



Assessment of the health risks associated with heavy metal contamination in the groundwaters of the Leh district, Ladakh

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Abstract There has been a significant rise in cancer-related mortality in the Ladakh region during the past 10 years. The most common type of case is gastrointestinal cancer, which has been linked in theory by medical research to lifestyle factors, high altitude conditions, and the prevalence of *Helicobacter pylori* bacteria brought on by poor hygiene. Nevertheless, the precise cause of the rise in cancer cases is still unknown. Concurrently, there has been a significant change in Ladakh's water use practices due to development, improved basic utilities, and related vocational shifts. The local population has become increasingly reliant on groundwater since it provides a year-round, continuous water supply for home and

agricultural uses. In this study, we assessed heavy metal contamination in groundwaters and associated human health risks. The results indicate that 46–96% of the groundwater samples have heavy metal pollution with a health hazard index > 1, which means using these groundwaters for drinking, food preparation, and agriculture is likely to result in carcinogenic and non-carcinogenic health hazards. The main heavy metal contaminants found in the groundwater of the Leh district include Cr, As, Hg, and U. According to the health risk assessment, 46–76% of the groundwater samples contain unsafe levels of Cr and As. Prolonged exposure to these levels is likely to cause gastrointestinal cancer in the local population. Acute to chronic exposure to U and Hg concentrations present in some groundwater samples is likely to result in various non-carcinogenic health risks.

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Introduction

Medical studies in the high-altitude Ladakh region have demonstrated an unprecedented increase in the number of cancer cases during the last three decades (Anand et al., 2006; Bhasin, 1997; Hussain et al., 2019; Norboo & Yangzom, 2010). For example, mortality in Ladakh per year due to cancer cases has increased from 135 in 2013 to 171 in 2022 (27%