March 11, 2011

Grants Mineral Belt Uranium Biomonitoring Project Summary

1. Background

The Department of Health's Environmental Health Epidemiology Bureau (EHEB) recruited volunteers in the Grants Mineral Belt during May and June of 2010 as part of public health surveillance for uranium exposure. The Grants Mineral Belt was selected for uranium testing due to its known natural deposits of uranium, as well as its history of uranium contamination due to mining and milling activities. Specifically, the communities of Grants, San Mateo, San Rafael, Bluewater, Milan, and Laguna Pueblo participated. What follows is a description of why the EHEB conducted this testing, how this testing was conducted, what was found, what the results mean, and what the recommendations are.

2. Why test for uranium exposure?

From 2004-2008, New Mexico was one of six participating states in the Rocky Mountain Biomonitoring Consortium (RMBC), which studied exposure to arsenic and other metals, including uranium. Biomonitoring is the assessment of human exposure to chemicals by measuring the presence of those chemicals (or their break-down products) in urine, blood, hair, saliva, or other biological samples. There are many reasons why biomonitoring is useful, but one reason is that the test result for a given chemical can be compared to average levels of this same chemical found in the general population (i.e. the US population). This can indicate if an individual or group has a higher or lower exposure to the chemical than the general population. The RMBC recruited volunteers so that baseline levels of chemicals could be determined for the participating New Mexico residents statewide. The New Mexico study focus was initially in areas with a known or suspected arsenic presence in drinking water. However, the results also indicated that urine uranium concentrations among volunteers were higher than the average uranium concentrations measured among the US population (National Health and Nutrition Examination Survey, 2005-2006). Specifically, the average volunteer in New Mexico had 0.03 micrograms per liter of uranium in their urine, whereas in the NHANES study, which consisted of a sample representative of the general US population, the average level was 0.005 micrograms per liter. This suggested that New Mexicans might have more exposure to uranium than the typical American.

During the 2007 legislative session, funding was allocated for uranium testing through Senate Bill (SB) 611. In 2010, the EHEB used the funding to support testing for uranium exposure in the Grants Mineral Belt, which includes portions of Cibola and McKinley counties.[1] This area was selected because it was known to have naturally rich uranium deposits as well as uranium contamination due to past mining and milling activities. For example, in the 20th century, the Grants Uranium District was the largest United States uranium producer. The area was also selected because it had not been a focus of the RMBC study. We wanted to know if urine uranium levels among residents in this area were different from the levels we had found in other investigations, including the RMBC study and we wanted to learn about the potential need for exposure reduction. This project was not intended, however, to provide information about the health effects from exposure to uranium.

[1] Funding was also provided through CDC Cooperative Agreement 5U38EH000183-05, which provides sole funding for the New Mexico Environmental Public Health Tracking program.

3. How was testing conducted?

The EHEB began outreach and recruitment, as well as initial education in the communities in February 2010 by contacting the local public health office and community organizations, and also by distributing flyers and fact sheets, placing an announcement in the local newspaper and working with environmental agencies and other partners and stakeholders. The entire population of the prescribed area of Cibola County was invited to participate (see Figure). Residents on private water wells and veterans of the Persian Gulf War and Afghanistan conflict were specifically encouraged to participate. In order to learn about uranium exposure, we asked residents to provide a drinking water sample from home and a urine sample. The Department of Health's Scientific Laboratory Division (SLD) in Albuquerque tested the water and urine samples to measure total uranium. The urine samples were also tested for creatinine to calculate the amount of uranium per gram of creatinine. Creatinine is a natural substance in urine that tells us how concentrated (weak or strong) the urine is. [Note that testing performed on very dilute or "weak" urine will not produce accurate results.] Uranium levels in urine are affected by *how much* uranium enters the body through *all routes of exposure*, including eating, drinking, breathing, and skin absorption (the latter being the least concern for uranium exposure). For example, if food has uranium in it, eating it will result in uranium exposure. Therefore, an exposure survey was also administered to gather information about potential sources of uranium exposure other than the participant's drinking water.

