

The Relationship Between Air Lead and Blood Lead in a Modern US Lead-Acid Battery Facility: A Longitudinal Study

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Background and Purpose: To date, there has been little observational evidence on the relationship between air lead and blood lead at relatively low workplace air lead concentrations. This study improves upon prior studies methodologically and aims to examine this relationship in a modern workplace environment.

Methods: Personal measurements of air lead and blood lead concentrations were collected in a modern lead-acid battery manufacturing facility in the United States. A total of 236 workers and their 2,221 air-blood lead measurement pairs, collected between 2001 and 2021, were included in the statistical analysis. The association between air lead and blood lead was examined using linear mixed-effects models to account for data correlation. Potential confounders adjusted for include age, sex, job department, time trend, tenure, and seasonality.

Results: The workers were mostly (83%) male and on average 29.75 years of age at the first included measurement. Their air lead concentrations ranged from 1 to 50 (arithmetic mean 16.85) $\mu\text{g}/\text{m}^3$; blood lead concentrations ranged from 2 to 35 (arithmetic mean 15.47) $\mu\text{g}/\text{dL}$. After adjusting for potential confounders, a 1 $\mu\text{g}/\text{m}^3$ increment in air lead was associated with 0.025 (95% confidence interval: 0.005 - 0.045; marginal, semi-partial $R^2 = 0.002$) $\mu\text{g}/\text{dL}$ higher blood lead.

Conclusions: The relationship between air lead and blood lead at relatively low workplace air lead concentrations over a long employment period may be very weak, but this needs to be further investigated in future observational studies with quantified lead exposures from non-inhalation routes and non-occupational sources.