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Lead as a social determinant of child and adolescent physiological stress and behavior

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Lead is an environmental neurotoxicant that causes neurocognitive deficits and cardiovascular and metabolic disorders. It also disproportionately affects socially disadvantaged communities. The

association between lead exposure and children's IQ has been well studied, but few studies have examined the effects of blood lead on children's physiological stress and behavior. Three University of Pennsylvania School of Nursing (Penn Nursing) studies shed light on how lead can affect children and adolescents' physiological stress and emotional/behavioral development.

Lead exposure and the psychological stress response

Exposure to lead during childhood and adolescence is associated with a host of detrimental outcomes that persist into adulthood. Until now, however, few studies have tested the association between lead exposure and the physiological stress response, which in and of itself may act as a precursor to and/or underlying mechanism of detrimental health outcomes.

A study from Penn Nursing adds new evidence suggesting that early childhood lead exposure is significantly associated with dysregulated heart rate variability during an induced stress task in early adolescence, indicative of a dysregulated stress response. These findings hold implications for cardiovascular health and overall growth and development.

"The biological mechanisms underpinning the relationship between lead and physiological stress functionality are relatively unknown," said first-author Olivia M. Halabicky, Ph.D., RN, who completed this work as a doctoral student at Penn Nursing.

Dysregulated stress responses are associated with a host of health consequences including cardiovascular and metabolic diseases as well as impaired neurodevelopment and neurocognitive outcomes of general and higher-order cognition. "Understanding these relationships could help to develop interventions to target this biological mechanism and thereby

reduce the harmful effects of lead exposure for children at greatest risk," said senior-author and principal investigator Jianghong Liu, Ph.D., RN, FAAN, the Marjorie O. Rendell Endowed Professor in Healthy Transitions and the Faculty Director of Global Health Minor. Liu is also Director of the NIH-funded China Jintan Child Health Project, which follows more than 1,000 children in Jintan, China from pre-school into adolescence to understand the influence of exposure to environmental lead, nutrition, and psychosocial factors on their behavior.

The article "Early Childhood Lead Exposure and Adolescent Heart Rate Variability: A Longitudinal Cohort Study" was published in the journal *Environmental Research* and is available online. Co-authors also include Penn Nursing's Jennifer A. Pinto-Martin, Ph.D., MPH, and Peggy Compton, PHD, RN, FAAN. A similar study from Liu, published in the *International Journal of Hygiene and Environmental Health* in 2020, investigated the gaps in understanding about the effects of lead on resting heart rate.

Lead exposure explains adversity-antisocial relationship

In another novel investigation, Liu and collaborative researchers recently documented that blood lead in adolescents from Philadelphia aged 11 and 12 was positively correlated with both more social adversity and more externalizing behavior, and importantly that blood lead levels mediated the social adversity-externalizing behavior relationship.

"These findings have potentially important implications for public health and environmental regulation as well as understanding biological mechanisms that link social inequality with health outcomes, especially in youth from low-income, urban areas," says Liu.

These findings also highlight the importance of both social and environmental determinants of adolescent health. They underline the

need to mitigate adverse social influences and monitor lead exposure in children's environments to reduce likelihood of developing problems with externalizing behaviors, a risk factor for criminality and lower social mobility later in life. The article "Blood Lead Levels Mediate the Relationship Between Social Adversity and Child Externalizing Behavior" was published in the journal *Environmental Research* and is available online. Coauthors include Jill Portnoy and Presley McGarry, both of the University of Massachusetts; Adrian Raine, Margaret Gladieux and Aimin Chen of the University of Pennsylvania.

More information: Olivia M. Halabicky et al, Early childhood lead exposure and adolescent heart rate variability: A longitudinal cohort study, *Environmental Research* (2022). DOI: 10.1016/j.envres.2021.112551

Jianghong Liu et al, Blood lead levels mediate the relationship between social adversity and child externalizing behavior, *Environmental Research* (2021). DOI: 10.1016/j.envres.2021.112396

Jianghong Liu et al, Blood lead and mercury levels are associated with low resting heart rate in community adolescent boys, *International Journal of Hygiene and Environmental Health* (2021). DOI: 10.1016/j.ijheh.2020.113685

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