

Lead isotope application for tracing aerosol contribution to inhaled metal

YU-HSUAN CRYSTAL LIANG¹, YI-GIEN TSAI², SHAU-KU HUANG³, KUO-FANG HUANG¹, MAO-CHANG LIANG¹
AND DER-CHUEN LEE¹

¹Institute of Earth Sciences, Academia Sinica

²Changhua Christian Children's Hospital

³National Health Research Institutes

The airborne particulate matter may carry pollutants and enter the human body through the lungs. For certain metals, such as lead, inhalation is the primary route of exposure [1], and these metals can be toxic to humans. Additionally, inhaled metals may induce the production of reactive oxygen species (ROS) [2,3], leading to oxidative stress and contributing to the onset of asthma [3]. Therefore, tracing the sources of these pollutants is a crucial objective, and this study applied lead isotope analysis on this target. Since lead isotopic composition remains unfractionated during biological, industrial, and transport processes, it serves as an effective tool for tracing sources. This study analysed the concentrations of metals and lead isotopic compositions in the urine of Taiwanese adolescents collected in 2019 and 2022 to explore the relationship between metal exposure and inhalation, as well as to identify potential sources of urinary metal. Benefiting from strict COVID-19 prevention measures, wearing mask not only blocked the virus but also likely had a significant impact on reducing the inhalation of pollutants.

The results revealed a significant decrease (40–70%) in urinary concentrations of Mn, Fe, Cu, and Pb under mandatory mask-wearing periods. In contrast, in the year without mask mandates, the lead isotopic signal in the urine of some subjects was consistent with the characteristic lead isotopic composition of petroleum products. In 2019, urine samples that matched the lead isotope signature of petroleum products also exhibited significantly higher metal concentrations compared to other samples, and all of these samples were collected from asthma subjects. Based on these findings, this study proposes the following conclusions: (i) wearing a mask significantly reduces inhalation exposure to metals, (ii) in the absence of mask-wearing, inhaled lead is indeed one of the primary sources of lead detected in urine, and (iii) isotopic analysis strongly supports that some asthma patients have likely inhaled substantially higher amounts of metals than others.

[1] Al osman et al. (2019) *BioMetals*. 32, 563-573.

[2] Han et al. (2001) *Free Radic Biol Med*. 30, 516-25.

[3] Michaeloudes et al. (2022) *Molecular Aspects of Medicine*. 85, 101026.