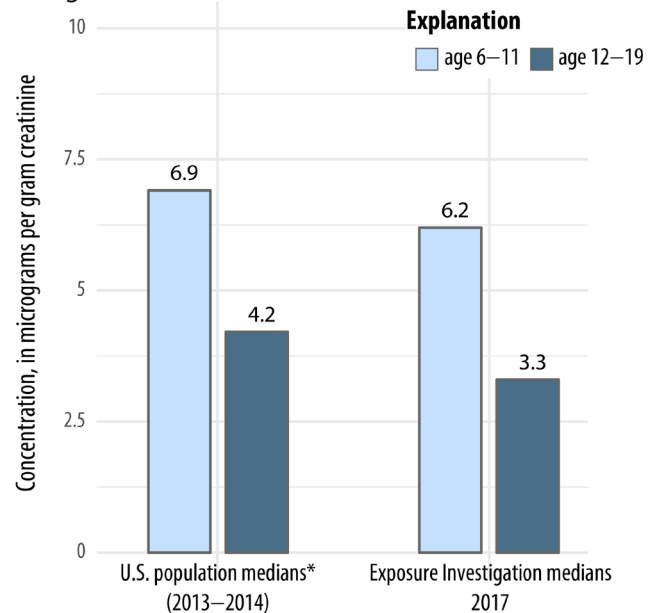
We recommend that community members

- Follow the tips in the box below to keep dirt and dust from getting into your body.
- Sign up for the free home lead-based paint testing and abatement project with Central Arizona Governments. Contact Alan Urban at 480-474-9300 or aurban@cagaz.org.
- Make sure children have regular follow-up blood lead testing, as recommended by their health care provider or state and local health departments. Yearly or more frequent testing may be necessary for children under six years old or children who have previously had a confirmed blood lead level greater than or equal to 5 micrograms per deciliter ($\mu\text{g}/\text{dL}$).
- Maintain healthy eating habits for your family; people who eat healthy diets rich in vitamin C, iron, calcium, and zinc absorb less lead.

How do I learn more about ATSDR's work in Hayden and Winkelman?

- For more details, see the full report "ASARCO Hayden Smelter Site 2017 Urine Arsenic Exposure Investigation" available at <https://www.atsdr.cdc.gov/HAC/PHA/HCPHA.asp?State=AZ>
- Call ATSDR's Region 9 office director, Libby Vianu, at 415-947-4319 and LVianu@cdc.gov or our toll-free number at 1-800-CDC-INFO.

Figure 2: Urinary total arsenic levels by age group for the U.S. population and participants in ATSDR's 2017 Exposure Investigation



* National Health and Nutrition Examination Survey (NHANES) 2013–2014 (CDC 2018)

† The ATSDR Exposure Investigation follow-up level is based on the lowest age-specific 95th percentile value from reported values for the U.S. population from 2010–2011 (CDC 2018).

Note: The 20–44 years age group is not displayed because ATSDR only tested 4 people in this age group and the corresponding NHANES age group is different (20 and older).



Community members can keep dirt and dust from getting into their bodies by following these tips

Outside

- Don't play in arroyos or on waste piles.
- Stay away from railroad tracks in Hayden.
- Do not trespass on mine or smelter property.

At Home

- Wipe shoes on a doormat and remove shoes before entering your house.
- Wet-mop or wet-wipe floors, windowsills, counters and hard-surface furniture every 2-3 weeks.
- Make sure your child does not chew on surfaces painted with lead-based paint.
- Wash pets that spend time outside and inside your home at least every 2-3 weeks.

Keep things clean

- Wash things children put into their mouths, such as pacifiers, bottles, and toys whenever they fall on the floor or ground.
- Wash your hands and your children's hands before eating and after being outside.
- Wash fruits, vegetables, and root crops (like potatoes) before preparing them to eat.

At work

- If you could be exposed to lead or arsenic in your workplace, change your clothes at work before returning home or immediately after arriving home.
- Wash your work clothes separately from the clothes of other family members.

