

# Nitrate in drinking water and health studies in Denmark



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Several recent epidemiological studies in the Danish population have assessed the relationship between exposure to nitrate in drinking water and a variety of health outcomes.

## AIM

Agricultural losses of nitrate are a major source of pollution of groundwater, which is sourced for drinking water production. Known and suspected health effects of nitrate exposure include blue-baby syndrome (due to endogenous formation of nitrite and methemoglobin) and carcinogenic effects due to the endogenous formation of *N*-nitroso compounds.

This study presents an overview of the considerable number of studies on drinking water nitrate and health performed on Danish data. An interdisciplinary approach is used to examine the links between drinking water quality and health indicating several health effects of nitrate in drinking water below the current drinking water standard of 50 mg/L.

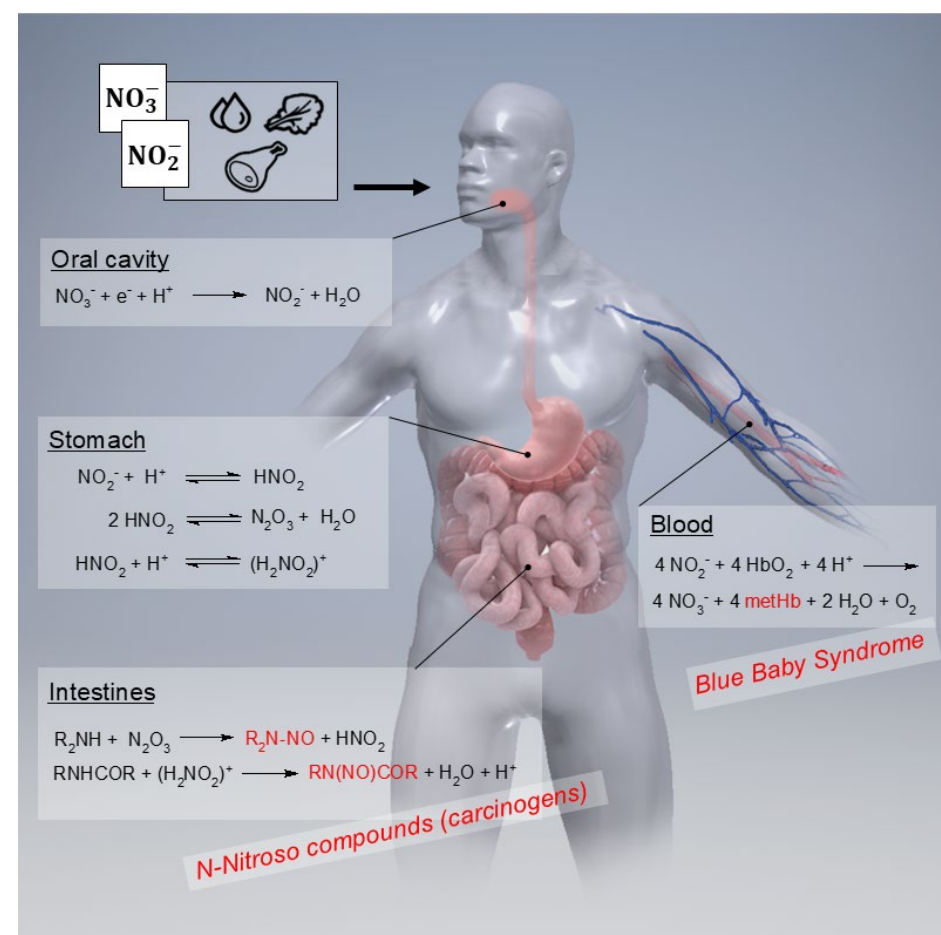


Figure 1: Transformation processes of nitrate in the body and possible health effects.

## STUDY DESIGN

Denmark stands out as an ideal country for performing epidemiological studies on an individual level for the entire population on the link between drinking water quality and human health. This is mainly due to:

- 1) The extensive tradition for collecting and storing comprehensive individual health data linked to our personal identity number
- 2) High-quality drinking water chemical analyses time series in the public accessible geodatabase, Jupiter
- 3) Significant contrasts in the drinking water quality across the country.
- 4) Low consumption of bottled water

## DRINKING WATER QUALITY CONTRASTS

The geographical contrast in drinking water nitrate exposure originates from:

- 1) The variation in nitrate leaching due to different farming practices and fertilization
- 2) The varying geological settings of the groundwater aquifers supplying drinking water production
- 3) The varying geochemical conditions in the subsurface such as variations in the potential for natural removal by denitrification
- 4) A very decentralized drinking water supply structure with nowadays more than 2600 public water supplies and approximately 50,000 private wells
- 5) Normally only simple treatment of the drinking water with aeration and filtration at the waterworks

## RESULTS

The Danish studies contribute with large study populations and detailed spatiotemporal exposure assessment to the globally growing body of evidence that the current standard of 50 mg/L does not sufficiently protect the general population from adverse health outcomes after prolonged exposure.

