

Impacts of In Utero and Early Childhood Exposure to Arsenic in Drinking Water

Background: Worldwide, millions of people routinely consume water containing high levels of naturally occurring arsenic. In the United States, arsenic concentrations in ground water generally are highest in the West, while areas in the Midwest and Northeast also have arsenic concentrations that exceed 10 µg/liter.

The links between long-term consumption of arsenic-contaminated water and cancers of the bladder, lung, and skin are well established. More recently, research has expanded to include non-cancer endpoints including reproductive and developmental effects. Dr. Allan Smith of the University of California at Berkeley SBRP has been at the forefront of research on the potential risks from arsenic in drinking water since the 1980's. His current work examines two diverse health impacts of *in utero* and early childhood exposures to arsenic in drinking water.

Advances: Working in West Bengal, Dr. Smith's research team and collaborators in India studied pregnancy outcomes and infant mortality in women consuming well water containing arsenic at levels of 0–49 µg/liter, 50–199 µg/liter, and > 200 µg/liter. The researchers collected water samples from all functioning tube wells that had been used by participants for at least six months since their first pregnancy and conducted extensive interviews with each participant to establish reproductive histories. After adjusting for socioeconomic variables and other potential confounders, the research team found a six-fold increase in risk of stillbirth among women drinking water during pregnancy with arsenic levels > 200 µg/liter. And among those women who were found to have developed arsenic-caused skin lesions, the risk of having a stillbirth was increased 13-fold. The risk of neonatal death was increased more than twofold at exposure levels of > 200 µg/liter compared with levels below 50 µg/liter, but the confidence interval was wide and included unity. No association between arsenic and spontaneous abortion was found and no increase in overall infant mortality was seen with prenatal arsenic exposure or exposure during the first year of life.

To examine a quite different impact of *in utero* and early childhood exposures to arsenic in drinking water, the researchers conducted an epidemiological study in the Chilean cities of Antofagasta and Mejillones. This arid region has a unique history. From 1958 to 1971, the municipal water supplies drew water from rivers with extremely high levels of arsenic. For 13 years the water supply for all residents in the two cities contained an average of 860 µg/liter of arsenic. Dr. Smith's research team and collaborating scientists in Chile used this history to assess adult mortality from lung disease in those born or were young children during the high exposure period.

The researchers' findings were dramatic. For young adults exposed to arsenic only as children, the death rate from lung cancer was seven times greater than in the rest of Chile, while the death rate from bronchiectasis (a rare lung disease that causes distortion and dilation of the bronchi of the lungs) was 12 times greater. For those with both early childhood and *in utero* exposure, the death rate from lung cancer was six times greater than that in the rest of Chile, and the death rate from bronchiectasis was 46 times greater. These findings provide some of the first human evidence that fetal or early childhood exposure to any environmental toxic substance can result in markedly increased disease rates in adults. The mechanisms of these and other health effects of arsenic are still to be elucidated and are a priority for study in the UC Berkeley Superfund Research Program directed by Dr. Martyn Smith.

Significance: While the findings concerning stillbirths in India need to be confirmed, ideally in a prospective pregnancy study, when combined with the findings of the Chile mortality study, they provide substantial evidence to support implementation of preventive actions to reduce the exposure of childbearing-age women and young children with high levels of arsenic in their drinking water. The researchers concluded that the marked increase in mortality in young adults was also of public health importance and should be taken into consideration in setting arsenic drinking water standards.

They also noted that the findings concerning arsenic were important in a broader context in that they provide some of the first human evidence of effects from environmental exposure to any toxic chemical *in utero* and early childhood resulting in disease in adults.

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To learn more about this research, please refer to the following sources:

- Smith, Allan H., Guillermo Marshall, Yan Yuan, Catterina Ferreccio, Jane Liaw, Ondine S. von Ehrenstein, Craig Murray Steinmaus, Michael N. Bates, and Steve Selvin. 2006. Increased Mortality from Lung Cancer and Bronchiectasis in Young Adults Following Exposure to Arsenic In Utero and Early Childhood. *Environmental Health Perspectives*. (in press)
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