Prenatal $PM_{2.5}$ and subcortical volumes in children with neurodevelopmental disorders

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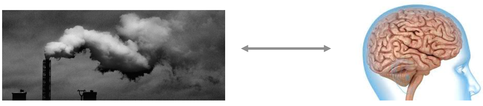
Key findings: Prenatal exposure to $PM_{2.5}$ may be associated with increased subcortical volumes in children later diagnosed with neurodevelopmental disorders (5-15 years)

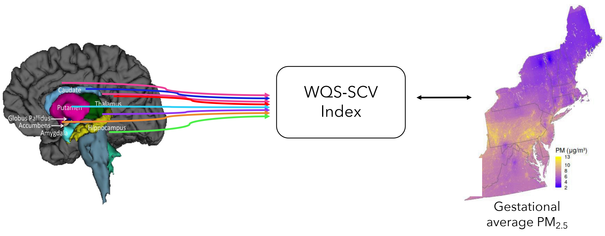
Background

- With the growing climate crisis, particulate matter (PM) air pollution is expected to increasingly impact human health with effects magnified in vulnerable populations including pregnant women and young children.
- Air pollution (particulate matter < 2.5 um; PM2.5) exposure increases risk for autism spectrum disorder (ASD) and attention deficit hyperactivity disorder (ADHD), yet the neural mechanisms underlying these associations are largely unknown.
- To understand links between prenatal PM2.5 exposure and structural brain changes, we take a transdiagnostic approach in a cohort enriched with ASD and ADHD subjects.



Materials and Methods

- **Participants:** 238 children enrolled in the Healthy Brain Network (HBN); behavioral and magnetic resonance imaging (MRI) phenotyping biobank.
- **Exposure:** We estimated average prenatal PM2.5 levels using a satellite-based gradient boosting hybrid model at a 1x1 km spatial resolution.
- **Outcome:** Subcortical volumes (14) from high-resolution structural T1-weighted images
- **Statistical analysis:** Weighted quantile sum (WQS) regression to generate a subcortical volume index (representing 14 subcortical brain regions volumes) and investigated associations between the subcortical index and PM2.5.



Results

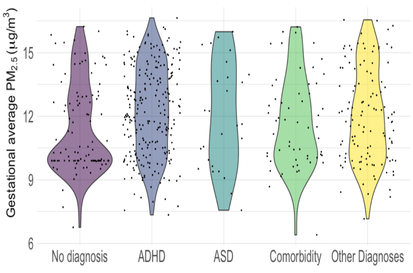


Figure 1. $PM_{2.5}$ Distribution of prenatal average PM2.5 among 557 participants enrolled in HBN, stratified by Dx.

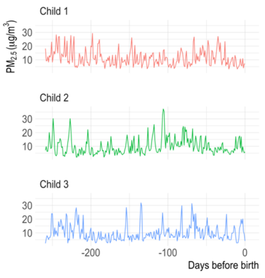


Figure 2. $PM_{2.5}$ exposure profile from 37 weeks (~259 days) before birth to birth (time 0) in 3 HBN subjects. Individual PM2.5 ranges 2 to 37 μg/m3.

- $PM_{2.5}$ was positively associated with the subcortical index (β = 0.19 [95% CI 0.18, 0.20), indicating higher prenatal exposure to $PM_{2.5}$ is associated with increased subcortical volumes. This association is driven mainly by volumetric changes in the thalamus and pallidum.

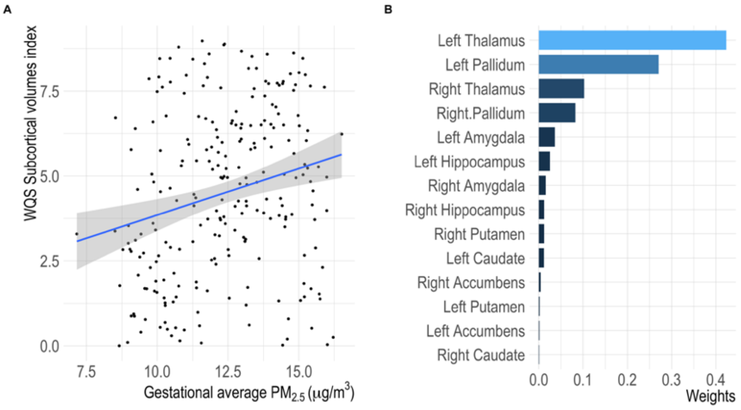


Figure 3. Associations between prenatal $PM_{2.5}$ and the WQS subcortical volumes index from weighted quantile sum (WQS) regression among 238 HBN participants. (A) Regression lines and standard errors between $PM_{2.5}$ and the WQS index. (B) Estimated weights contributing to overall effect.

Conclusions

- Prenatal exposure to $PM_{2.5}$ is associated with changes in subcortical volumes in a pediatric population enriched with ASD and/or ADHD
- This association is driven mainly by volumetric changes in the thalamus and pallidum, regions that play key roles in ASD and ADHD.
- These preliminary results should be replicated in a larger cohort and expand to associations with cognition and behavior