Health Concerns with Nitrates in Drinking Water

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Nebraska Populations

• Where Nebraskans get their water
  • 20% from private domestic wells
  • 80% from a community public water system

• Agriculture
  • 92% of Nebraska’s land
  • 1 in 4 jobs is related back to agriculture
  • 77,097 producers

• 2019 estimated population of 1,934,408 people – 660,417 living in rural areas (USDA-ERS)

• Indigenous Populations
  • 4 state and federally recognized tribes with headquarters in NE (Omaha, Santee Sioux, Ponca, and Winnebago); neighboring states such as the Iowa, Sac and Fox, Pawnee, and Oglala Sioux
Water Quality Issues
Issues

- Nutrients
  - Organic Nitrogen, Phosphorus
- Pathogens
  - Bacteria
- Geogenic contaminants
  - Arsenic, uranium, etc.
- Emerging contaminants
  - Hormones, antibiotics
- Pesticides
- Lead
Nebraska towns pay millions to fight nitrates as water bills go up

By Jessica Fargen Walsh Special to The World-Herald  May 1, 2020 Updated May 1, 2020  

“If you are a community of 500, this is just devastatingly expensive,”

- Millions spent to mitigate water contamination; taxes increasing
- Small communities disproportionately impacted; fewer resources to address the problem
Watch: Small Towns Look For Unique Solutions To Agricultural Water Pollution

BY JEREMY BERNFIELD  •  SEP 28, 2016

Stange and his team have designed a unique line of defense. They’re using wells strategically placed on the outskirts of town to act as a filter for the aquifer, skimming off nitrates as they move toward the city.

The city of Hastings will spend $46 million to build the system, Stange says, which is a big hit to a city of just 25,000 people.
Links to Health
Nitrate in Drinking Water

• **Sources**: Nitrogen fertilizers, animal and human waste

• **Regulatory limit**: 10 mg/L as NO$_2$-N (USA)

• **Greatest exposure**
  • Agricultural areas
  • Private wells
    • Not regulated
    • Sparse measurements
N-nitroso compounds

- Several hundred NOC compounds have been tested
  - 80% are carcinogenic

- 40 animal species
  - Several type of cancers

- In utero exposure causes congenital malformations
  - Central nervous system
  - First trimester
Nitrate and Human Health

• Regulatory limits of nitrate in drinking water are set for infant development of methemoglobinemia, not for other health outcomes
• Numerous scientific studies have looked at the relationship of nitrate in drinking water on human health
• High concentration of nitrate in drinking water have been linked to adverse health outcomes
• Strongest links
  • Methemoglobinemia (Infants less than 6 months)
  • Colorectal cancer (5 studies; 4 positive)
  • Thyroid disease (3 positive studies)
  • Neural tube defects (birth defects of spine, brain and spinal cord)
Other links to health

- Increased heart rate, nausea, headaches, and abdominal cramps
- Other cancers
  - Pediatric brain cancers (2 studies; 2 positive)
  - Kidney cancer (2 studies; 2 positive)
  - Bladder cancer (4 studies; 2 positive)
  - Non-Hodgkin lymphoma (3 studies; 1 positive)
- Non-Hodgkin Lymphoma had a three-fold increase in risk with nitrate and atrazine in Nebraska study (Rhoades et al 2013)
- Alzheimer's, Diabetes And Parkinson's Disease
Adverse reproductive outcome

• CDC report 1996 showed a cluster of spontaneous abortions (miscarriages) in rural Indiana
  • Private wells >20 mg/L NO$_2$-N
  • Switched to low nitrate water and healthy births

• Central Nervous System (CNS) Malformations
  • 5 of 6 studies found a positive association with nitrate
  • 4 of the studies had concentrations less than 10mg/L
Most Vulnerable Populations

• Young infants (< 6 months of age) appeared to be particularly sensitive to the effects of nitrite on hemoglobin

• Pregnant women and her fetus
  • Especially at 30 weeks of pregnancy

• People with oxygen transport or delivery conditions like anemia, cardiovascular disease, lung disease, sepsis and presence of other structural hemoglobin variants

• People with nitrate in their well water
  • Diet also plays a role
Uranium and nitrate concentrations in groundwater in Great Plains region

Source: Natural uranium contamination in major US aquifers linked to nitrate
https://pubs.acs.org/doi/abs/10.1021/acs.estlett.5b00174
Centers for Disease Control and Prevention

Data from 2003 – 2014 and reported as age-adjusted incidence rates of childhood cancer per 1 million:

United States: 173.7
- New Hampshire: 205.5
- New Jersey: 192.3
- Maine: 190.5
- New York: 190
- Pennsylvania: 186.6
- Connecticut: 185.8
- Nebraska: 183.2
- Texas: 183.2
- Oregon: 182.6
- Massachusetts: 181.5

