



Dr Tim Chambers

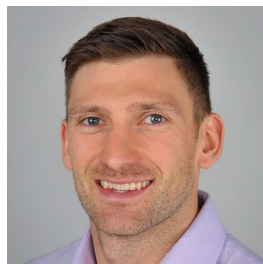
Nitrates – Are they an emerging risk?

University of Otago



water
NEW ZEALAND
CONFERENCE & EXPO
17-19 OCTOBER 2023
Tākina, Te Whanganui-a-Tara Wellington

Team and funding



Nitrate contamination in New Zealand

Nitrate in New Zealand

70% increase in dairy cattle
(3.8 million to 6.5 million 1994-2017)

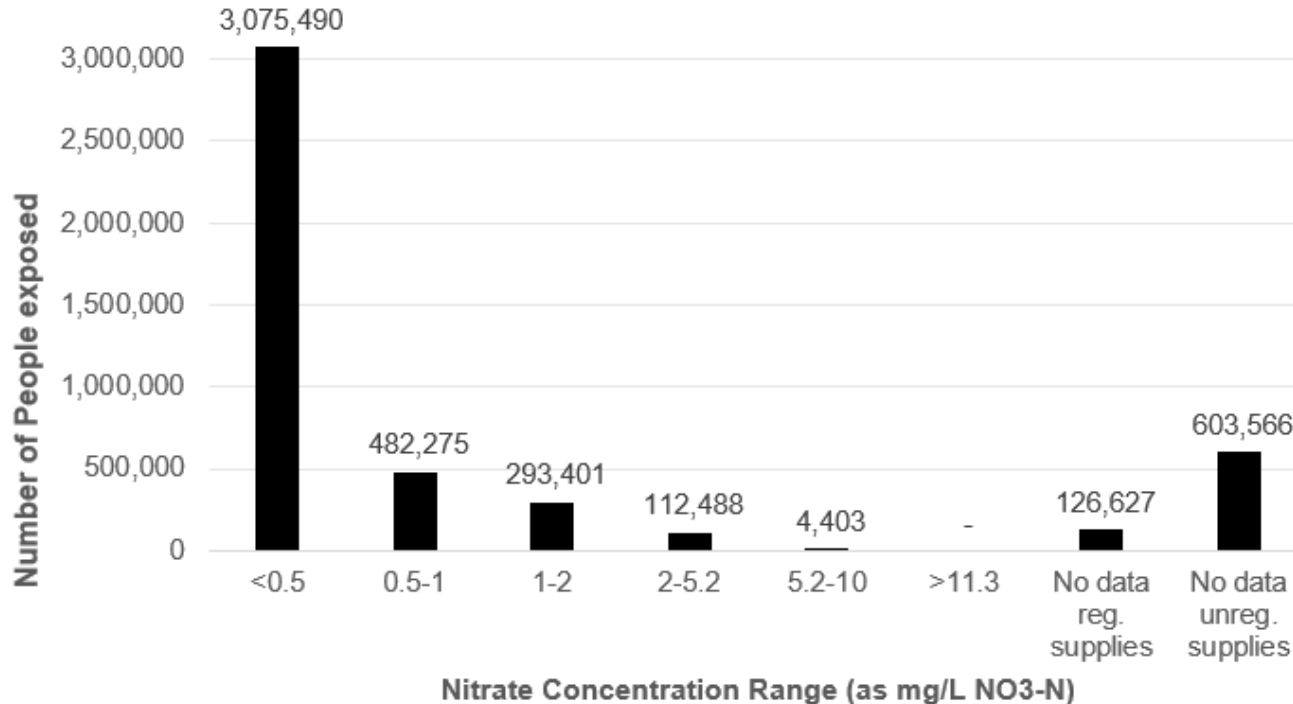
Six-fold increase in the use of
nitrogen fertilisers
(59,000 tonnes to 429,000 tonnes)