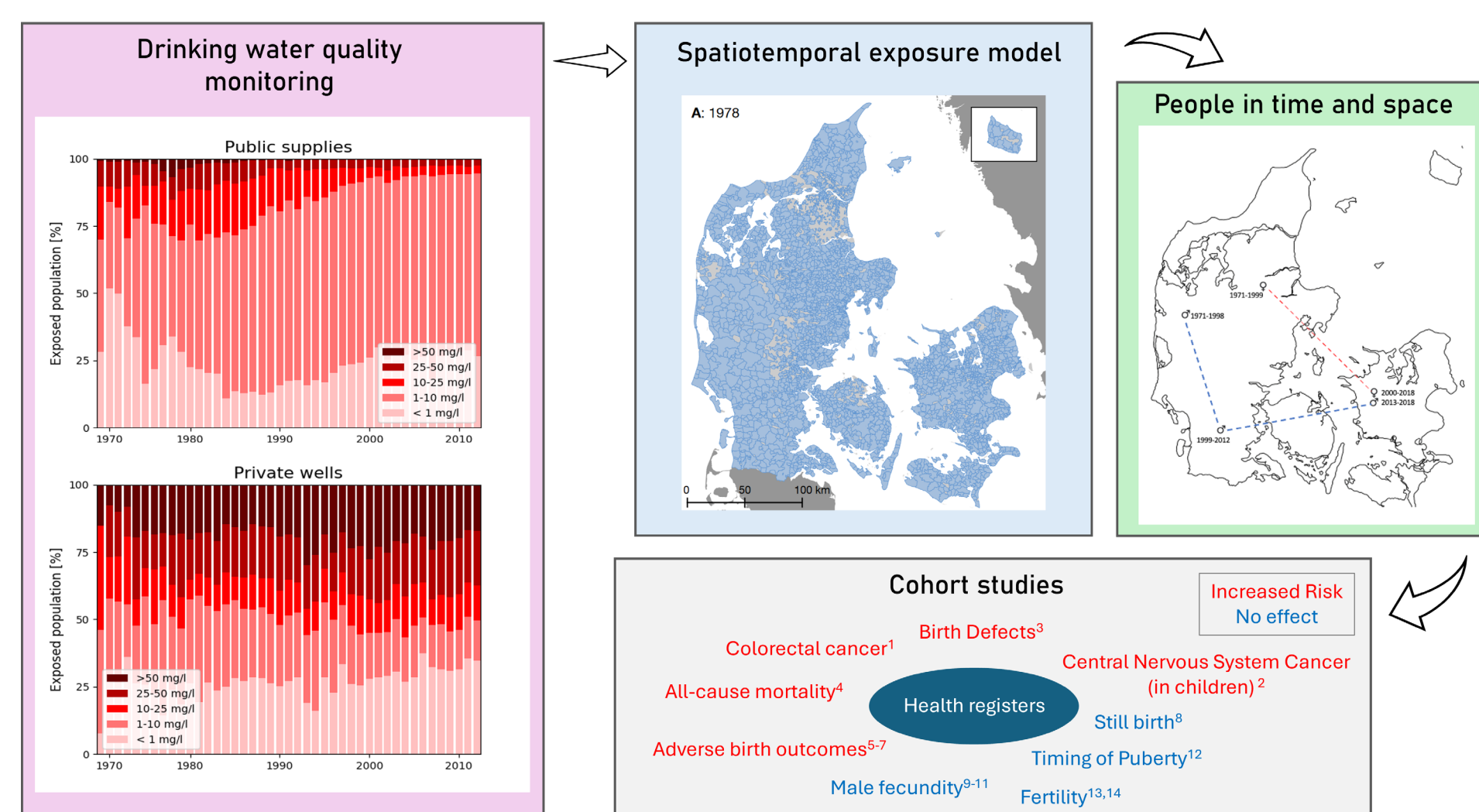


Figure 2: The concept and overall results of long-term epidemiological individual cohort studies on drinking water nitrate and health effects in Denmark

## HEALTH ECONOMIC ASPECTS

Denmark could avoid more than 120 colorectal cancer cases and save more than US\$ 300 million a year by reducing the amount of nitrate in its drinking water. An analysis of nitrate levels in Denmark's water supplies shows that roughly 10% of Danish drinking water has a nitrate concentration above 9 mg/L, and an additional approximately 10% is above 4 mg/L as an average for 2018-2021<sup>15</sup>.