ICCC: International Classification of Childhood Cancer

Courtesy of Don Coulter, MD

Incidence of pediatric cancers in Nebraska is among the five highest in the United States (Farazi et al., 2018).
Fig 1. Age-adjusted cancer incidence in Nebraska Watersheds VS national average for (A) CNS Tumors, (B) Leukemia, (C) Lymphoma; (D) Land use.
63% (54/86) Pediatric CNS Cancers

41% (35/86) Pediatric Leukemia

43% (38/86) Pediatric Lymphoma

Fig 1A. Age-adjusted incidence (AAI) of pediatric brain and other CNS cancer per county in Nebraska from 1987-2016

Counts with groundwater nitrate concentration between 2.1 and 5 mg/L have higher incidence

Fig 1B. Age-adjusted incidence (AAI) of pediatric leukemia per county in Nebraska from 1987-2016

Fig 1C. Age-adjusted incidence (AAI) of pediatric lymphoma per county in Nebraska from 1987-2016
 Birth Defects in the Lower Elkhorn NRD

• Total congenital anomalies in LENRD= 1,140 (1995-2014)
• 468 – females (avg. birth weight 3,126 gm)
• 672 – males (avg. birth weight 3,164 gm)
• 229 pregnant women with history of smoking
• 55 women diagnosed with gestational diabetes
Birth Defects

• National average: 3.3% of all live births

• Nebraska (2005-2014): 5.8%

• Counties in parts of NE reaching 9-12%

• Counties with higher birth defects had greater prevalence of agrichemicals in water

The median compound growth rate of birth defects in LENRD: 7.08% (95% CI 5.73-8.42)
Median compound growth rate in Nebraska: 4.71 (95% CI 3.73-5.70)
Summary

• Studies have found that various negative health outcomes are associated with high concentrations of nitrate in drinking water
• Nebraska has one of the highest rates of some pediatric cancers
  • Some of these pediatric cancers seem to have an association with areas that have high nitrate
• Number of birth defects are increasing in Nebraska
Public Health can assist with addressing, educating, and understanding the health impacts. 

Public health spending is estimated to be between 1.5% and 3% of all U.S. health spending.
Water, Climate and Health Program

• Interdisciplinary collaborations across University of Nebraska system
• Address Nebraska’s public health challenges related to water and climate
  • Research
  • Education
  • Policy Development
  • Training
Water Quality

Nebraska towns pay more for water

Communities are collectively paying millions of dollars to fight nitrate contamination as they watch their bills increase.

By Jennifer Francis Wang

Water is one of the most precious resources on earth. It is essential for life, and in Nebraska, it is a precious commodity. However, the quality of water in some areas of the state is becoming a serious concern as nitrate levels increase.

In recent years, nitrate has become a growing concern in Nebraska. High levels of nitrate can be harmful to both human and animal health. It is important to monitor and manage nitrate levels in water to ensure its safety for consumption.

Nebraska towns are not immune to this threat. In some areas, nitrate levels have surpassed safe limits, posing a risk to public health.

The impact of nitrate contamination is not limited to the affected communities. It can also have broader implications for the economy and the environment.

To address this issue, communities and state authorities are working together to find solutions. This includes implementing strict regulations, improving monitoring systems, and promoting better agricultural practices.

While progress is being made, there is still much work to be done. The challenge of managing nitrate contamination in Nebraska is complex, and it requires a collaborative effort from all stakeholders.

In the meantime, communities are urged to monitor their water supply closely and take necessary steps to protect public health.

Read more on the Water Quality section for more information.

Nitrates A Costly, Persistent Problem For Small Towns

by Grant Cornett, NET News/Nebraska Public Media

Nitrates can be a costly and persistent problem for small towns in Nebraska. The small-town lifestyle is often associated with a slower pace and lower costs, but this can be misleading when it comes to managing nitrate contamination.

In many small towns, nitrate levels have reached alarming levels, posing a serious health risk to residents. The cost of dealing with nitrate contamination is substantial, and it can impact the local economy as well.

To combat this issue, small towns are working to improve their monitoring systems, implement stricter regulations, and promote better agricultural practices. It is a challenging task, but one that is crucial for maintaining the health and well-being of the community.

In the end, the fight against nitrate contamination is a shared responsibility. It requires the commitment of everyone involved—individuals, communities, and state authorities alike.

For more information on how you can help, visit the Water Quality section on the website.
Water Quantity
Safer and Healthier State

• Identifying multidisciplinary solutions to Nebraska’s water and health issues
• Building collaborations with leaders tackling water and health issues
• Educating and informing Nebraskans about these environmental issues
• Providing mentorship and support to the next generation of problem solvers
• Recruiting experts to help address these issues
What comes next?

- Fellowships for students
- Pilot grants
- Water and Health Summit, June 2021
- Climate Summit, Fall 2021
- Expanding Public Health Education into UNMC curriculum
  - Emerging Medical Education Track beginning Fall 2021
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Interest in the Program

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