Poverty negatively impacts structural wiring in children's brains, study indicates

June 27 2023

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A new study from Washington University School of Medicine in St. Louis suggests that growing up in poverty may influence the wiring of a child's brain.

The study, published June 27 in *JAMA Network Open*, indicates a link between both neighborhood and household poverty and the brain's white matter tracts, which allow for communication between brain regions. White matter plays a critical role in helping the brain process information.

The findings stem from the largest long-term study of brain development and child health conducted in the U.S.—the Adolescent Brain Cognitive Development (ABCD) Study, which was launched by the National Institutes of Health (NIH) in 2015. Washington University is a national leader in studies of the developing brain and is one of 21 study sites around the country participating in the ABCD Study, which is following nearly 12,000 children, beginning at ages 9 to 10, for at least a decade.

"White matter integrity is very important in brain development," said first author Zhaolong (Adrian) Li, a neuroimaging research technician in the Department of Psychiatry. "For example, weaknesses in white matter are linked to visuospatial and mental health challenges in children. If we can capture how socioeconomic status affects white matter early on in a child's life, the hope is we can, one day, translate these findings to preventive measures."

The researchers also found that childhood obesity and lower cognitive function may explain, at least partially, poverty's influence on white matter differences. Generally, children who grow up in poverty have a higher risk of obesity and score lower on tests of cognitive function than their peers in higher income neighborhoods and households. The latter could be due, in part, to limited access to enriching sensory, social and cognitive stimulation.

"Our finding that obesity and cognitive enrichment may be relevant mediators, if confirmed, would provide strong support for managing healthy weight and encouraging cognitively stimulating activities to

support brain health in disadvantaged children," said Tamara Hershey, Ph.D., the James S. McDonnell Professor of Cognitive Neuroscience and a professor of psychiatry and of radiology.

The research was conducted in the Neuroimaging Labs Research Center in the university's Mallinckrodt Institute of Radiology.

White matter, the densely packed nerve fibers deep in the brain, gets its white color from the fatty substance that surrounds nerve fibers. The fatty coating is responsible for the rapid transmission of information along nerve cell tracts. The organization and connectivity between these tracts support learning and proper communication across brain regions. Disruption in these communication pathways has been linked to physical challenges as well as worse mental health outcomes.

The scientists used the publicly available ABCD Study database, through which they were able to model water movement as an indicator of white matter integrity in the brain scans of 8,842 children ages 9 to 11. Just like rocks, pebbles and boulders impact the flow of water in a river, diverse brain cell structures create barriers that hinder water diffusion. The researchers found less directional movement of water molecules in the brains of children living in poverty, signifying structural changes in white matter regions. They also found higher water content in spherical spaces in the brain, which hinted at possible neuroinflammation in children who live in poverty.

A child's environment is complex, involving both neighborhood and family influences. Disadvantaged neighborhoods suffer disproportionately from unemployment, poverty, and income disparity. Single-parent homes are more common, and residents are typically less educated, earn a lower income, and own less property.

"Our analysis revealed that neighborhood poverty is linked to white

matter differences and putative immune cell presence. We found a similar link when looking at household socioeconomic status, taking into account annual income and parental education," Li said.

"Wealth and income inequality are accelerating in the U.S.," said co-corresponding author Scott Marek, Ph.D., an assistant professor of radiology and of psychiatry. "We and others are starting to scratch the surface of how inequality may harm the developing brain and affect mental health outcomes. Our findings emphasize shifting away from the thinking that socioeconomics is a unitary construct. It's not schools or parenting alone that matter for brain health. It's likely the collection of many neighborhood and familial life factors."

Hershey, who directs the Neuroimaging Labs Research Center and is a co-corresponding author, cautioned that the study only looked at one time point. Therefore, it is too soon to know if poverty triggered the brain differences seen in the study, she said. However, the ABCD Study continues to track enrolled children through brain scans and cognitive testing with the potential for future long-term brain development studies in disadvantaged children.

"We hope this work encourages future studies to examine modifiable health risk factors in large and longitudinal samples that would one day translate to intervention," Hershey said.

More information: Associations Between Socioeconomic Status, Obesity, Cognition, and White Matter Microstructure in Children., *JAMA Network Open* (2023). DOI: 10.1001/jamanetworkopen.2023.20276

Provided by Washington University School of Medicine