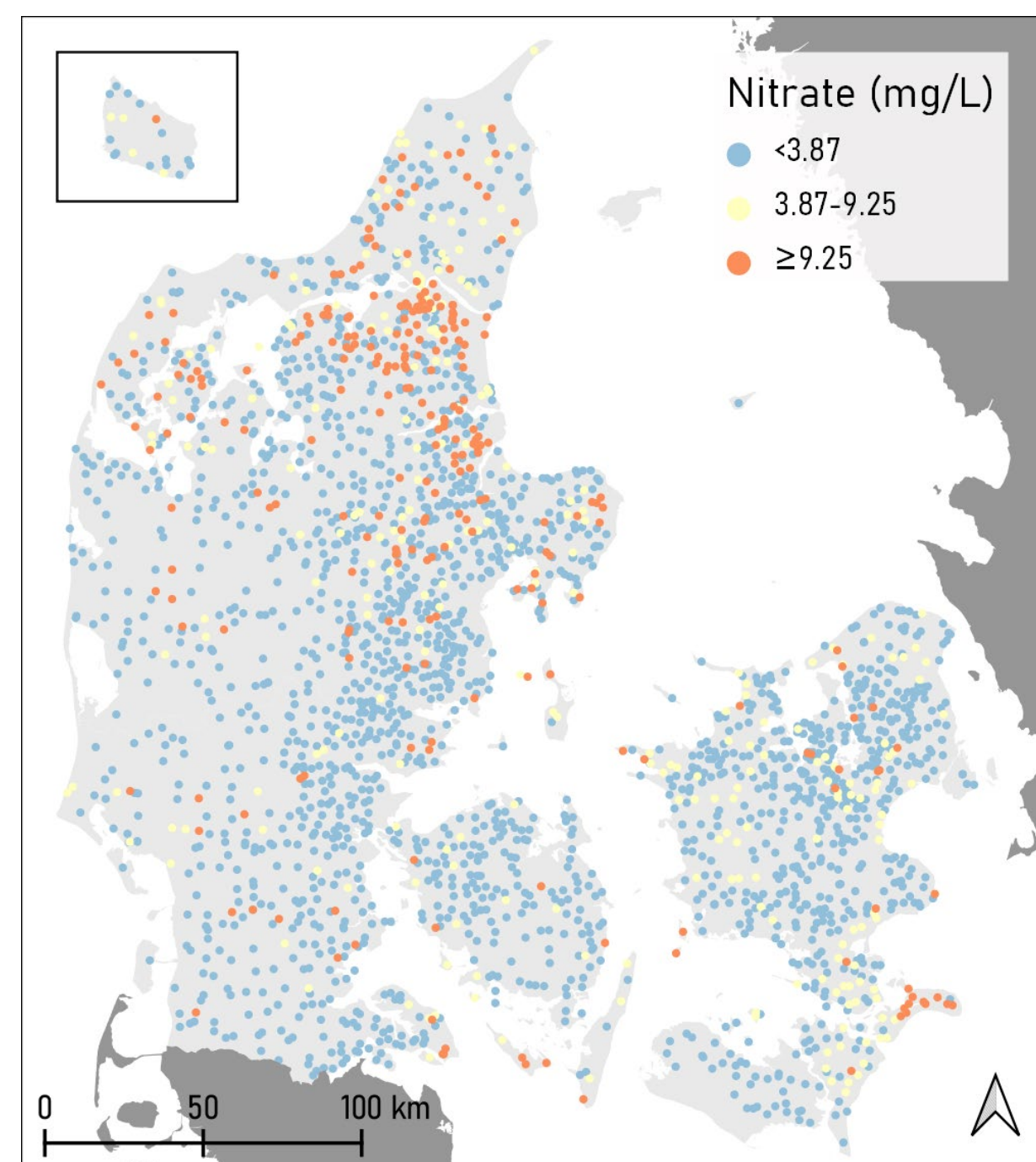


Figure 3: Average nitrate at public water production facilities in Denmark 2018-2021<sup>15</sup>

## EVALUATION OF DRINKING WATER STANDARD

The new evidence has initiated a re-assessment of the drinking water standard for nitrate by the Danish administration. An expert committee is expected to report a suggestion for a potentially new, health-based drinking water quality criterion by the end of 2025.

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