

TITLE

Maternal Exposure to Criteria Air Pollutants and Congenital Heart Defects in Offspring: Results from the National Birth Defects Prevention Study

AUTHOR(S)

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ABSTRACT

Background:

Air pollution is typically made up of gaseous and fine particulate chemicals that are released into the air from the burning of fossil fuels or wood. The types of substances include ozone (O₃), particulate matter (PM) carbon monoxide (CO), nitrogen dioxide (NO₂), and sulfur dioxide (SO₂). Humans have been exposed to these air pollutants with increasing frequency since the start of the Industrial Revolution, and in greater quantities, since the 20th century when cars became abundant. Humans are exposed to air pollution when breathing contaminated air, particularly in large urban areas. Previous studies have shown that inhalation of these contaminants is associated with increased and worsened cases of asthma, and other more serious complications.

Objective:

To examine associations between maternal exposure to air pollutants during pregnancy and the incidence of congenital heart defects in their infants.

Methods:

The National Birth Defects Prevention Study (NBDPS) maintains registries of birth anomalies within nine US states. For this study, all mothers in these states who had given birth to a child with a congenital heart defect (CHD) were contacted for participation. Controls were randomly selected from unaffected live births. Using data from air monitors within 50 km of the mother's residence, researchers determined the daily maximum hourly measurement for CO, NO₂, and SO₂, the daily maximum 8-hr average for O₃, and 24-hr measurements of both fine and coarse PM, to determine exposure. These air pollution measurements were recorded for weeks 2-8 of each pregnancy. Analyses were adjusted to account for potential confounders including maternal demographics and tobacco and alcohol use. Relationships between exposure levels and CHD were assessed in a multipollutant context.

Results:

Positive associations were observed between exposure to NO₂ and narrowing of the aorta and pulmonary valve stenosis. Exposure to fine PM was positively associated with hypoplastic left heart syndrome. Associations between left ventricular outflow tract obstructions and NO₂, and between hypoplastic left heart syndrome and PM, were supported by findings from the multipollutant analyses.

Conclusion:

Using daily maximum pollutant levels and exploring individual exposure-weeks revealed some positive associations between certain pollutants and defects and suggested potential windows of susceptibility during pregnancy within the window of cardiac development. This research emphasizes the need to limit pollutant exposure during pregnancy and further study the incidence of CHDs within these windows of vulnerability.

POLICY IMPLICATIONS

The U.S. Environmental Protection Agency (EPA) first established National Ambient Air Quality Standards (NAAQS) as part of the Clean Air Act (CAA) of 1970. The NAAQS sets pollution limits on six principal air pollutants, including CO, lead, NO₂, O₃, fine and coarse PM, and SO₂, based on the average level of those pollutants in the air over a longer period of time or maximum exposure times for shorter periods. Two different levels exist in the standards with the primary level relating to public health protection, specifically aimed at "sensitive" populations such as children and asthmatics. The secondary level is meant to provide public welfare protection for safe visibility and preventing damage to farms, animals, and buildings. The CAA mandates that EPA review the NAAQS every 5 years to ensure that they are adequately protecting human health and the environment.

This study highlights the need to update these standards in an effort to protect the developing child during pregnancy in regards to NO₂ and fine PM exposure. The EPA primary standard for NO₂ levels is 100 ppb over an hour or an annual mean of 53 ppb. However, the models of this study showed that daily levels of NO₂ over 45.5 ppb made women two times likely to have a child with narrowing of the aorta and pulmonary valve stenosis. In addition, women with 24-hr fine PM exposure above 19.7 µg/m³ were associated with having more hypoplastic left heart syndrome births, yet the 24-hr primary standard for fine PM is 35 µg/m³ and an annual mean of 12 µg/m³. These findings also highlight the need for improved air monitoring and enforcement for "hot spots"—areas not in compliance with the standards. Residents of these hot spots are more likely to be low income and minority communities living near sources of substantial pollution.

EPA recently announced that, by December 2014, the agency will be issuing a new proposed limit on O₃ levels to better protect children and other sensitive populations from increased respiratory symptoms and decreased lung function. The EPA science advisory committee recommended that the O₃ standard should be lowered from its current 75 ppb to between 60-70 ppm. Once proposed, the new rule must be approved by the White House before becoming a final rule before October 2015.

References

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KEY WORD(S)

[Congenital Heart Defects \(CHD\)](#), [National Birth Defects Prevention Study](#)