



ECHO

Environmental influences
on Child Health Outcomes

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Study Summary

Air Pollution Exposure During Pregnancy Associated with Slightly More Behavior Problems in Young Children, ECHO Study Suggests

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Who sponsored this study?

The Environmental influences on Child Health Outcomes (ECHO) Program, Office of the Director, National Institutes of Health supported this research.

Why was this study needed?

[Air pollution](#) is common in many places, and pregnant women can be exposed to it where they live, work, and travel. Scientists think some air pollutants may affect a baby's developing brain during pregnancy, which could later show up as differences in behavior. This study used data from the large, nationwide ECHO Cohort to better understand whether exposure to common air pollutants like fine particulate matter (PM_{2.5}), nitrogen dioxide (NO₂), and ozone (O₃) during pregnancy is associated with behavior problems in young children.

What were the study results?

Overall, the study found that exposure to air pollutants PM_{2.5} and NO₂ during pregnancy was associated with modest increases in childhood behavior problems, including externalizing behaviors (e.g., acting out, aggression, attention problems) and internalizing behaviors (e.g., anxiety, withdrawal, emotional reactivity) in preschool-aged children (1.5–5 years).

Exposures in different “sensitive windows” during pregnancy showed different links to child behavior. First trimester PM_{2.5} exposure was associated with higher externalizing behavior scores. Second trimester PM_{2.5} exposure was associated with higher internalizing behavior scores. Third trimester NO₂ exposure was linked to higher internalizing and externalizing behavior scores. Ozone (O₃) exposure was not significantly associated with child behavior scores overall.

The study also found that certain individual and community-level sources of stress like prenatal depression and childhood neighborhood opportunity (e.g., job opportunities, economic resources, socioeconomic inequities, housing quality) influenced the association between prenatal exposure to air pollution and child behavior.

What was the study's impact?

The changes in behavior scores linked with air pollution exposure were small for any one child, but many pregnant women are exposed to these pollutants, so even small differences could matter when they

affect a large number of children. Notably, the association between prenatal PM_{2.5} exposure and children's behavior was still seen even when PM_{2.5} levels were below the current U.S. annual air-quality standard.

Who was involved?

The study included 8,370 mother–child pairs from 28 ECHO Cohort Study Sites across 21 U.S. states and Puerto Rico. Children were between about 1.5 and 5 years old when caregivers completed the behavior questionnaire.

What happened during the study?

Researchers estimated each mother's exposure to three common outdoor air pollutants during pregnancy (PM_{2.5}, NO₂, and O₃) using home address histories and detailed air-pollution models. They looked at average exposure across the whole pregnancy and during each trimester. Caregivers later reported on children's behavior using a widely used questionnaire (the Child Behavior Checklist for ages 1.5–5). The research team used statistical methods to compare differences in children's behavior scores in relation to prenatal air-pollution levels while accounting for other factors that can affect behavior, such as regions, maternal age and education, and neighborhood conditions.

Footnote: Results reported here are for a single study. Other or future studies may provide new information or different results. You should not make changes to your health without first consulting your healthcare professional.

What happens next?

Future studies can help researchers understand if prenatal air pollution exposure continues to show an association with children's behavior beyond early childhood. Researchers can also explore how other factors, such as stress, access to healthcare, housing conditions, and other environmental exposures, might influence the association between prenatal air pollution exposure and children's brain development.

Where can I learn more?

Access the full journal article, titled "Prenatal Exposure to Nitrogen Dioxide, Fine Particulates, and Ozone in Relation to Child Behavior: The Environmental influences on Child Health Outcomes (ECHO) Cohort," in [Environmental Science & Technology](#).

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