About ATSDR

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency of the U.S. Department of Health and Human Services. <https://www.atsdr.cdc.gov/>

For more information

visit: <https://www.atsdr.cdc.gov/>

email: LVianu@cdc.gov

call: 800-CDC-INFO

Appendix F: Resumen de la investigación de la ATSDR del 2017 sobre la exposición a arsénico

Sitio de la fundición de ASARCO en Hayden, Hayden y Winkelman, Arizona

Resumen de la investigación de la ATSDR del 2017 sobre la exposición a arsénico

Diciembre del 2019

Hay personas en Hayden y Winkelman que pueden estar expuestas al plomo y al arsénico debido a actividades de fundición y otras fuentes en su entorno. En el 2015 la ATSDR ofreció pruebas de sangre y de orina a los residentes. En el 2017 les ofrecimos pruebas de seguimiento del nivel de arsénico en la orina a personas de hogares que participaron en las pruebas del 2015. Nuestra meta en el 2017 fue averiguar los niveles de arsénico en la orina de los participantes cuando la calidad del aire era la típica en la comunidad. Este es un resumen del informe de la investigación del 2017.

¿Cuáles son las preocupaciones de la comunidad?

Los miembros de la comunidad tienen preocupaciones de salud acerca de la exposición al plomo y al arsénico en el pasado y en curso, así como de la exposición a otros contaminantes relacionados con la minería y la fundición. Los líderes comunitarios también tienen preocupaciones acerca del seguimiento del trabajo ambiental y sobre la salud en Hayden y en Winkelman, al igual que acerca de la reactivación de la economía local.

Lo más importante

- Los niveles de arsénico en los 33 residentes de Hayden y Winkelman a los que la ATSDR hizo pruebas en el 2017 fueron similares a los niveles en la población de los Estados Unidos.
- Los residentes permanecen en riesgo de exposición al arsénico y al plomo en la comunidad.
- Las organizaciones y los miembros de la comunidad deberían continuar tomando medidas para reducir la exposición al plomo y al arsénico.

Acerca de estas pruebas y los resultados

Estas pruebas nos indican cuánto arsénico había en el cuerpo de los participantes al momento de la prueba, pero la cantidad de arsénico en el cuerpo de una persona puede cambiar rápidamente. Además, los resultados podrían no representar los de la comunidad en general.



Un área de juegos para niños al lado de la planta de ASARCO, en Hayden, Arizona.



U.S. Department of
Health and Human Services
Agency for Toxic Substances
and Disease Registry

¿Qué hizo la ATSDR?

En octubre del 2017, la ATSDR ofreció pruebas de seguimiento del nivel de arsénico en la orina a los hogares que participaron en la investigación del 2015. Nos concentramos en hacerles pruebas a los residentes en alto riesgo de tener efectos en la salud por la exposición al arsénico: niños, adolescentes y mujeres en edad de procrear.

- Hicimos pruebas a un total de 33 residentes de Hayden y de Winkelman de 13 hogares.
- A poco más de la mitad (17 de 33 o el 52 %) de los participantes del 2017 se les hicieron pruebas de arsénico durante la investigación sobre la exposición del 2015.
- La ATSDR envió cartas con el resultado a cada uno de los participantes en diciembre del 2017.

La ATSDR usó mediciones de arsénico del aire de Hayden desde el 2017 para determinar si la calidad del aire durante la prueba era la típica de la comunidad.

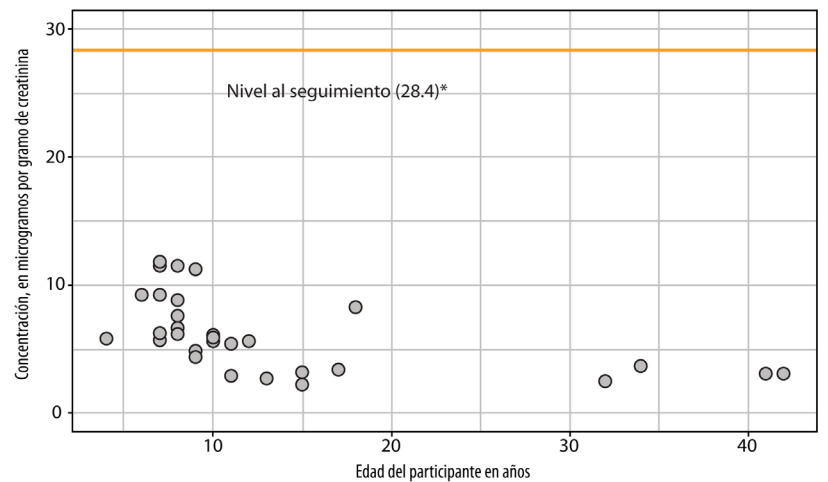
En el 2018, la ATSDR ayudó a un grupo de organizaciones que trabajaban en asuntos de salud ambiental en la comunidad a comenzar a enviar regularmente actualizaciones por correo electrónico a los líderes de la comunidad.

