An analysis of correlation between agrichemical contaminated wells and birth defects in Nebraska

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ABSTRACT

Evidences that agrichemicals might be associated with the incidence of birth defects are inconsistent. This study examines whether triazine, acetanilide, carbamothioate, nitrate, trifluralin and uracil present in well-water are associated with birth defect rates in Nebraska counties and to identify the well types contaminated with these agrichemicals. Birth defects data obtained from Nebraska Department of Human and Health Services were merged with data on wells tested for agrichemicals obtained from Quality-Assessed Agrichemical Contaminant Database for Nebraska Ground Water. The 33 contaminants sampled from the wells were sub classified into 6 predictors and expressed as percentages for analysis in linear regression model with birth defect rates as the response variable. The agrichemicals sampled from the wells were also categorized into parent and degradate to examine the nature of agrichemicals associated with birth defects. The percentage for triazine and nitrate in domestic wells were 10.6% and 21.5% respectively. Birth defect rates were discovered to correlate with percentage of wells positive for triazine (r= 0.21 p=0.041). Percentage of wells positive for Triazine in domestic wells was found to be linearly associated with birth defect rates in the regression model (p=0.019). A stronger correlation was found between the parent contaminants and birth defect rates(r=0.22 p=0.034) than the degradate. (r=0.15 p=0.163).
This study suggests an association between birth defect and percent of wells positive for agrichemical compounds. However, this association does not imply causation but provides direction for future investigation.

Introduction

Birth defects are a known cause of infant death in the United States(1). Most agrichemicals are mutagenic, carcinogenic and toxic to humans(2) and some studies have linked birth defects to agrichemical-contaminated surface water. However no clear evidence have shown the magnitude of the association between birth defects and agrichemical-contaminated water(3)

Agrichemicals in this study were classified into nitrates, triazine, acetanilide, carbamothioate, substituted urea and dinitroaniline. Water surfaces in the United States are highly affected by triazines and nitrates(4). Most agrichemicals can easily be converted to other forms (degradates) that are potentially more toxic than the parent compound. Thus it is important to account for the degradates alongside the parent compounds when considering the effects of agrichemicals on human health(5).

This study seeks to examine the magnitude of the correlation of triazine, acetanilide, carbamothioate, nitrate, dintroaniline, uracil and substituted urea with birth defect rates and also identify the classes of agrichemicals present in the well types of Nebraska counties.

Materials and Methods

Study population:
The study population included is 264,188 live births from 2005-2014 in the 93 counties of Nebraska that are potentially exposed to surface water. All cases of birth defects were included in the study.
Outcome definition:
The outcome is the birth defect rate for each of the 93 counties in Nebraska. This was calculated from county-level birth defects and live births from the database of Nebraska Department of Health and Human Services and expressed as case rate per 10,000 population. Any case of birth defect was included.
Exposures:
Contaminant data was assessed using the Quality-assessed Agrichemical Contaminant for Nebraska Ground Water database , which contains data for 33 contaminants were sampled from wells in Nebraska. These wells were identified using clearing house numbers and the well types considered for sampling were commercial, domestic, heat pump, irrigation, public water, monitoring and livestock. The 33 contaminants tested from the wells were sub- classified based on identical functional groups into 6 predictors: nitrate, triazine, acetanilide, carbamothioate, dinitroaniline, uracil and substituted urea. The contaminants were analyzed in parts per billion but was expressed for data analysis in percentages of wells positive.
Statistical analysis:
We calculated the percentage of wells positive for agrichemicals. A linear regression model was fitted for the 6 predictors (nitrate, triazine, acetanilide, carbamothioate, dinitroaniline, uracil and substituted urea), well types and birth defect rates with the best fit model obtained through the backward model selection. All analysis were conducted using SAS version 9.4(English).