Area under irrigation increased
91% from 2002 to 2019



Nitrate in drinking water

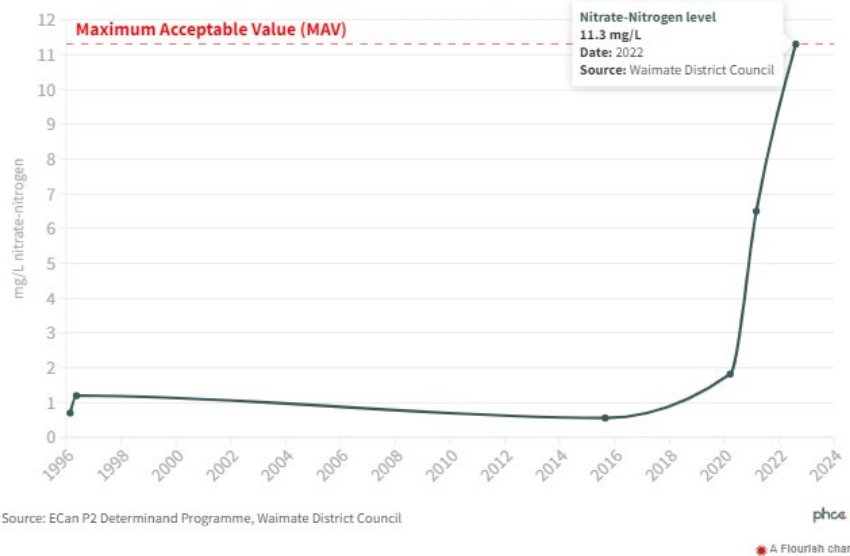
2020 – registered supplies



Registered supplies

Contamination events

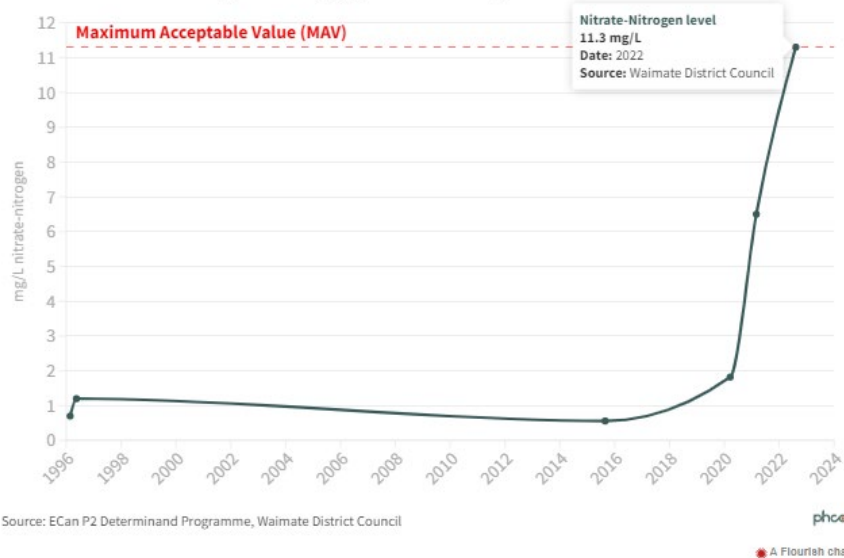
Lower Waihao Drinking water supply nitrate-nitrogen



