

Occupational and Environmental Health Impacts of Lithium Mining and Processing

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Introduction

Lithium is a crucial resource in today's technology-driven world

- Primary Uses: Lithium-ion batteries (74% of production) that power electric vehicles, portable electronics, and energy storage systems; aluminum, specialized glass and ceramics, some medications
- Global surge in demand for lithium, with a 256% increase in lithium production over the last decade, projected to reach 2.4 million metric tons by 2030¹
- As mining expands to meet demand, the potential for health and environmental impacts on surrounding communities, employees and ecosystems become of greater concern

Objective

- To identify the primary health risks faced by workers in lithium mining and extraction
- To evaluate health impacts associated with lithium dust and compounds on both workers and nearby populations
- To identify gaps in current lithium exposure knowledge and guidelines, recommending enhanced safety protocols

Occupational Health Concerns

Respiratory Irritation: In a 1980 NIOSH survey², most frequently reported issues were upper respiratory irritations, with 52% of respondents experiencing dry throat and 43% reporting sinus problems. More severe inhalation exposures to lithium dust have been associated with chemical pneumonitis and pulmonary edema⁸

- Workers involved in lithium carbonate bagging had exposure levels as high as **18.9 mg/m³** (lithium carbonate dust) and up to **42.3 mg/m³** during grinding
- Detectable Lithium levels (**0.3 and 0.14 mEq/L**) were measured from 2 pre-shift blood specimens involved in LiOH bagging and a pelletizer out of 21 workers
- Detected lithium levels were below recognized therapeutic levels (0.8 -1.2 mEq/L)
- Most blood lithium levels were below the detection limit (<0.1 mEq/L)

Skin Irritation and Burns: Exposure to highly alkaline lithium compounds can cause skin irritation (38% reported in the NIOSH 1980 Survey²), burns, and more serious dermatological conditions

Systemic Effects: Cumulative exposure over time or exposure to high concentrations of lithium compounds contribute to systemic health effects, including kidney and neurological damage resulting from medical use of oral lithium carbonate to treat psychiatric conditions; however, no occupational long-term exposure levels or surveillance results are available

