PERSPECTIVES

Lithium mining: How can science address a new exposure scenario in workers that has not been previously studied?

Minería del litio: ¿Cómo enfrentar desde la ciencia un nuevo escenario de exposición en trabajadores que no ha sido antes estudiado?

Muriel Ramírez-Santana[a], Sandra Cortés Arancibia[b], Vivienne C. Bachelet[c*]

[a]Departamento de Salud Pública, Facultad de Medicina, Universidad Católica del Norte, Coquimbo, Chile; [b]Escuela de Salud Pública, Centro de Desarrollo Urbano Sustentable (CEDEUS), Pontificia Universidad Católica de Chile, Santiago, Chile; [c]Escuela de Medicina, Facultad de Ciencias Médicas, Universidad de Santiago de Chile, Santiago, Chile

KEYWORDS Lithium, occupational health, Chile

Chile has 34% of the world's lithium reserves [1]. Due to the growing use of lithium in energy storage solutions and the advance of electromobility that characterizes the global energy transition process, this mineral has high strategic value for the country's development [2]. However, this mining activity has not been studied from the human health perspective. In this commentary, we call attention to the need to address this gap in scientific knowledge, knowing that studying new problems involves difficulties that sometimes are not easy to overcome.

Lithium carbonate has been used clinically for the management of mood disorders, with recommended therapeutic concentrations between 0.8 and 1.2 mEq/L [3]. It acts on neurotransmitters such as dopamine, glutamate and GABA [3]. Although there is not always a correlation between the dose and symptoms of intoxication, severe intoxication is described in doses higher than 4 mEq/L, caused by mechanisms such as increased cell permeability, sodium substitution in cell membranes and inhibition of the function of the sodium-potassium ATPase substrate pump [3,4]. Dysarthria, ataxia, seizures, visual disturbances, vertigo, confusion and delirium may be found in cases of moderate intoxication. Severe intoxication can lead to electrocardiogram disturbances, hypotension, arrhythmias, peripheral vascular collapse, shock, and death [4]. Additionally, the long-term use of lithium drugs has been associated with an increased risk of chronic kidney disease, hypothyroidism, hyperparathyroidism, and increased body weight and cognitive impairment [5–8].

At the occupational level, the U.S. National Institute for Occupational Safety and Health (NIOSH) includes the compound lithium hydride (LiH) in its guide to hazardous chemicals [9] and sets recommended maximum exposure limits for workers in the air matrix (NIOSH REL: TWA 0.025 mg/m3 and OSHA PEL: TWA 0.025 mg/m3). In this scenario, exposure routes include inhalation, dermal contact and ingestion. The eyes and skin are targeted organs, and the respiratory and central nervous systems can be affected. Acute damage includes irritation and burns of the eyes, skin, mouth and esophagus; if ingested, nausea, muscle twitching, mental confusion and blurred vision are reported [9]. There are no studies evaluating chronic exposure to lithium in workers.

In lithium mining, lithium hydroxide (LiOH) is extracted from natural salt lakes and processed for commercialization as lithium carbonate (Li_2CO_3). Environmental harm (geomorphological, biodiversity, ethnocultural) has been associated with lithium brine extraction processes in Chile [10–12].

A 2024 systematic review of environmental and occupational exposures related to the global lithium battery market describes

* **Corresponding author** vivienne.bachelet@usach.cl
Citation Ramírez-Santana M, Cortés Arancibia S, Bachelet VC. Lithium mining: How can science address a new exposure scenario in workers that has not been previously studied?. Medwave 2024;24(9):e3029 **DOI** 10.5867/medwave.2024.09.3029
Submitted Oct 14, 2024, **Accepted** Oct 15, 2024,
Published Oct 22, 2024
Postal address Escuela de Medicina, Universidad de Santiago de Chile Avenida Libertador Bernardo O'Higgins 3363, Estación Central, Santiago, Chile

the risks associated with toxic metals, such as cobalt and nickel, used in this industry. Notably, the authors did not identify any articles that evaluated the toxicity of lithium at mining sites and concluded that there is a need for further research to understand better and characterize the risks associated with lithium brine extraction [13].

The fact that there are no studies on the toxicity of lithium compounds in workers does not mean that this risk does not exist. Faced with the challenge of addressing a potential health risk at unestablished doses in exposure scenarios in workers or the general population, Lindhout et al. argue that this lack of information leads to the "acceptance of an unknown risk" [14]. The authors propose methodologies to systematically identify and reduce these unknown risks, concluding that safety management requires more than the mere identification and risk assessment of hazards of the traditional model. Gilbert et al., in their book Safety Cultures, Safety Models: Taking Stock and Moving Forward, comment that when there is a lack of knowledge and an absence of risk perception, the approach to risk management should invoke a sense of vulnerability, creativity and a proactive focus on: what else? [15].

The growing development of lithium mining in Chile highlights occupational health challenges. To understand and act, we must promote initiatives based on scientific evidence on occupational exposure and its possible effects on workers. We also need to foster the development and use of technologies to reduce current exposure, appealing to the "sense of vulnerability" already mentioned.