Registered supplies

Contamination events

Lower Waihao Drinking water supply nitrate-nitrogen

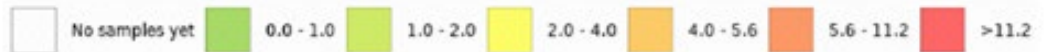
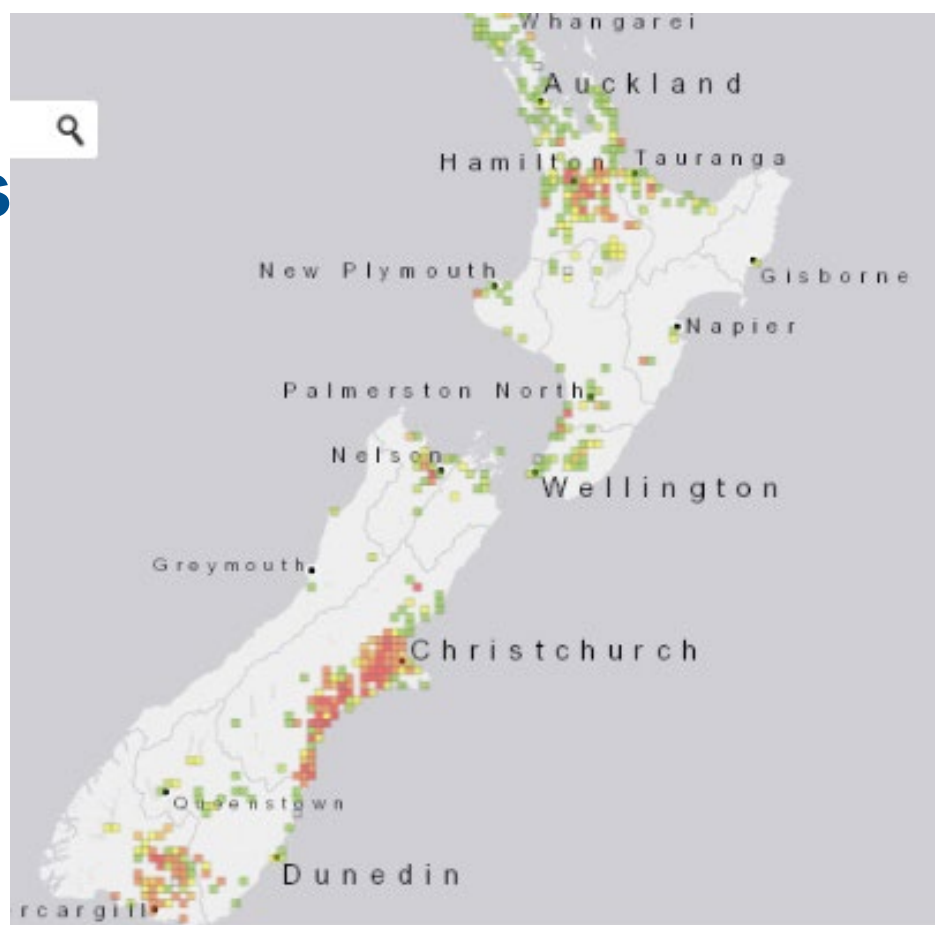


Water supplies	Population Served	Current NO ₃ -N	5 th to 95 th percentile (mg/L)
Christchurch	342,000	0.7	(3.0- 7.6)
Waimakariri	53,800	1.9	(3.0-8.3)

