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Exploring nonlinearity in the association between birth defect rates and agrichemicals in groundwater in an agricultural state

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Background: Agricultural practices over the last 70 years have led to increased agrichemical contamination in some drinking water supplies. Studies report an elevated risk of birth defects associated with exposure to nitrate or atrazine, but little is known about effects of co-exposure. This ecological study evaluated the relationship between the concomitant presence of nitrate and atrazine in Nebraska drinking water supplies and risk for birth defects.

Methods: County birth data were combined with water chemistry data retrieved from a state-sponsored agrichemical contaminant database. Segmented linear regression was used to examine associations between percentage of wells with nitrate and atrazine (separately and as a mixture), and the risk of birth defects.

Results: When modeled for wells with nitrate-N concentrations > 2 mg/L, the slope of the first regression segment was positive, increasing to 58% positive wells. After 58% positivity, the slope showed a negative association with birth defect rates. Adding atrazine to the model moved the changepoints to a lower percentage of wells positive for these agrichemicals in the association to birth defect rates. Models consistently showed this pattern of association with and without other nitrosatable compounds present.

Conclusions: The results support an effect of nitrate and nitrosatable compounds on fetal development and suggest the relationship may be nonlinear. Exposure to nitrate and nitrosatable compounds as a mixture may have separate biological effects on reproductive outcomes when compared to the single compounds.