Lithium Demand & Production

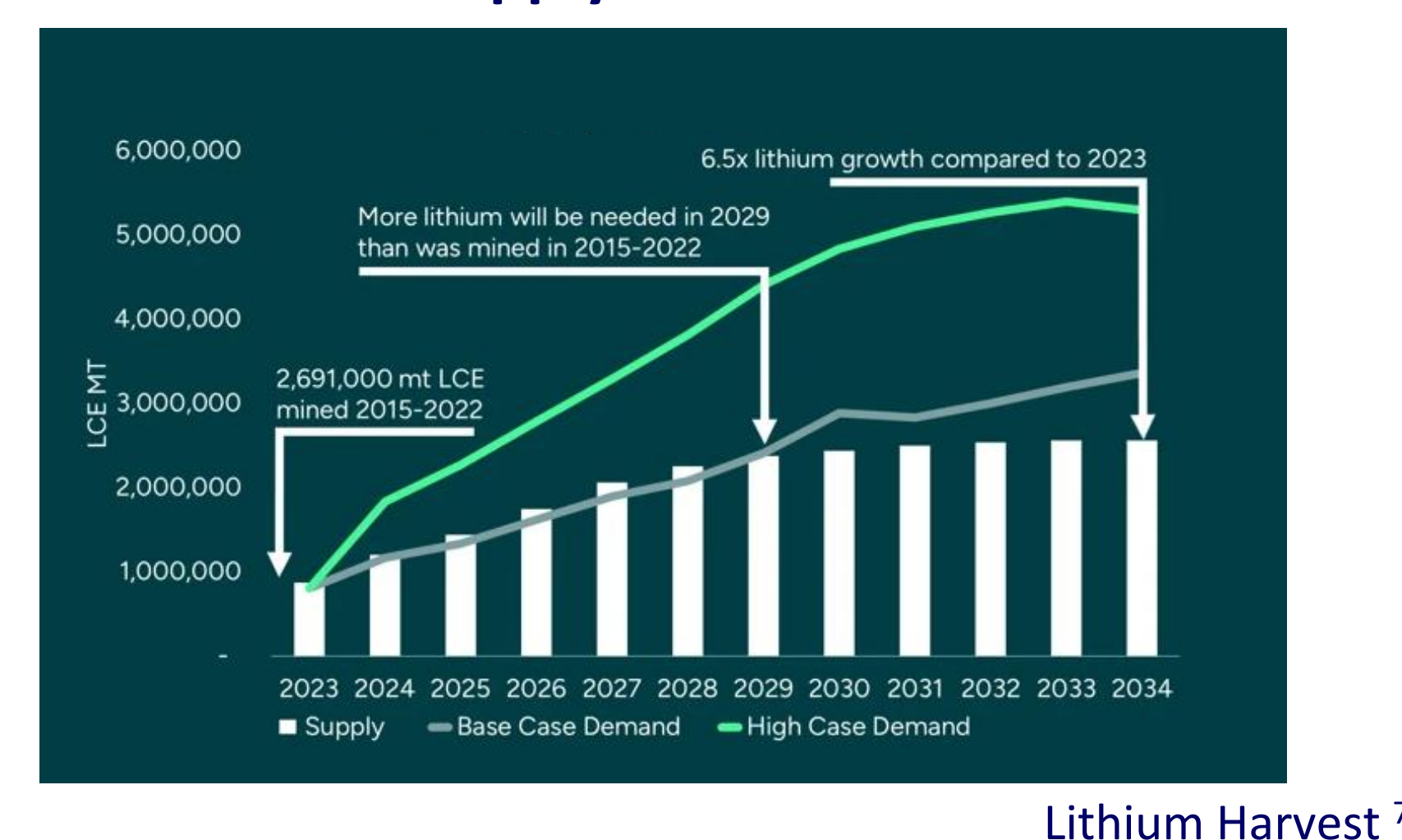
Technological Drivers of Lithium Demand

- Electric Vehicles (EVs)** are the largest consumers of lithium-ion batteries, and the global shift towards cleaner transportation has exponentially increased lithium consumption
- Large-scale Energy Storage Systems** utilize Lithium, crucial for stabilizing energy grids
- Consumer Electronics:** Lithium is widely used in rechargeable batteries for portable electronics