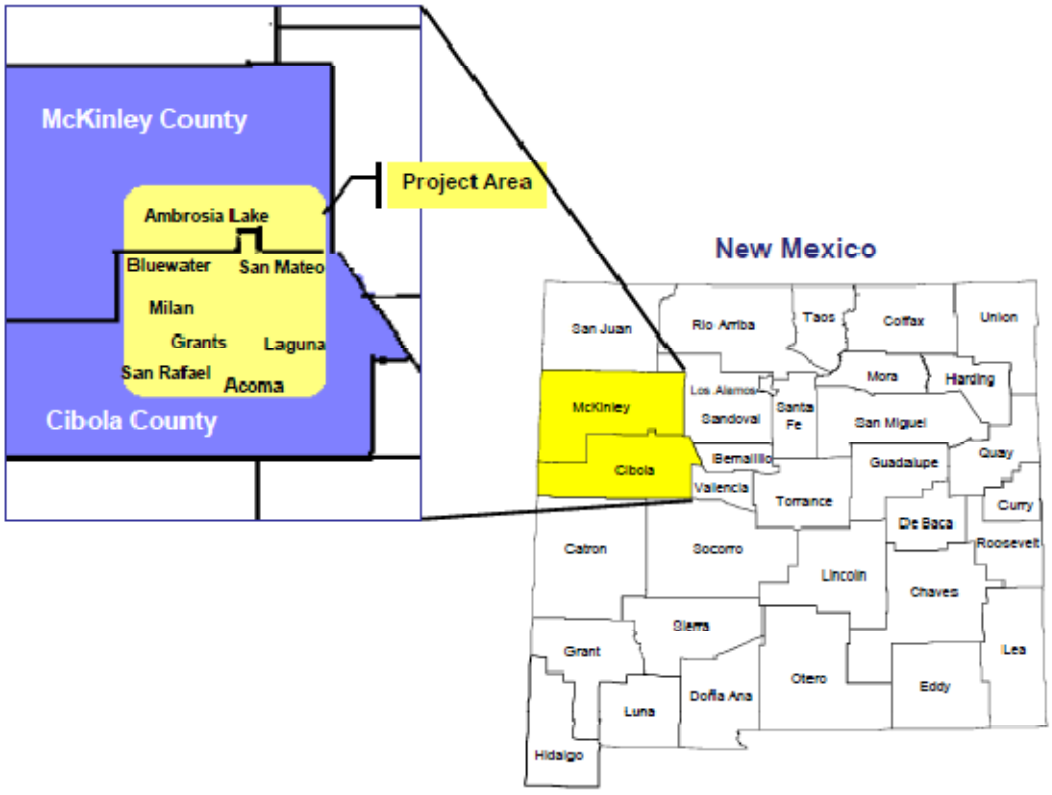

Figure. Location of public health surveillance of uranium exposure

4. What were the findings?

Ultimately, a total of 100 people from the Grants/Milan area and Laguna Pueblo participated in this project. There were 62 females (62%) and 38 males (38%) who participated and ages ranged from 14-79 years. Of the participants, 99 provided urine samples, 91 participants provided a household drinking water sample, and 99 completed an exposure survey. A total of 98 participants provided both a urine sample and completed an exposure survey.

a. Water Results

A total of 91 drinking water samples were submitted for uranium analysis. Only one water sample was collected per household even if there was more than one volunteer in a household since the water source was shared. The majority (97%) of drinking water samples from participants had concentrations of uranium below the safe drinking water standard of 30 micrograms per liter (30 µg/L). This means that 88 out of 91 samples were below 30 micrograms per liter and 3 samples (3%) were at or above 30 micrograms per liter. The average drinking water uranium concentration was 6.4 µg/L (range, <0.1 - 45 µg/L).

For those water samples with uranium levels at or above 30 micrograms per liter, we recommended that participants take steps to remove excess uranium from their water before using the water for drinking and cooking or that they use an alternative source of water for drinking and cooking, such as bottled water. One suitable option to remove excess uranium is the installation of a reverse osmosis unit.

b. Urine Results

A total of 99 participants provided urine samples. The average urine uranium concentration was 0.045 micrograms per liter of urine (range, 0.004 – 0.25 µg/L) and 0.067 micrograms of uranium per gram of creatinine (range, 0.0665 - 0.776 µg/g). This average of 0.045 micrograms of uranium per liter of urine is higher than the average urine uranium concentration of 0.005 micrograms per liter measured among the US population (National Health and Nutrition Examination Survey, 2005-2006). It is also higher than the average level (0.03 micrograms of uranium per liter) found in the RMBC study among residents in multiple areas of New Mexico.

