

Exposure to arsenic in air and drinking water: results of a study in Chile

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Haynes (1983) first reported a higher risk of lung cancer in Antofagasta, having analysed mortality rates in Chilean provinces for the period 1976–1978. He found an SMR of lung cancer of 503 for Antofagasta (a risk five times greater than that expected: 100). He considered that it was associated with arsenic in drinking water. The aim of this study was to identify the excesses of cancer risk for the period 1985–1992, and to relate this to the cumulative air and water arsenic exposure of the population. All the analyses were done at county level.

Methodology A database with historical records (1950–1996) of As levels in drinking water was completed for the 335 municipalities of Chile. Information also was collected on the sources of As in air, whenever available. Additionally, during the study period 1994–1996, measurements of As levels in the air and the water were made in a sample of the municipalities. On the basis of the As concentration, daily water ingestion, and air inhalation at different ages, a cumulative dose of ingested or inhaled As was estimated for a typical person living in any of these municipalities. To study the effects of As, five suspected cancers were selected: lung, bladder, skin, liver and kidney cancer; gastric cancer was also selected as control, given its high prevalence in Chile. For six age cohorts in each of the 335 municipalities, we analysed cancer mortality from 1985 to 1992, together with lifetime As cumulative dose. Estimates of effects were obtained using Poisson regression models.

Results Measurements of airborne As in the municipalities were few and incomplete, most of them being done by mining companies in the mining areas. No conclusions can therefore be drawn regarding the health effects of airborne As. Routine water measurements in most of the municipalities for the study period were available. The missing data were estimated on the basis of expert knowledge. As in water ($50 \mu\text{g l}^{-1}$) resulted in a highly significant risk factor for the five cancers: bladder RR: 1.29; lung, RR: 1.19; skin, RR: 1.12; kidneys, RR: 1.10; liver, RR: 1.05. However, no relation was found between As and gastric cancer (RR: 0.99). We estimated a population excess risk associated with the ingestion of water with As within the acceptable level established by the current Chilean norm ($50 \mu\text{g l}^{-1}$) during the entire lifespan (0–70 years; accumulated As of 2555 mg). In Chile, this represents an added risk of 4 per 1000 for lung cancer, 1 for bladder cancer, 0.5 for kidney or liver cancer, and 0.07 for skin cancer, with no added risk for gastric cancer. In terms of the absolute number of deaths, this represents annual increases of 299 more deaths from lung cancer, 66 from bladder cancer and five deaths from skin cancer.

Conclusions Given the paucity of information about historical levels of As in the air, it was not possible to demonstrate any effect on the observed added risk of cancer. We have strong evidence of cancer risk as being associated to the presence of As in drinking water. Ingested As was selectively related to lung, bladder, liver, kidney and skin cancers, but no effect was observed for gastric cancer. Ingested As explains most of the cancer risk differences between Chilean municipalities.

Arsenic and its impact on health

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Arsenic contamination of groundwater is increasingly recognized as a health concern. Overwithdrawal of groundwater appears to be the cause of the contamination by arsenic. The arsenic in groundwater occurs as As(III) and As(V), in varying proportions. As(III) is much more toxic than As(V). After it is ingested, most arsenic undergoes detoxification in the liver and is excreted through the kidney. The remaining arsenic is responsible for the health hazard. Dhaka Community Hospital and the School of Environmental Studies (SOES), Calcutta, jointly carried out a survey of tube-wells in 60 districts of Bangladesh, and of patients in 21 districts. So far, we have found 41 districts with wells contaminated with arsenic above the maximum permissible limit (0.05 ppm), and we have identified more than two thousand patients. The total area and population of these 41 districts are 89 186 km² and 76.9 million respectively.