¿Qué encontró la ATSDR?

Los niveles de arsénico en los residentes de Hayden y Winkelman a los que la ATSDR hizo pruebas en el 2017 fueron similares a los niveles encontrados en la población de los Estados Unidos.

- Todos los participantes tuvieron niveles totales de arsénico inferiores al nivel de seguimiento de la ATSDR (28.4 microgramos de arsénico por gramo de creatinina o mcg/g Cr). El valor más alto fue 11.8 mcg/g Cr (figura 1).
- El resumen de valores totales de arsénico en los niños y adolescentes participantes fue similar al de los niveles en la población de los Estados Unidos (figura 2).
- Muchos participantes no tenían niveles detectables de algunas de las especies de arsénico inorgánico relacionadas que se midieron.

Figura 1: Total individual de arsénico en los participantes en la Investigación de la ATSDR sobre la exposición



Explicación

— Nivel al seguimiento en la investigación de la ATSDR sobre la exposición (28.4 microgramos por gramo de creatinina)

○ Resultados del total de arsénico en la orina (corregido por creatinina) de un participante individual

*El nivel al seguimiento en la investigación de la ATSDR sobre la exposición está basado en el valor más bajo del percentil 95 específico, para la edad de los reportados en la población de los EE. UU. entre el 2010 y el 2011 (CDC 2018).

- Los niveles de arsénico individual de los participantes fueron generalmente más bajos en el 2017 que en el 2015.
- Los niveles de arsénico en el aire fueron los típicos de la comunidad antes y durante las pruebas de orina del 2017. En el 2015, la fundición fue cerrada para hacerle mantenimiento durante las pruebas de la ATSDR, lo cual redujo los niveles de arsénico y plomo en el aire.

Los residentes permanecen en riesgo de exposición al arsénico y al plomo en la comunidad.

- Hay personas en Hayden y en Winkelman que podrían estar expuestas al plomo y al arsénico en el aire exterior, en pilas de desechos mineros y en el suelo en algunos lugares no residenciales. Además, podrían estar expuestas al plomo de pintura en casas viejas.

Próximas medidas

La ATSDR recomienda que las organizaciones y los miembros de la comunidad continúen tomando medidas para reducir la exposición al plomo y al arsénico en la comunidad.

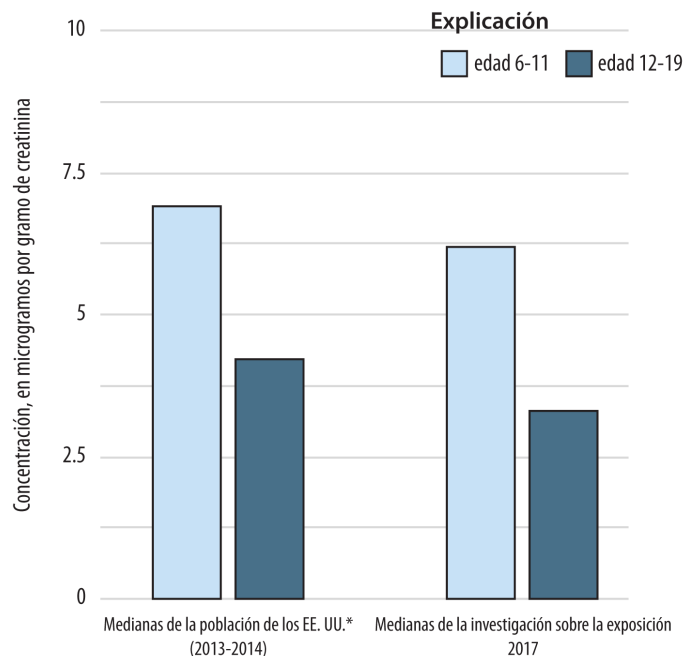
La ATSDR recomienda que la EPA, el Departamento de Calidad Ambiental de Arizona (ADEQ) y ASARCO continúen con lo siguiente:

- Implementación del decreto por consentimiento EPA/ASARCO del 2015.
- La toma de muestras ambientales y los esfuerzos de limpieza en Hayden y en Winkelman.