Results

Table 1. Counts and percent well types sampled for Nitrate, Acetanilide and Triazine

	Domestics	HeatPum p	Irrigation	Public	Monitoring	Livestock	Commercial e
Nitrate	5409(21.5)	2(0.0)	16221(64.4)	404(1.6)	2427(9.6)	667(2.6)	69(0.3)
Acetanilide	180(2.3)	0	900(11.5)	7(0.9)	663(84.7)	2(0.3)	3(0.4)
Triazine	175(10.6)	0	409(24.7)	58(3.5)	997(60.2)	10(0.6)	23(0.5)

Figure 1. Plot of Birth defect rates and Percent positive wells of Triazine for domestic and irrigation well types
Scatterplot With Regression Lines for WELL TYPES

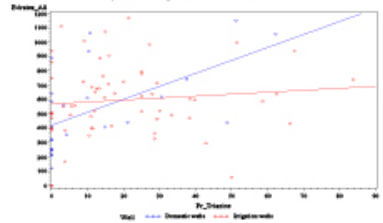

Table 2. Linear regression of birth defect rates and % positive wells for Triazine and well types

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	362.00004	89.23966	4.06	0.0001
Well	Well	1	29.89852	15.45928	1.93	0.0565
Pr_Triazine	Pr_Triazine	1	12.12680	3.92540	3.09	0.0027
Well_Triazine		1	-1.53799	0.64330	-2.39	0.0191

- 175 (10.6) and 5409(21.5) of the domestic wells sampled were positive for triazine and nitrate respectively (Table1)
- A correlation was found between wells positive for triazine and birth defect rates (r=0.21,p=0.041) (Table 2)
- A stronger correlation was found between the parent contaminants and birth defect rates(r=0.21 p=0.045) than the degradate (r=0.15 p=0.163)
- Moderate association between triazine in domestic wells and birth defect rates (r=0.57,p=0.0035)
- No association between triazine in irrigation wells and birth defect rates(r=0.105,p=0.41)
- The effect of triazine on birth defects differ in domestic and irrigation wells.(p=0.019)
- Thus, when comparing two counties whose percentage positive wells of triazine for domestic wells differ by 1 percent, the expected birth defect rates is 10.58cases/10,000 for the county with higher percent. (p=0.019) (Table 3)

Discussion

- Results of this research is consistent with other similar studies
- From this study it was observed that most of the wells sampled in the counties were irrigation and domestic wells. It is important in further studies to consider sampling additional wells. This factor could be a possible barrier to understanding fully the correlation between wells positive for agrichemicals and birth defect rates in Nebraska.
- However this study was able to bring to bare some evidence of association between triazine and birth defect rates in Nebraska.
- Stayner et.al., also showed that atrazine, a member of triazine class is strongly associated with birth defect rates(6).
- Another interesting finding is the association between parent pesticides and birth defect rates.
- This is important in understanding the danger of early exposure to agrichemicals and when to take actions from environmental health perspective
- While other studies have shown good correlation between nitrate and birth defect rates (7), this study does not support such evidence.

Conclusion and future recommendations

This study suggests an association between birth defect and percent of wells positive for agrichemical compounds. However, this association does not imply causation but provides direction for future investigation. Additional studies of direct exposures are needed (case-control).

Limitations

- These data do not constitute direct exposure of the mother to the water source
- These study does not consider other potential exposures to triazine.

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References

1.Rose, R. L., Tang, J., Choi, J., Cao, Y., Usmani, A., Cherrington, N., & Hodgson, E. (2005). Pesticide metabolism in humans, including polymorphisms. Scandinavian journal of work, environment & health, 156-163.
2. Larson, S. J., Gilliom, R. J., & Capel, P. D. (1999). Pesticides in Streams of the United States--Initial Results from the National Water-Quality Assessment Program. US Department of the Interior, US Geological Survey.
3. Squillace, P. J., Scott, J. C., Moran, M. J., Nolan, B. T., & Kolpin, D. W. (2002). VOCs, pesticides, nitrate, and their mixtures in groundwater used for drinking water in the United States. Environmental Science & Technology, 36(9), 1923-1930.
4.Kolpin, D. W., Thurman, E. M., & Linhart, S. M. (2000). Finding minimal herbicide concentrations in ground water? Try looking for their degradates. Science of the Total Environment, 248(2), 115-122.
5.Winchester, P. D., Huskins, J., & Ying, J. (2009). Agrichemicals in surface water and birth defects in the United States. Acta paediatrica, 98(4), 664-669.
6.Stayner, L. T., Almberg, K., Jones, R., Graber, J., Pedersen, M., & Turyk, M. (2017). Atrazine and nitrate in drinking water and the risk of preterm delivery and low birth weight in four Midwestern states. Environmental Research, 152, 294-303.
7.Winchester, P. D., Huskins, J., & Ying, J. (2009). Agrichemicals in surface water and birth defects in the United States. Acta paediatrica, 98(4), 664-669.