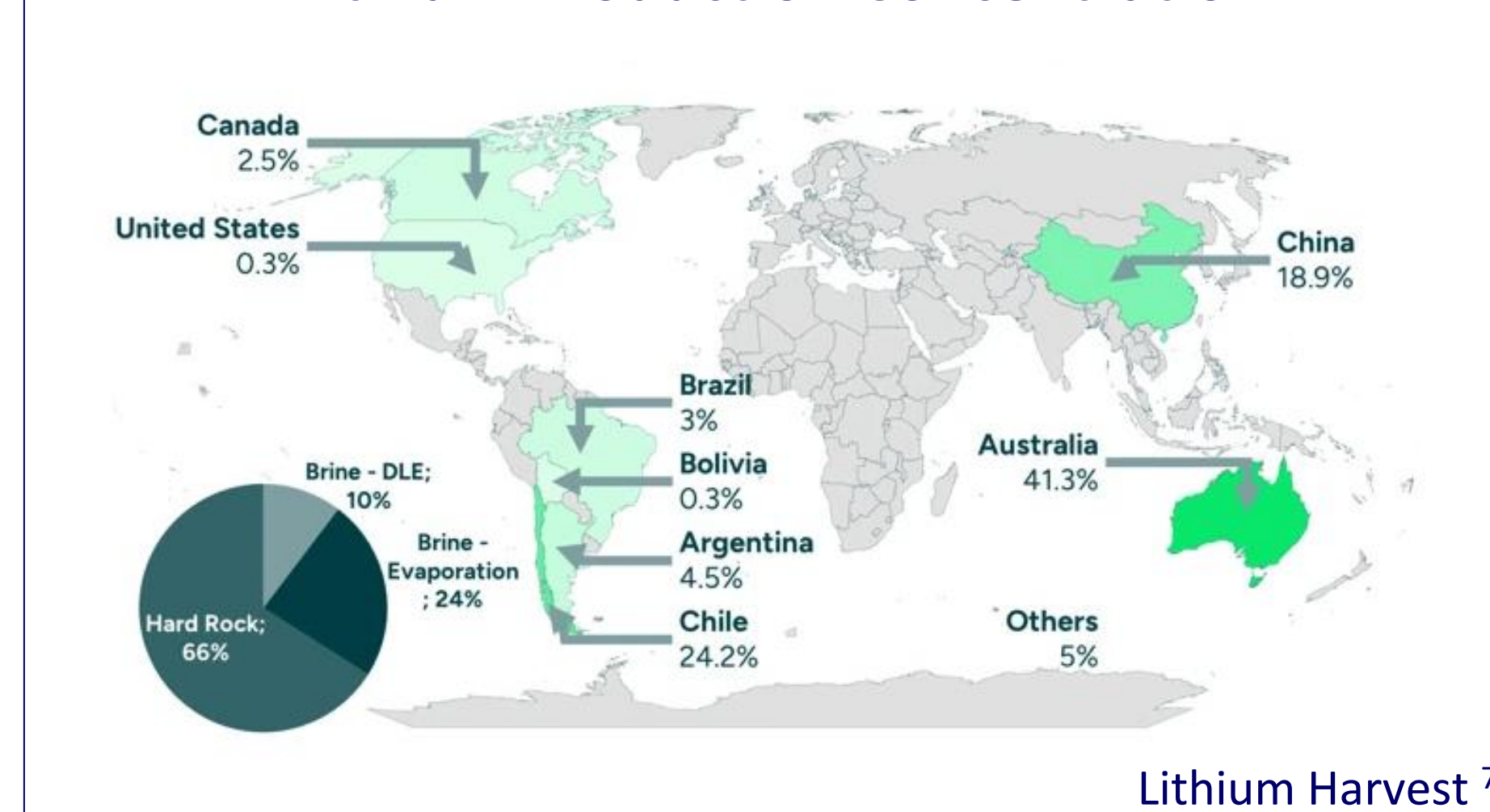
Economic Implications

- Energy Revolution:** Lithium has become a strategic resource, akin to oil in previous decades, as economies shift towards clean energy
- Lithium mining operations are critical to national economies, especially in Latin American countries where it supports significant economic growth
- U.S. government is working to boost and expand lithium production to strengthen national security

Lithium Supply-Demand Forecast



Lithium Production Concentration



Community Health Effects

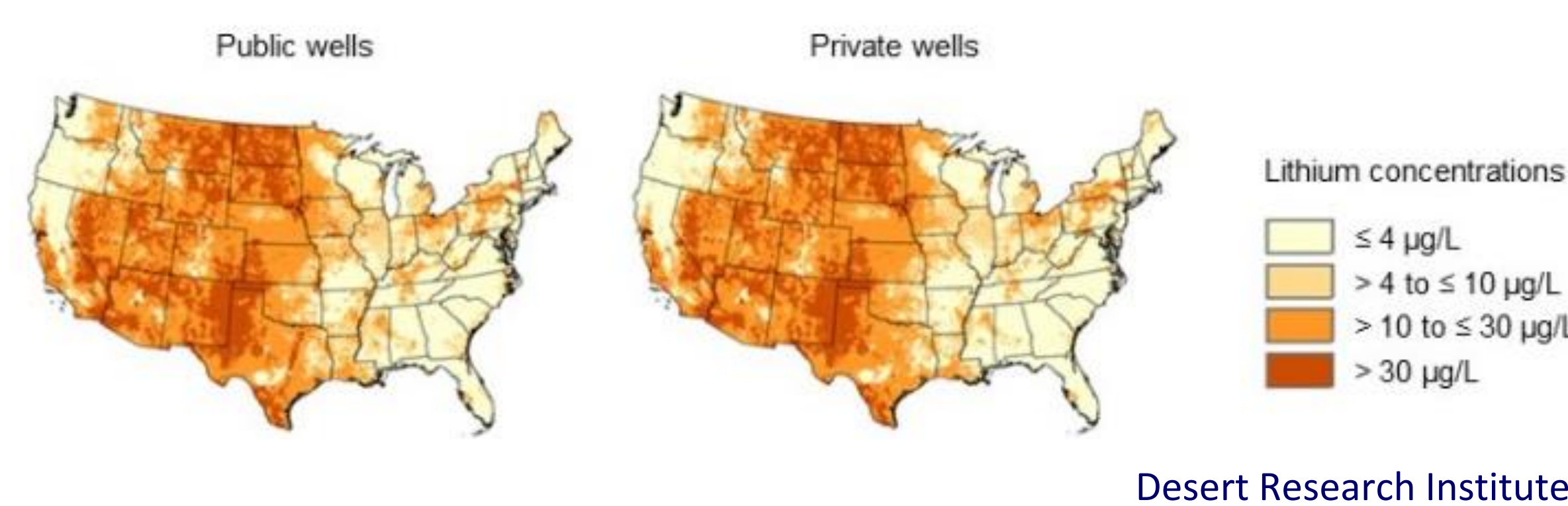
Airborne Lithium Exposure: Communities located near lithium extraction and processing sites potentially might be at higher risk for adverse health outcomes, particularly due to alkaline lithium-rich dust generated from mining operations