Unregistered supplies

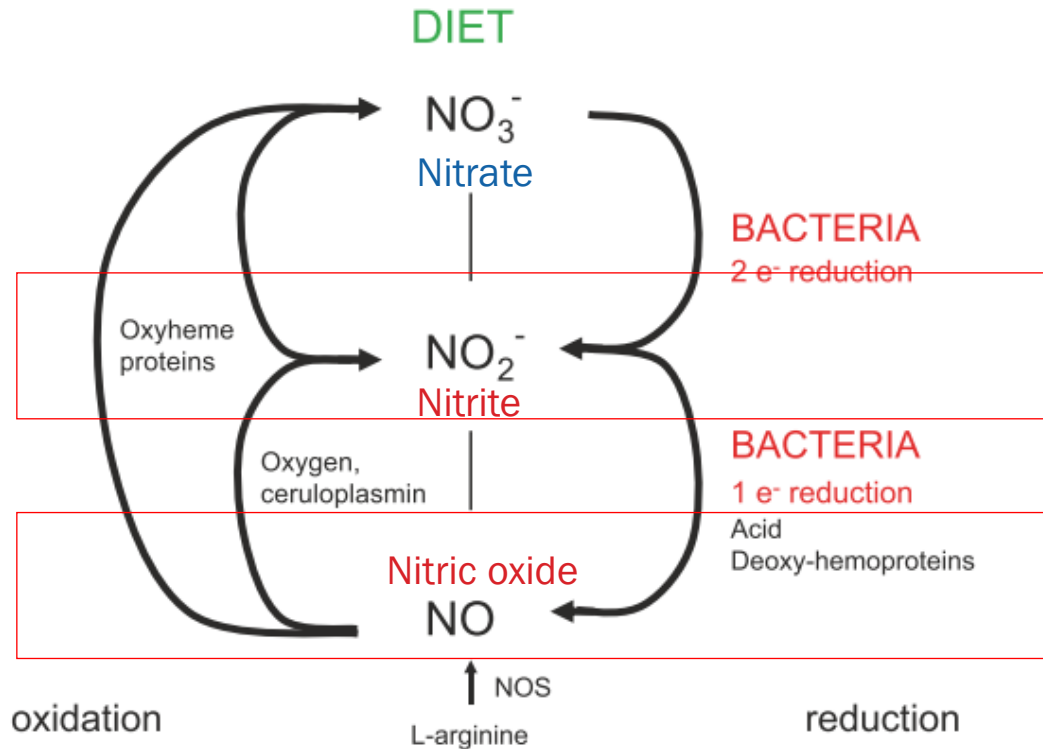


GREENPEACE



Nitrate and health

Nitrate metabolism



Current nitrate limit

WHO set nitrate limit 11.3 mg/L
nitrate-nitrogen (50mg/L as nitrate)
based on risk of Blue Baby Syndrome
in 1950

Same limit adopted in NZ drinking
water standards



Nitrate is reduced to nitrite



nitrite

binds to haemoglobin



formation methaemoglobin



less oxygen carried in blood
+ oxidative stress



Methaemoglobinemia

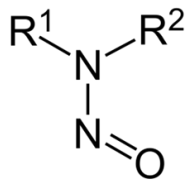
Nitrate and preterm births

Births <37 weeks

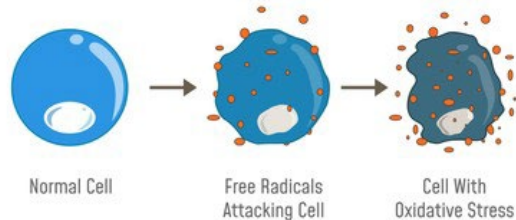
Leading cause of infant mortality
(23% of deaths)



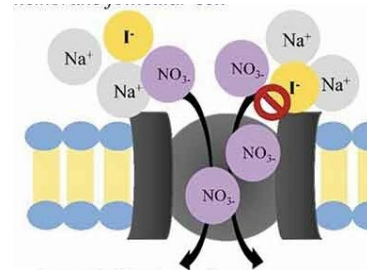
N-nitroso compounds (NOC)
e.g. N-nitrosamines



OXIDATIVE STRESS



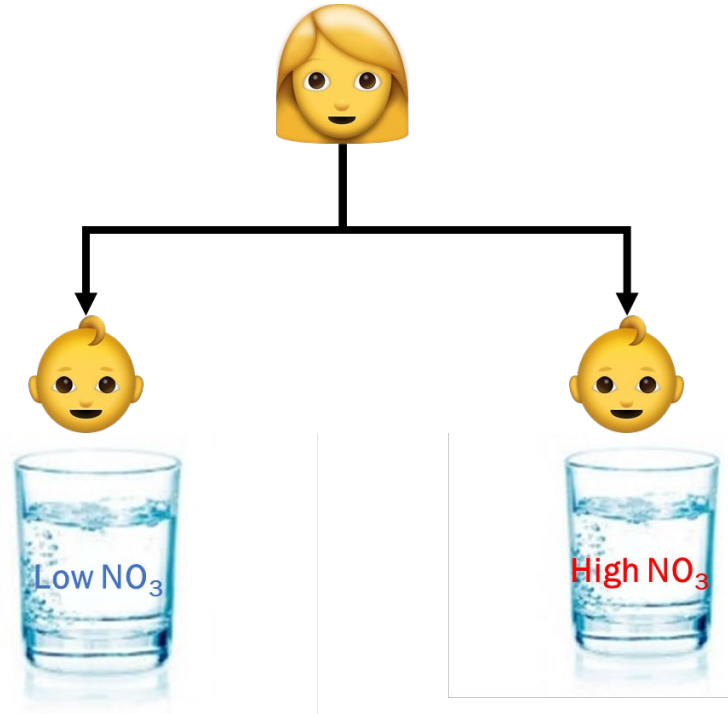
Thyroid dysfunction



Nitrate and preterm births

Stanford Study (2022)

