

Arsenic in drinking water and bladder cancer: a case-control study in Utah, USA

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Mortality from bladder cancer and other cancers is elevated among populations exposed to high levels of arsenic ($170\text{--}800\ \mu\text{g l}^{-1}$) in drinking water in Taiwan, Chile, and Argentina. A small case-control study in Utah, conducted in 1978, suggested elevated risk among male smokers exposed to lower levels of arsenic (range = $0.5\text{--}16\ \mu\text{g l}^{-1}$, mean = $5\ \mu\text{g l}^{-1}$). To evaluate these associations in a larger study population we used data from a case-control interview study of 312 bladder cancer patients and 625 population-based controls conducted in Utah in 1979–1983. Indices of exposure for each subject were developed by combining information from a state database of arsenic in community drinking water supplies, with individual residential histories and information on fluid ingestion. In preliminary analyses, we found no overall association of bladder cancer risk with estimates of total lifetime arsenic intake. However, in subgroup analyses of cumulative exposure, we found modest elevations in bladder cancer risk among non-smokers and among females. Among non-smokers, odds ratios were 1.7, 2.2, and 1.9, and among females, odds ratios were 1.8, 1.4, and 1.9 for total lifetime arsenic intakes of 60–89, 90–149, and 150+ mg, relative to <60 mg. Analyses of risk by total exposure in decade-long time windows suggested associations with bladder cancer for exposures that occurred 50–59 years prior to diagnosis. These preliminary findings suggest possible elevations in bladder cancer risk many years after exposure to relatively low levels of arsenic in drinking water and among sub-populations with a low baseline risk.

Exposure to arsenic in air and drinking water: results of a case-control study in northern Chile

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The population of northern Chile has high death rates for some cancers. Arsenic (As) is present in drinking water. There is also air pollution from As as a result of mining activity. Current levels of As in drinking water are below the recommended level of $50\ \mu\text{g l}^{-1}$ and there is ongoing debate about its causal role. To assess the cancer risk

associated with these arsenic levels, a case-control study of lung and bladder cancer in the north of Chile was conducted from 1994–1996.

Methodology We studied cases diagnosed as lung or bladder cancer in Chile's northern region (Regions I, II and III) from November 1993 to July 1996, with enrollment carried out from November 1993 to July 1996. Two hospital controls were selected for each case. Data were obtained from patients admitted to hospitals in the northern region. Controls were frequency matched, but not pairwise matched. The first control was a patient with a cancer unrelated to As; the second was a patient with a condition unrelated to As. A physical examination of the skin, a review of clinical records, and a questionnaire were applied to the cases and controls by a nurse. The questionnaire asked about location and duration of residence, employment, health history, and other risk factors or possible confounders (socio-economic characteristics; eating, drinking and smoking habits; and occupational exposure). Relatives or close friend of each study subject were also interviewed to validate the information collected. Using the database of As concentrations in water and air in the municipalities, and the survey information on the subject's places and periods of residence, an estimate of cumulative As ingested and inhaled was obtained for each study subject. This estimate was made blind, i.e without reference to the status of the case or control of the subject. Univariate and multivariate analyses (conditional logistic regression) were performed to measure association of As and the risk of cancer.

Results Two hundred and forty-three cancer cases were analysed (71% of eligible cases): 136 lung cancers and 107 bladder cancers. Three hundred and sixty-one controls (ratio of 1.5 controls/case) were entered in the study (136 controls with health problems unrelated with As, and 145 controls with cancers unrelated with As). Study subjects' mean age was 64, and 61% were males. Significant risk factors by univariate analysis were: to have been born in Antofagasta; to have worked in a copper mineral mine; to have been a tobacco smoker; to have a history of skin cancer; hyperkeratosis or hyperpigmentation of the skin at the time of the examination; and to ingest drinking water containing arsenic. Total As ingested was significantly higher in the cases (10 161 mg) than in the controls (6976 mg) ($p < 0.000$). As inhaled was not a significant risk factor; however, it was higher among cases (73.1 mg) than controls (40.8 mg). Doses of ingested As, stratified in quintiles (Q), showed a clear dose-response curve: Q_1 , odds ratios (OR) = 1; Q_2 , OR = 2; Q_3 , OR = 2.8; Q_4 , OR = 4.2; and Q_5 , OR = 4.8. Inhaled As showed no dose-response curve. The multivariate analysis model with age, sex, socio-economic class, alcohol consumption and As inhaled, showed that packs of cigarettes smoked per year and total dose in milligrams of As ingested throughout the individual's lifetime were the only significant variables and may explain up to 21% of the risk of cancer (26% of lung cancer risk and 15% of bladder cancer risk).

Conclusion Ingested As and tobacco smoking are the main risk factors for cancer among residents in the northern regions of Chile. The Chilean norm for permissible As in drinking water ($50 \mu\text{g l}^{-1}$) represents an excess of risk beyond the normally accepted safe standard. It is necessary to review the Chilean standard for As in drinking water and to initiate surveillance of airborne As.