“Creativity" is required to innovate in measuring exposure and exploring potential health effects. Options to be developed, such as biological monitoring of lithium exposure [16], require much more sensitive laboratory techniques than standard clinical lithium level measurements usually used to assess therapeutic concentrations in patients undergoing lithium treatment because concentrations in occupational or environmental exposure are expected to be much lower.

Given the benefits that the exploitation of lithium could entail as we move towards sustainable energy matrices, the "proactive approach to what else?" requires us to address the issue. The National Lithium Strategy, the Chilean national policy on lithium, sets forth a vision for advancing sustainably in the economic, environmental and social dimensions without disregarding the territorial and intercultural specificities underpinning public-private initiatives beneficial for the country [2]. Public health and epidemiology—its applied science—are called upon to generate knowledge for policy and decision-making and to promote actions to prevent diseases and protect workers.

Contributor roles MRS prepared the first version of the article. SCA and VCB reviewed the manuscript and made contributions and corrections. All authors approved the final version of the commentary.

Competing interests The authors declare that they have no conficts of interest with the subject matter of this commentary.

Language of submission Spanish, English.

Peer review and provenance Commissioned. With internal editorial revision.

REFERENCES

1. Cochilco. Mercado del Litio: Proyección 2024-2025. 2024. In: Gobierno de Chile [Internet]. https://www.cochilco.cl/Mercado%20de%20Metales/Informe%20Litio_VF_1908%20RPI.pdf
2. Gobierno de Chile. In: Estrategia Nacional del Litio: Por Chile y su Gente [Internet]. 2023. https://www.gob.cl/chileavanzaconlitio/
3. Perrone J, Mudan A. In: Lithium poisoning - UpToDate [Internet]. Wolters Kluwer; 2022. https://www.uptodate.com/contents/lithium-poisoning
4. Olagorta GarcíaS, Esteban Ciriano ME, Vicente de Vera Floristán JM, Juan Belloc S, Bueno Lozano M. Intoxicación por carbonato de litio. Med Gen y Fam (Digital). 2013;2: 20–23.
5. Højlund M, Winkel JS, Nybo M, Hallas J, Henriksen DP, Damkier P. Lithium and the risk of chronic kidney disease: A population-based case-control study. Basic Clin Pharmacol Toxicol. 2022;131: 129–137. https://doi.org/10.1111/bcpt.13758
6. Shireen H, Akshay A, Swoboda Henry. Lithium Toxicity. In StatPearls. 2023.
7. McKnight RF, Adida M, Budge K, Stockton S, Goodwin GM, Geddes JR. Lithium toxicity profile: a systematic review and meta-analysis. Lancet. 2012;379: 721–8. https://doi.org/10.1016/S0140-6736(11)61516-X
8. Shang N, Zhang L, Wang S, Huang T, Wang Y, Gao X, et al. Increased aluminum and lithium and decreased zinc levels in plasma is related to cognitive impairment in workers at an aluminum factory in China: A cross-sectional study. Ecotoxicol Environ Saf. 2021;214: 112110. https://doi.org/10.1016/j.ecoenv.2021.112110
9. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health. NIOSH Pocket Guide to Chemical Hazards. 2007. https://www.cdc.gov/niosh/npg/default.html
10. Liu W, Agusdinata DB, Myint SW. Spatiotemporal patterns of lithium mining and environmental degradation in the Atacama Salt Flat, Chile. Int J Appl Earth Obs Geoinf. 2019;80: 145–156. https://doi.org/10.1016/j.jag.2019.04.016
11. Delgado F, Shreve T, Borgstrom S, León-Ibáñez P, Castillo J, Poland M. A Global Assessment of SAOCOM-1 L-Band Stripmap Data for InSAR Characterization of Volcanic, Tectonic, Cryospheric, and Anthropogenic Deformation. IEEE Trans Geosci Remote Sens. 2024;62: 1–21. https://doi.org/10.1109/TGRS.2024.3423792

12. Rentier ES, Hoorn C, Seijmonsbergen AC. Lithium brine mining affects geodiversity and Sustainable Development Goals. Renew Sustain Energy Rev. 2024;202: 114642. https://doi.org/10.1016/j.rser.2024.114642
13. Brown CW, Goldfine CE, Allan-Blitz L-T, Erickson TB. Occupational, environmental, and toxicological health risks of mining metals for lithium-ion batteries: a narrative review of the Pubmed database. J Occup Med Toxicol. 2024;19. https://doi.org/10.1186/s12995-024-00433-6
14. Lindhout P, Kingston-Howlett J, Hansen FT, Reniers G. Reducing unknown risk: The safety engineers' new horizon. J Loss Prev Process Ind. 2020;68: 104330. https://doi.org/10.1016/j.jlp.2020.104330
15. Gilbert C, Journé B, Laroche H, Bieder C, editors. Safety Cultures, Safety Models: Taking Stock and Moving Forward. Cham: Springer International Publishing; 2018. https://doi.org/10.1007/978-3-319-95129-4
16. Scheepers PTJ, van Brederode NE, Bos PMJ, Nijhuis NJ, van de Weerdt RHJ, van der Woude I, et al. Human biological monitoring for exposure assessment in response to an incident involving hazardous materials. Toxicol Lett. 2014;231: 295–305. https://doi.org/10.1016/j.toxlet.2014.03.002