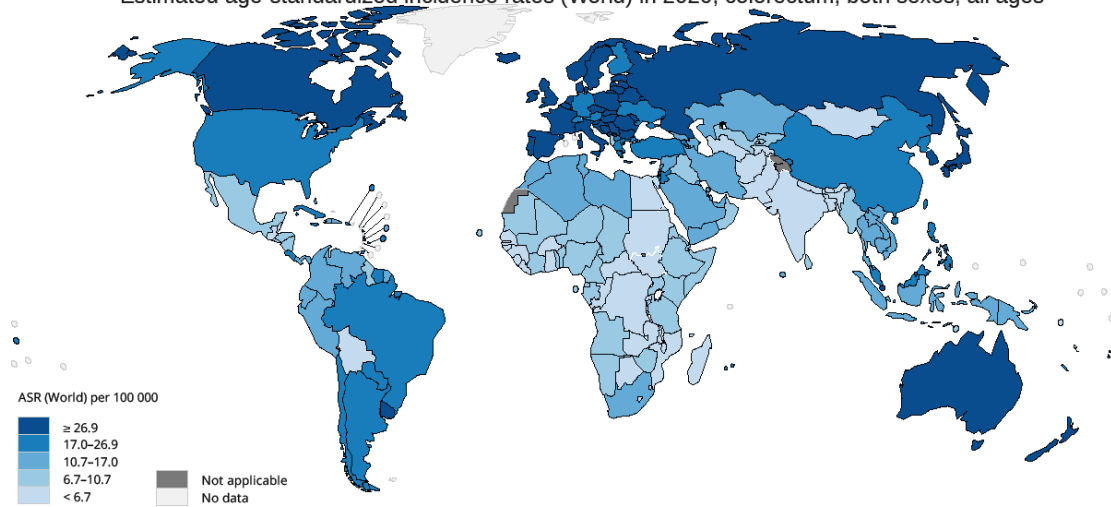
- 4.6 million births from 2000-2011
- 47% increase in risk of preterm birth (<32 weeks) where nitrate in drinking water **5 to 10 mg/L NO₃-N** compared to <5mg/L



Bowel cancer

Each year approximately 1,200 people in NZ die of bowel

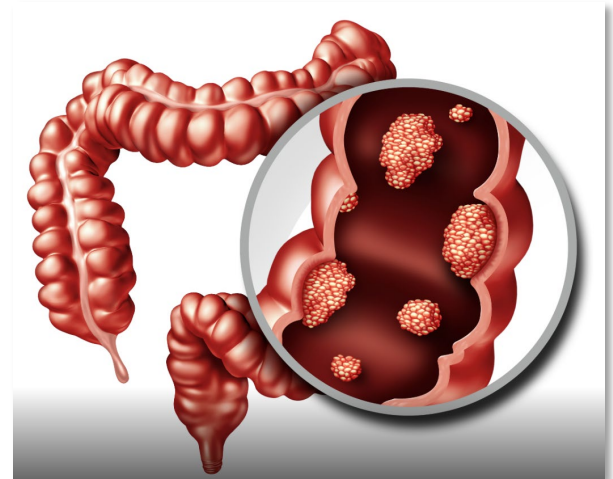
Estimated age-standardized incidence rates (World) in 2020, colorectum, both sexes, all ages

