Antimony: An Unlikely Confounder in the Relationship between Well Water Arsenic and Health Outcomes in Bangladesh

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Recent in vitro studies have suggested a potential role for antimony as a confounder in human health studies related to arsenic in drinking water. We measured tube-well water concentrations of antimony and arsenic in the Pabna region of Bangladesh, where arsenic concentrations are known to be elevated and the concentrations of antimony have not yet been thoroughly documented. Two hundred forty-five tube-well water samples were collected from various regions in Pabna, Bangladesh, as part of an ongoing case–control study. Water samples were analyzed for arsenic and antimony concentrations by inductively coupled plasma–mass spectrometry using U.S. Environmental Protection Agency method 200.8. The arsenic concentrations in the tube-well water samples ranged from < 1 µg/L to 747 µg/L. All 245 water samples had antimony concentrations < 1 µg/L. Based on consideration of the concentrations used in the in vitro studies compared with field-observed concentrations, our results do not support the hypothesis that antimony would be a significant confounder in observed relationships between arsenic exposure through drinking water and potential health outcomes in Pabna, Bangladesh. Key words: antimony, arsenic, Bangladesh, drinking water, tube well. Environ Health Perspect 112:809–811 (2004). doi:10.1289/ehp.6800 available via http://dx.doi.org/ [Online 12 February 2004]

Arsenic toxicity is multifactorial, with predisposing factors hypothesized to be sex, age, nutritional status, genetic polymorphisms, and coexposure to other environmental contaminants (Guha Mazumder et al. 1998; Hsueh et al. 1998; Vahter 2000). The precise biologic mechanisms through which As exerts toxicity are currently not well established (Gebel 2000). In addition, there also appear to be differences in susceptibility to As between populations. Gebel (2000) hypothesized that coexposure to antimony may confound the relationship between As exposure and potential health outcomes. As and Sb individually exert toxic effects. However, two in vitro studies showed that coexposure to As and Sb can result in less cell damage than expected based on their individual toxicities, suggesting that coexposure to Sb and As may be subadditive. In an in vitro study of V79 Chinese hamster cells, Gebel (1998) found that chromosome mutagenicity induced by As(III) was significantly suppressed by Sb(III) in micronucleus tests. In sister chromatid exchange tests using human lymphocytes in vitro, Gebel et al. (1997) concluded that the combined effect for As and Sb was subadditive. Gebel and colleagues carried out their experiments using Sb concentrations ranging from 0 to 3,043 µg/L (0–25 µM), which were comparable with or greater than the molar concentration of As (2 µM or 148.9 µg/L). Whether or not Sb has the potential to amplify or attenuate the toxicity of As in vivo in humans at environmentally relevant exposure levels has not been explored in epidemiologic studies (Gebel 2000).

Sb and As have been found to co-occur in the environment (Gebel 2000). However, in most regions of the world where there are elevated concentrations of As in the drinking water, the presence and concentrations of Sb have not yet been thoroughly documented. Because of the potential for co-occurrence of As and Sb and confounding effects from concurrent exposure, it has been suggested that Sb concentrations be measured in regions of the world where As concentrations are known to be elevated and to assess the potential impact of Sb on human health (Gebel 1998, 1999, 2000).

Although extensive human health and hydrogeologic studies have documented the scope of the As crisis in Bangladesh (Asahan et al. 2000; Harvey et al. 2002; Nickson et al. 1995; Smith et al. 2000), the importance of Sb as a potential confounder of As exposure has not been adequately addressed. As part of a larger epidemiologic study of health effects of As exposure in Bangladesh, we measured Sb concentrations in a randomized subset of 245 tube-well water samples from our study region of Pabna to assess the potential for Sb to act as a confounder of As exposure.

Materials and Methods

We analyzed 245 water samples collected in 2001–2002 from tube wells in the Pabna district of Bangladesh, located north of Dhaka on the Jamuna River in central Bangladesh, as part of a case–control study conducted by the Harvard School of Public Health in collaboration with the Dhaka Community Hospital Trust. When each 100-mL sample of tube-well water was collected, two drops (0.2 mL) of concentrated nitric acid were added and the sample was sealed. Samples were stored at 4°C until analysis for As and Sb by inductively coupled plasma–mass spectrometry at Environmental Laboratory Services (North Syracuse, NY, USA) following U.S. Environmental Protection Agency (EPA) method 200.8 (U.S. EPA 2001a). The limit of detection (LOD) using this method was 1 µg/L for both As and Sb.

Results

All of the water samples were found to have < 1 µg/L Sb. The results of the water analysis for As are presented in Table 1. The data are presented as samples < 50 µg/L As or ≥ 50 µg/L; the As drinking-water standard is 50 µg/L in Bangladesh. Of the 245 water samples analyzed, 87 samples contained As < the LOD, and 107 samples contained 1–50 µg/L As, with a mean As concentration of 10.2 µg/L. In 51 samples containing ≥ 50 µg/L As, the mean was 299.9 µg/L. The certified reference material we used for Sb and As was QC Standard 1 (catalog no. 140-102-012; SCP Science, Champlain, NY), a multielement standard solution. The mean ± SD recovery rates for Sb and As were 101.1 ± 3.129% and 99.6 ± 3.896%, respectively.

Discussion

Sb and As are individually considered toxic to human health, and each is regulated in drinking water by the U.S. EPA. The U.S. EPA drinking water maximum contamination level goal for Sb is 6 µg/L (U.S. EPA 2002); the

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Table 1. As concentrations in water from tube wells in Pabna, Bangladesh.

| As concentration in water samples | No. of water samples | Mean ± SD (µg/L) | Median (µg/L) | Range (µg/L) |
|-----------------------------------|----------------------|-----------------|---------------|--------------|
| < LLOD                            | 87                   | NA              | NA            | NA           |
| 1–50 µg/L                         | 107                  | 10.2 ± 11.9     | 5.1           | 1.0–48.3     |
| ≥ 50 µg/L                         | 51                   | 298.9 ± 195.5   | 262.0         | 57.9–747.0   |

All 245 water samples were < LLOD for Sb.
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