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Lithium exposure in the Western US: water and urinary levels in the Strong Heart Family Study

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Lithium mobility in groundwater systems is governed by lithology, water-rock interaction, and hydrochemical conditions. Yet the extent to which spatial variability in groundwater lithium translates into human exposure remains poorly constrained at the population scale. This question is particularly relevant in regions of the Western United States and Northern Plains where lithium exploration and development are expanding and where many Tribal communities rely on local groundwater resources. We analyzed lithium from household tap water collected between 2022-2024. For the same households, participants of the Strong Heart Family Study, a longitudinal cohort conducted in partnership with Tribal communities in Arizona, Oklahoma, North Dakota, and South Dakota provided spot urine samples collected during two study phases separated by approximately fifteen years (2006-2009 and 2022-2024). This longitudinal data gives us the opportunity to evaluate both spatial patterns and temporal persistence of exposure. Drinking-water lithium exhibited strong regional heterogeneity, with a median (interquartile range) concentration of 35.6 (9.0-54.1) µg/L. Concentrations exceeded the USGS health-based screening level of 10 µg/L in all Arizona samples, in 93% of samples from North Dakota and South Dakota, and in 35% of Oklahoma samples, consistent with differing hydrogeologic settings across study regions. Urinary lithium concentrations remained stable over time, with median values of 31.5 (17.8-54.2) µg/g creatinine in 2006-2009 and 31.3 (18.0-59.5) µg/g creatinine in 2022-2024, indicating persistent exposure conditions. Water lithium showed moderate correlations with urinary lithium in both sampling periods ($\rho \approx 0.6$), which indicates that dissolved lithium in groundwater contributes substantially to internal dose. Mixed-effects models showed that each two-fold increase in water lithium corresponded to higher urinary lithium concentrations, and groundwater concentrations explained approximately 29% of variation beyond participant-level factors. These results demonstrate that regional hydrogeochemical controls on lithium occurrence are reflected directly in human biomonitoring data. The stability of the association across a ~15-year interval supports persistent geogenic inputs controlled by aquifer lithology and water-rock interaction rather than short-term anthropogenic sources. From a GeoHealth perspective, the data establish a quantitative link between groundwater chemistry and population exposure and show that spatial heterogeneity in aquifer geochemistry translates into measurable differences in internal lithium dose among groundwater-dependent communities.