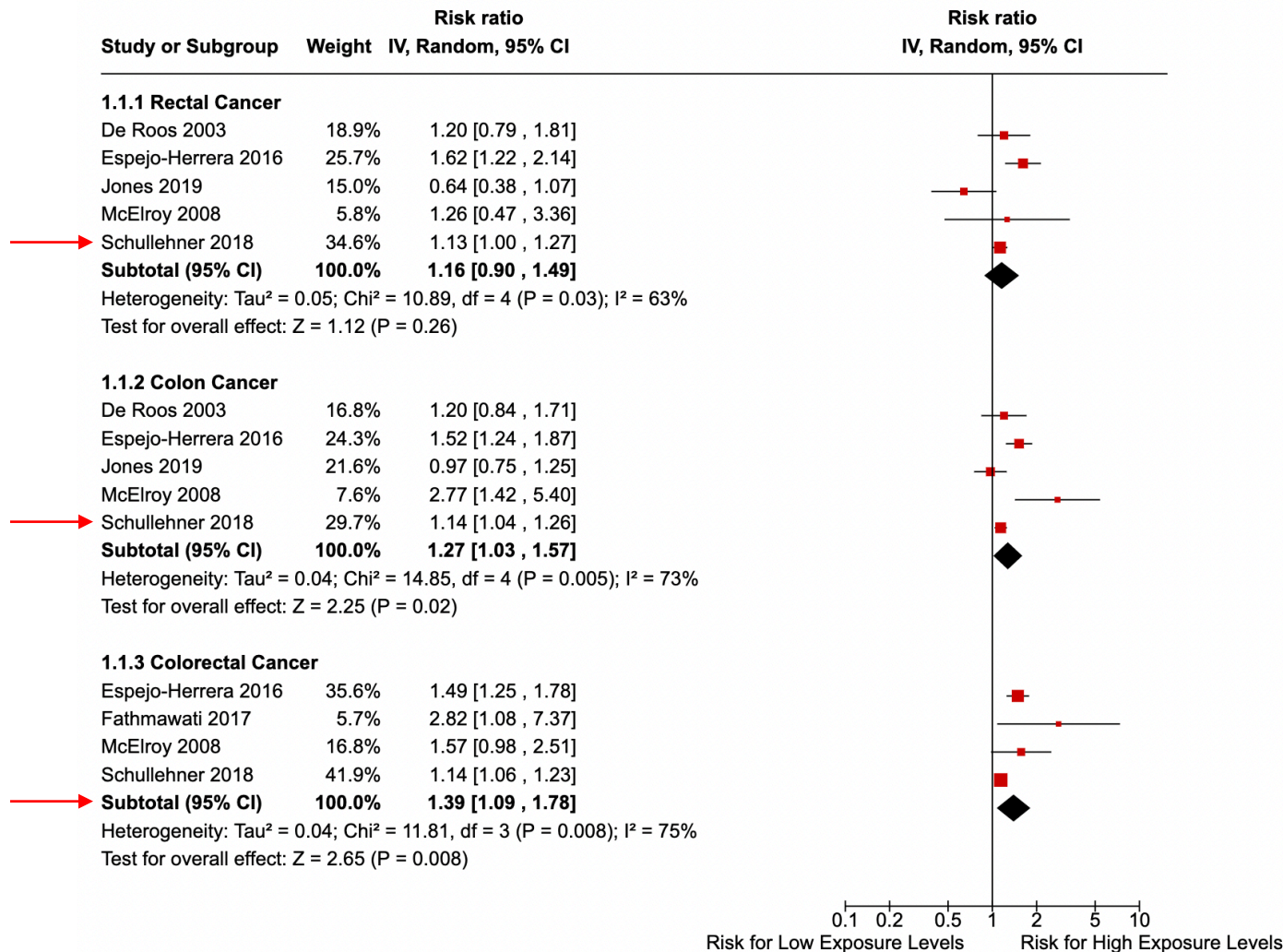


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Data source: GLOBOCAN 2020
Map production: IARC
(<http://go.iarc.fr/today>)
World Health Organization

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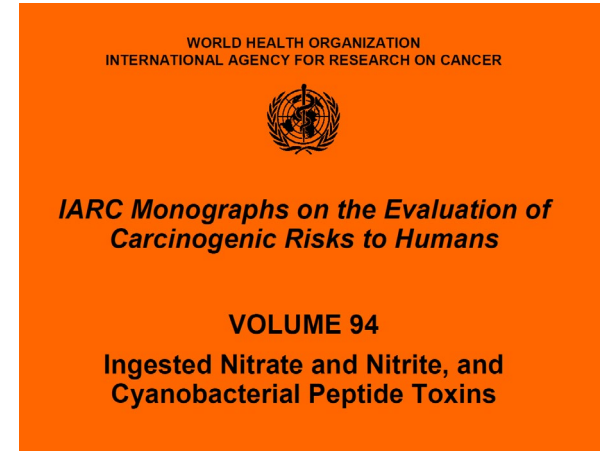


Agency responses

International Agency for Research on Cancer (IARC, 2010)

Studies up until 2006

“Ingested nitrate or nitrite under conditions that result in endogenous nitrosation is **probably** carcinogenic to humans (group 2A)”





Agency responses

World Health Organization (2019)

Tel. direct: +41 22 791 1540
E-mail: defrancosj@who.int

In reply please
refer to:

Your reference:

Dr Caroline McElnay
Director of Public Health
Ministry of Health New Zealand
133 Molesworth Street
PO Box 5013
Wellington 6140
New Zealand

ACT 1982

“There is a biological plausibility of endogenous nitrosation of ingested nitrate and nitrite which **could potentially** cause cancer in humans”

However

“the weight of evidence does not support an association between cancer and exposure to nitrate or nitrite **per se.**”

Agency responses

French Agency for Food, Environmental and Occupational Health & Safety (2022)

“There is an association between the risk of bowel cancer and exposure to nitrites and/or nitrates, whether they are ingested via the consumption of processed meat or drinking water.”