Participants with evidence of recent or ongoing exposure to uranium were identified as those who had uranium in urine levels at or above 0.08 micrograms of uranium per liter **or** at or above 0.08 micrograms of uranium per gram of creatinine. Using this definition, 29 participants (or 29.3% of participants) were identified as having recent or ongoing exposure to uranium. We advised all of these participants to contact their doctor to discuss retesting after reducing exposure for at least one week.

Of these 29 participants, 12 (41.4%) had levels of uranium in urine at or above 0.08 µg/L and 24 (82.8%) had levels of uranium in urine at or above 0.08 µg/g creatinine. A person could have levels of uranium in urine at or above 0.08 µg/L but below 0.08 µg/g creatinine and vice versa which is why the total number of participants with uranium exposure is 29.

c. Exposure Sources Reported by Participants

A total of 99 people responded to the exposure assessment survey. There appeared to be several different potential sources of exposure to uranium (other than drinking water), as reported in the questionnaire. These potential sources included:

1. **Consumption of locally-grown fruits, vegetables and meat in past 3 days:** A small percentage (9%) of participants indicated they had eaten locally grown fruits or vegetables in the past three days
2. **Collecting plants or gardening in Cibola or McKinley counties in past 30 days:** Nearly half of participants indicated they had either collected plants or gardened in Cibola and/or McKinley counties in the past 30 days
3. **Running, hiking and/or biking in Cibola or McKinley counties in past 30 days:** More than half (53%) of participants ran, biked, and/or hiked in the past 30 days in Cibola and/or McKinley counties. Depending on where they were, this may have been a source of uranium exposure from uranium-contaminated dirt.

In the tables below, the exposure assessment survey responses are summarized for those participants with (≥0.08 µg/L or ≥0.08 µg/g creatinine) and without (<0.08 µg/L or <0.08 µg/g Creatinine) evidence of recent uranium exposure.

Table 1. During the past three days, did you eat fruits or vegetables grown at your home?

Number and (Percentage) of Participants with Uranium Exposure* (n=29)		**Number and (Percentage) of Participants Without Uranium Exposure (n=69)**	
Yes	2 (6.9%)	**Yes**	5 (7.2%)
No	27 (93.1%)	**No**	64 (92.8%)

*≥0.08 µg/L or ≥0.08 µg/g creatinine

Among those participants who were identified as having recent or ongoing uranium exposure, 6.9% said 'yes' to eating fruits or vegetables grown at their home in the past three days. Among those participants who were identified as **not** having recent or ongoing uranium exposure, 7.2% said 'yes' to eating fruits or vegetables grown at their home in the past three days. Therefore, the consumption of fruits or vegetables grown at home was similar among those with and without recent or ongoing uranium exposure.

Table 2. During the past three days, did you eat locally grown fruits or vegetables?

Number and (Percentage) of Participants with Uranium Exposure* (n=29)		**Number and (Percentage) of Participants Without Uranium Exposure (n=69)**	
Yes	3 (10.3%)	**Yes**	6 (8.7%)
No	26 (89.7%)	**No**	62 (89.9%)
Don't Know	0 (0%)	**Don't Know**	1 (1.4%)

*≥0.08 µg/L or ≥0.08 µg/g creatinine

Of those with recent or ongoing uranium exposure, 10.3% said 'yes' to consuming locally grown fruits or vegetables. Of those without recent or ongoing uranium exposure, 8.7% said 'yes.' Therefore, the consumption of locally grown fruits or vegetables was also similar among those with and without recent or ongoing uranium exposure.

Table 3. During the past three days, did you eat local livestock?

Number and (Percentage) of Participants with Uranium Exposure* (n=29)		Number and (Percentage) of Participants Without Uranium Exposure (n=69)	
Yes	2 (7.4%)	**Yes**	12 (17.4%)
No	27 (93.1%)	**No**	57 (82.6%)

*≥0.08 μg/L or ≥0.08 μg/g creatinine

Among participants who were identified as having recent or ongoing uranium exposure, 7.4% responded that they had eaten local livestock in the past three days. Among participants without recent or ongoing uranium exposure, 17.4% indicated they had eaten local livestock in the past three days. Therefore, participants without uranium exposure had a higher consumption of livestock in the past three days than those with uranium exposure.

Table 4. Over the course of a year, what portion of the fruits, vegetables and meat that you eat are raised locally?