- Asthma Rates:** Children living near the Salton Sea, a high-mining region, exhibit asthma rates of 20-22.4%, compared to the California state average of 14.5%.³ Precise causation is unknown, but Lithium has been suggested as a possible contributor
- Respiratory Issues:** Lithium-rich dust can induce a neutrophil inflammatory response, resulting in respiratory irritation, chronic coughing, and even pulmonary edema in some individuals³ Whether these result in long term effects are unknown

Lithium in Drinking Water: The use of large amounts of water in lithium mining can lead to elevated lithium levels in local water supplies

- United States:** Lithium levels in public water supply wells have been measured between 1–1700 µg/L, with domestic wells reaching up to 396 µg/L⁴
- Chile:** In regions with high lithium mining activity, lithium concentrations in drinking water have been reported as high as 1500 mg/L⁴
- Health Implications:** Elevated lithium in drinking water has been associated to disturbances in calcium homeostasis, particularly during pregnancy, which could impact both maternal and fetal bone health⁵

Estimated Lithium Concentration in Groundwater that supplies public and private drinking wells



References

- Adeel, M., Zain, M., Shakoor, N., et al. (2023). Global navigation of lithium in water bodies and emerging human health crisis. *npj Clean Water*, 6, 33. <https://doi.org/10.1038/s41598-023-38864-6>
- National Institute for Occupational Safety and Health (NIOSH). (1981). *Health hazard evaluation report 80-036-922: Lithium Corporation of America, Bessemer City, North Carolina*. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.
- Biddle, T. A., et al. (2023). Aerosolized aqueous dust extracts collected near a drying lake trigger acute neutrophilic pulmonary inflammation reminiscent of microbial innate immune ligands. *Science of the Total Environment*, 858, 159882. <https://doi.org/10.1016/j.scitotenv.2022.159882>
- Dobosy, P., Illés, Á., Endrédi, A., & Záray, G. (2023). Lithium concentration in tap water, bottled mineral water, and Danube River water in Hungary. *Scientific Reports*, 13(1), 12543. <https://doi.org/10.1038/s41598-023-38864-6>
- Harari, F., Åkesson, A., Casimiro, E., Lu, Y., & Vahter, M. (2016). Exposure to lithium through drinking water and calcium homeostasis during pregnancy: A longitudinal study. *Environmental Research*, 147, 1-7. <https://doi.org/10.1016/j.envres.2016.01.031>
- Desert Research Institute. (2023, September 18). *New study estimates lithium in groundwater*. <https://www.dri.edu/new-study-estimates-lithium-in-groundwater/>
- Lithium Harvest. (n.d.). *The lithium mining market*. <https://lithiumharvest.com/knowledge/lithium/the-lithium-mining-market/>
- New Jersey Department of Health. (n.d.). *Lithium: A toxic substance fact sheet*. Retrieved October 6, 2024, from <https://nj.gov/health/eoh/rtkweb/documents/fs/1119.pdf>

Limited Regulations

- There is limited and outdated regulatory guidance for many lithium compounds, especially considering the rapid expansion of lithium mining and production
- Most lithium compounds are treated as nuisance dust, overlooking their high alkalinity and potential health risks
- OSHA PELs exist for Lithium Hydride, neglecting Lithium Carbonate and Hydroxide exposures which are the major exposures in modern Lithium mining and processing

Occupational Safety Recommendations

Protective Measures to minimize health risks associated with occupational exposure to lithium:

- Personal Protective Equipment
- Environmental Controls: Ventilation systems designed to reduce airborne lithium dust
- Medical Surveillance: Focusing on respiratory, kidney, thyroid, and neurological health, and considering testing, such as chest X-rays, spirometry, blood lithium concentration

Conclusions

- As global demand for lithium use rises, the health risks associated with its mining and production are of greater concern
- Workers are primarily exposed to lithium dusts through inhalation and skin contact, possibly leading to respiratory issues and skin complications
- Research is needed to understand the employee blood lithium levels at occupational sites
- Comprehensive data on occupational exposure to lithium compounds across diverse work environments is essential for risk assessment and regulatory development
- Appropriate regulations must be established for different lithium compounds in line with modern lithium production
- Further research is needed to explore potential long-term health effects of occupational lithium exposure

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