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Analysis of non-affected populations exposed to chromium (VI) sources

RAMIRO C. RODRÍGUEZ & MARIA AURORA H. ARMIENTA
Geophysics Institute, UNAM, Del. Coyoacan, 04510 México, DF, Mexico
e-mail: rrdz@tonatiuh.igeofcu.unam.mx

Abstract The presence of sources of chromium compounds in the Valley of Leon, Mexico, could be associated with adverse health effects in exposed populations. The levels of hexavalent chromium in groundwater vary from 0.002 to more than 5.0 mg l^{-1}. Groups of people exposed to chromium were identified. People working at a chromium compounds factory until 1992 were in the highest risk group, and tannery workers were also exposed to chromium. Inhabitants of Buenavista, a community located behind the factory, were exposed to dust and to polluted groundwater. Workers from the local water supply company could have been exposed to chromium (III) in wastewater while cleaning drainage pipelines. Residents of Las Huertas were potentially exposed to dust containing chromium. Residual leather was used as fuel in brick factories, and people handling the ashes were also exposed to chromium. Results from an integrated assessment revealed that none of the groups at risk were affected, at least in terms of observable effects. There was no evidence of cancer induction in the analysed groups. There was less exposure to chromium through the consumption of drinking water than by the inhalation of dust.

INTRODUCTION

In the Valley of Leon in central Mexico, several different sources of chromium contamination have been detected (Rodriguez *et al.*, 1991; Armienta *et al.*, 1993). These include industrial wastes and urban wastewaters containing chromium (III), ashes with chromium (VI) and leachates from chromium (III)-bearing rocks. The occurrence of chromium in the environment is strongly related to the presence of local industries that use chromium-contaminated materials, including tanneries and leather processing operations. These sources may be responsible for the release of chromium into local aquifers. The presence of chromium (VI) in groundwater is clear evidence of a source of anthropogenic pollution. Urinary chromium content is used as an indicator of exposure. Relatively high values of this biomarker of exposure do not necessarily indicate adverse health effects, but they provide a warning that the effects may occur. Biomonitoring must be conducted along with an epidemiological survey and clinical evaluations to determine whether suspected symptoms can be detected. The US Environmental Protection Agency advises that long-term exposure levels of 0.24 mg l^{-1} of chromium (VI) in water for children and 0.84 mg l^{-1} for adults could adversely affect human health.

POPULATIONS AT RISK

Among the groups exposed to chromium from various sources, the workers from a chromium compounds factory received the highest levels of exposure. These individuals were primarily exposed to chromium dusts that were generated during the processing of chromite, which occurred until 1992. The inhabitants of Buenavista, a community of less than 500 people located behind the chromium factory, were exposed to dust and to polluted groundwater. For over five years, people were exposed to levels of 0.1–0.3 mg l^{-1} of chromium in the groundwater. Tannery workers from Leon City were also exposed through contact with solutions of chromium (III). Workers at the local water supply company were exposed to chromium (III) in waste-water from tanneries as they cleaned drainage pipelines. Inhabitants of Las Huertas, a residential area of Leon City where solid wastes from the chromium factory were used for terrain levelling, were also potentially exposed to chromium dusts. Waste leather (with chromium (III)) from shoe manufacturing was used as fuel in brick factories. When the leather is burned, chromium (III) is oxidized to chromium (VI). Exposure can occur through the inhalation of the dust and handling of contaminated ashes.

ROUTES OF EXPOSURE AND POTENTIAL RISKS

In the study area, three routes of exposure were detected: dust inhalation, ingestion of water, and skin contact. The first route poses the greatest opportunity for exposure to high levels of chromium, particularly in occupational environments. The chromium factory had more than 320 workers until 1992. Their mean urinary chromium concentration in 1994 was 33.23 ng ml^{-1}. Since 1982, when the factory started its operations, 700 workers have been working in this facility. Since that time only 17 individuals have presented nasal septum perforation. There was no evidence of cancer in a clinical survey performed on the workers. A wide variation in urinary chromium levels was observed (Rodriguez & Armienta, 1995). The factory has not processed chromite since 1993, and the number of workers decreased to 70 by 1998. The chromium factory workers were at the greatest potential risk due to exposure to relatively high levels of chromium in dust. Some workers showed tolerance to chromium, whereas others were sensitive (nasal bleeding, nasal septum perforation).

Although Buenavista residents were exposed to chromium simultaneously by water ingestion and dust inhalation, and had a mean urinary chromium content in 1994 of 26.25 ng ml^{-1}, adverse health effects were not found. The brick furnace workers had urinary levels of 50–110 ng ml^{-1}, and also did not present any adverse health effects. Similar observations were made in the residents of Las Huertas, where the exposure to low concentrations was intermittent and of short duration.

DISCUSSION

Although there are potential sources of chromium compounds in the valley, they do not represent an imminent risk due to the exposure levels, durations, and routes of exposure. Chromium is used in the Leon area as an environmental indicator. The local

industry uses other chemicals that may pose greater risks than chromium. There are no studies that have evaluated the presence and associated risks of solvents, hydrocarbons and/or agrochemicals in groundwater.

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