Number and (Percentage) of Participants with Uranium Exposure* (n=29)		Number and (Percentage) of Participants Without Uranium Exposure (n=68)	
None	13 (44.8%)	**None**	20 (29.4%)
Some	14 (48.3%)	**Some**	31 (45.6%)
Half	1 (3.4%)	**Half**	12 (17.6%)
Most	1 (3.4%)	**Most**	4 (5.9%)
Don't Know	0(0%)	**Don't Know**	1 (1.5%)

*≥0.08 μg/L or ≥0.08 μg/g creatinine

Although we asked questions about locally grown fruit, vegetables and locally-raised meat that had been consumed recently, we also wanted to know if this was typical for consumption over the course of a year. Among those participants with recent or ongoing uranium exposure, only 3.4% responded that 'most' of their fruits, vegetables, and meat were raised locally. However, 48.3% said 'some' of these were raised locally. Among those without uranium exposure, a slightly higher percentage (5.9%) responded that most of their fruits and vegetables and meat were raised locally and about the same percentage (45.6%) responded that some were raised locally.

Table 5. Have you done any of the following activities in Cibola and/or McKinley County in the past 30 days?

a. Running/hiking/biking?

Number and (Percentage) of Participants with Uranium Exposure * (n=29)		Number and (Percentage) of Participants Without Uranium Exposure (n=69)	
Yes	15 (51.7%)	**Yes**	38 (55.1%)
No	14 (48.3%)	**No**	31 (44.9%)

*≥0.08 μg/L or ≥0.08 μg/g creatinine

Among those with uranium exposure, 51.7% responded that they had been running, hiking, and/or biking in Cibola and/or McKinley County in the past 30 days. A similar percentage (55.1%) of those without uranium exposure also did this type of activity.

b. Gardening/collecting plants?

Number and (Percentage) of Participants with Uranium Exposure* (n=29)		Number and (Percentage) of Participants Without Uranium Exposure (n=69)	
Yes	12 (41.4%)	**Yes**	35 (50.7%)
No	17 (58.6%)	**No**	34 (49.3%)

*≥0.08 μg/L or ≥0.08 μg/g creatinine

With respect to gardening and/or collecting plants, there was a slightly lower percentage of participants with uranium exposure who responded 'yes' to this activity (41.4%) than those who did not have uranium exposure and responded 'yes' (50.7%).

5. What do these results mean and what are their limitations?

It is important to understand the limitations of this public health surveillance project and its results. First, because this project relied on community volunteers, rather than recruitment of all the residents in the area, we are unable to draw definitive conclusions about uranium exposure or average urine uranium levels for everyone in McKinley and Cibola counties. We have learned about current or ongoing exposure to uranium among 99 residents who volunteered for testing. Second, while there are a number of potential sources of uranium exposure, this project only measured uranium in drinking water. Results indicate that for a few residents, drinking water was a significant source of uranium exposure. However, none of the participants who were on a public water system had levels of uranium in their drinking water at or above 30 micrograms per liter. Third, the surveillance project was not planned to be used to provide information about health effects from being exposed to uranium. Urine uranium levels indicate the degree of uranium exposure. Urine uranium levels do not indicate the likelihood of health effects.

Given these limitations, we can say the following: the project area has rich uranium deposits and numerous mine, mill and waste sites. Biomonitoring results thus far indicate that residents of New Mexico have a higher average urine uranium concentration than is found in the general US population (6 to 9 times the average US level).

6. What are the recommendations for residents in areas with high uranium concentrations?

The main recommendation is to reduce exposure to uranium in water and other sources.

Despite the lack of clearly-identified sources of uranium exposure other than private well water, steps to reduce uranium exposure for project participants and for the community at large can still be provided. In addition to well water as a source of uranium exposure, blowing dust and erosion/run-off may carry uranium from mine, mill, and waste sites to areas where residents live, work, and play. Therefore residents in any area with high uranium concentrations should take the following precautions:

- Educate yourself about uranium occurrence in your area.
- If you are on a private well, get the well tested for uranium. If the well has 30 micrograms or more of uranium per liter of water, treat the water to remove excess uranium before cooking, drinking, or irrigating food crops.
- Wash hands after hiking or biking or conducting other activities in uranium-contaminated areas. Knock off any dirt on boots or shoes before coming inside.
- Wash fruits and vegetables (peeling them if they are roots) before eating. If possible, avoid growing vegetables and fruit in areas with known high uranium concentration in soil and do not irrigate food crops with uranium-contaminated well water.