Recomendamos que los miembros de la comunidad:

- Sigam los consejos que aparecen más adelante para evitar que la tierra y el polvo entren a su cuerpo.
- Se inscriban con los Gobiernos centrales de Arizona en el proyecto de realización de pruebas gratuitas de detección de plomo en la pintura de sus casas y de eliminación del plomo. Contacten a Alan Urban llamando al 480-474-9300 o escribiendo a aurban@cagaz.org.
- Se aseguren de que a sus niños se les hagan pruebas regulares de seguimiento del nivel de plomo en la sangre, según lo recomendado por su proveedor de atención médica o los departamentos de salud estatales y locales. Podría ser necesario hacerles pruebas anuales o más frecuentes a los niños menores de seis años o a los niños a quienes previamente se les haya confirmado un nivel de plomo mayor o igual a 5 microgramos por decilitro de sangre ($\mu\text{g}/\text{dL}$).
- Mantengan hábitos de alimentación saludables para su familia; las personas que comen alimentos saludables ricos en vitamina C, hierro, calcio y zinc absorben menos plomo.

Figura 2: Niveles totales de arsénico en la orina por grupo de edad de la población de los EE. UU. y los participantes en la investigación de la ATSDR del 2017 sobre la exposición



* Encuesta Nacional de Exámenes de Salud y Nutrición (NHANES) 2013-2014 (CDC 2018)

El nivel al seguimiento en la investigación de la ATSDR sobre la exposición está basado en el valor más bajo del percentil 95 específico para la edad, de los reportados en la población de los EE. UU. entre el 2010 y el 2011 (CDC 2018).

Nota: El grupo de 20-44 años no se muestra debido a que la ATSDR solo hizo pruebas a 4 personas en este grupo de edad y el grupo de edad correspondiente a la NHANES es diferente (20 años y más).

¿Cómo puedo informarme más acerca del trabajo de la ATSDR en Hayden y en Winkelman?

- Para obtener más detalles, vea el informe completo “Investigación sobre arsénico en la orina por exposición en el sitio de la fundición de ASARCO en Hayden, 2017” disponible en <https://www.atsdr.cdc.gov/HAC/PHA/HCPHA.asp?State=AZ>
- Llame a la directora de la oficina de la Región 9 de la ATSDR, Libby Vianu, al 415-947-4319 y escríbale a LVianu@cdc.gov o llame a nuestra línea gratuita al 1-800-CDC-INFO.

Los miembros de la comunidad pueden evitar que la tierra y el polvo entren a su cuerpo siguiendo estos consejos

Afuera

- No jugar en arroyos ni en pilas de desechos.
- Mantenerse lejos de las vías férreas en Hayden.
- No ingresar en zonas no autorizadas de propiedades mineras o de fundición.

En casa

- Limpiarse los pies en un tapete y quitarse los zapatos antes de entrar a su casa.
- Pasar un trapeador o un paño húmedos por el piso y limpiar los marcos de las ventanas, mesones y muebles de superficie sólida con un paño mojado, cada 2 a 3 semanas.
- Asegurarse de que sus hijos no muerdan superficies pintadas con pintura a base de plomo.
- Bañar a las mascotas que pasen tiempo afuera y adentro de la casa como mínimo cada 2 o 3 semanas.

Mantener todo limpio

- Lavar las cosas que los niños se llevan a la boca, como chupetes (chupos), biberones y juguetes, todas las veces que se caigan al piso o al suelo.
- Lavarse las manos y lavarles las manos a sus hijos antes de comer y después de estar afuera.
- Lavar las frutas, las verduras y los tubérculos (como las papas) antes de prepararlos para comer.

En el trabajo

- Si es posible que en el lugar de trabajo estén expuestos al plomo o al arsénico, cambiarse la ropa en el trabajo antes de regresar a la casa o apenas lleguen al hogar.
- Lavar la ropa de trabajo separada de la del resto de la familia.

Sobre la ATSDR



U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

La Agencia para Sustancias Tóxicas y el Registro de Enfermedades (ATSDR) es una agencia de salud pública federal que forma parte del Departamento de Salud y Servicios Humanos de los EE. UU. <https://www.atsdr.cdc.gov/es/index.html>

Para obtener más información

Visite: <https://www.atsdr.cdc.gov/es/index.html/>
Correo electrónico: LVianu@cdc.gov
Llame al: 800-CDC-INFO