



Background lead and mercury exposures: Psychological and behavioral problems in children



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ABSTRACT

Background: The potential harm from exposure to nonessential metals, particularly mercury (Hg) and lead (Pb), has been the focus of research for years. Initial interest focused on relatively high exposures; however, recent evidence suggests that even background exposures might have adverse consequences for child development. Identifying the extent of these consequences is now a priority.

Methods: We assessed blood Pb and Hg levels in a biracial sample of 9–11 year-old children ($N = 203$). Neurodevelopment and psychological functioning assessments included hostility, disruptive behaviors, emotion regulation, and autism spectrum disorder behaviors. Parasympathetic (vagal) responses to acute stress were indexed by heart rate variability (HRV) at rest and during stress.

Results: With increasing Pb levels, children exhibit higher levels of hostile distrust and oppositional defiant behaviors, were more dissatisfied and uncertain about their emotions, and had difficulties with communication. These significant associations were found within a range of blood Pb levels from 0.19 to 3.25 $\mu\text{g}/\text{dL}$, well below the “reference value” for children of $> 5 \mu\text{g}/\text{dL}$. Vagal reactivity interacted with Hg such that increasing Hg was associated with increasing autism spectrum behaviors for those children with sustained vagal tone during acute stress.

Conclusions: This study is the first to demonstrate an association between very low-level Pb exposure and fundamental psychological mechanisms that might explain prior associations with more complex outcomes such as delinquency. Analyses of vagal reactivity yielded entirely novel associations suggesting that Hg may increase autism spectrum behaviors in children with sustained vagal tone during acute stress. The novelty of these later findings requires additional research for confirmation and the cross-sectional nature of the data caution against assumptions of causality without further research.

1. Introduction

The adverse effects of elevated blood lead (Pb) on children's development have been studied extensively in the domain of cognitive functioning (Lanphear et al., 2005), even at concentrations below those deemed to be elevated ($> 5 \mu\text{g}/\text{dL}$) by the Centers for Disease Control

and Prevention (CDC) in 2012 (Canfield et al., 2003). Effects of Pb exposure also have been examined for behaviors such as delinquency (Needleman et al., 1996); however, much of this work has focused on children with identified exposure routes (e.g., proximity to a battery factory) and thereby higher Pb levels (Wasserman et al., 1998). In contrast, background metal exposures would likely occur through less

Abbreviations: ADHD, Attention Deficit and Hyperactivity Disorder; ASD, Autism Spectrum Disorder; BMI, body mass index; CDC, Centers for Disease Control and Prevention; CDI, Child Depression Inventory; CVD, cardiovascular diseases; DBD, Disruptive Behavioral Disorders; DERS, Difficulties in Emotion Regulation Scale; EECHO, Environmental Exposures and Child Health Outcomes; ECG, electrocardiogram; HF-HRV, high frequency component of HRV; LF-HRV, high frequency component of HRV; Hg, mercury; IBI, interbeat interval; MDL, method detection limits; Pb, lead; SES, socioeconomic status

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