And recommended

”assessing, in light of new epidemiological and toxicological data, the relevance of the quality limit of 11.3 mg L of nitrates in drinking water.”



anses

Uncertainties

- Conversion of nitrate to nitrite (5-20% interpersonal variation)
- Other dietary sources of nitrite/nitrate (processed meats)
- Impact of antioxidants
- Not all NOC are carcinogens
- And much more...

Treatment options

Reverse osmosis and ion exchange

Registered supplies = \$750,000 (Waimate), \$6M (Selwyn), \$610M (Christchurch)

Unregistered supplies = low-end \$500-\$1000 to \$10,000s

Nitrates – Are they an emerging risk

YES

- Increasing levels of contamination in environmental monitoring sites, registered and unregistered supplies
- Uncertainties around potential adverse health outcomes
- Cost of treatment and groundwater lags

Current work

Outcome data: IDI back to 2008 – (700,000 births)

Exposure: Regional, district and city council data + modelling + community nitrate testing

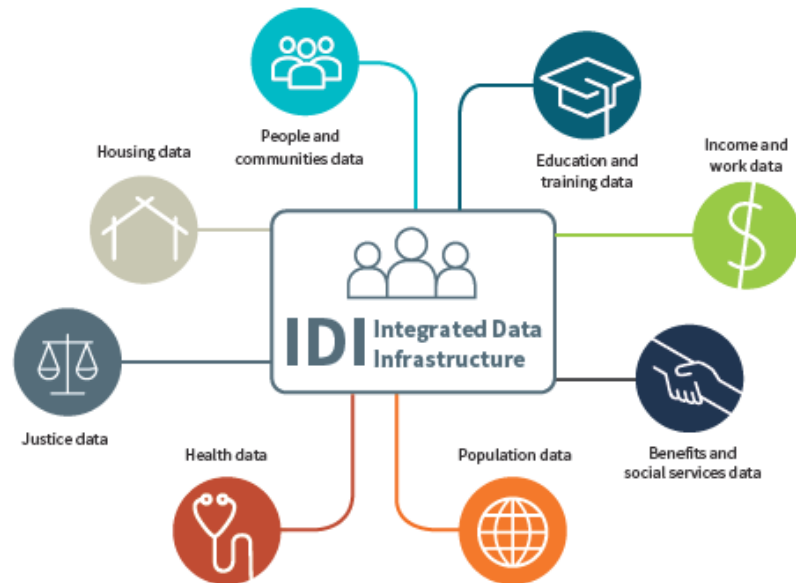
hrc**nz**

Stuff.co.nz

Nitrate risk to unborn babies to be measured in \$1.2 million

...

The results found the risk of early preterm birth (where an infant is born at least nine weeks early) increased by half when nitrates in...



Thank you

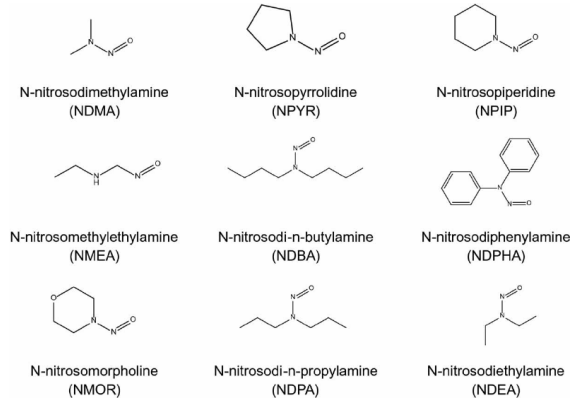
tim.chambers@Otago.ac.nz

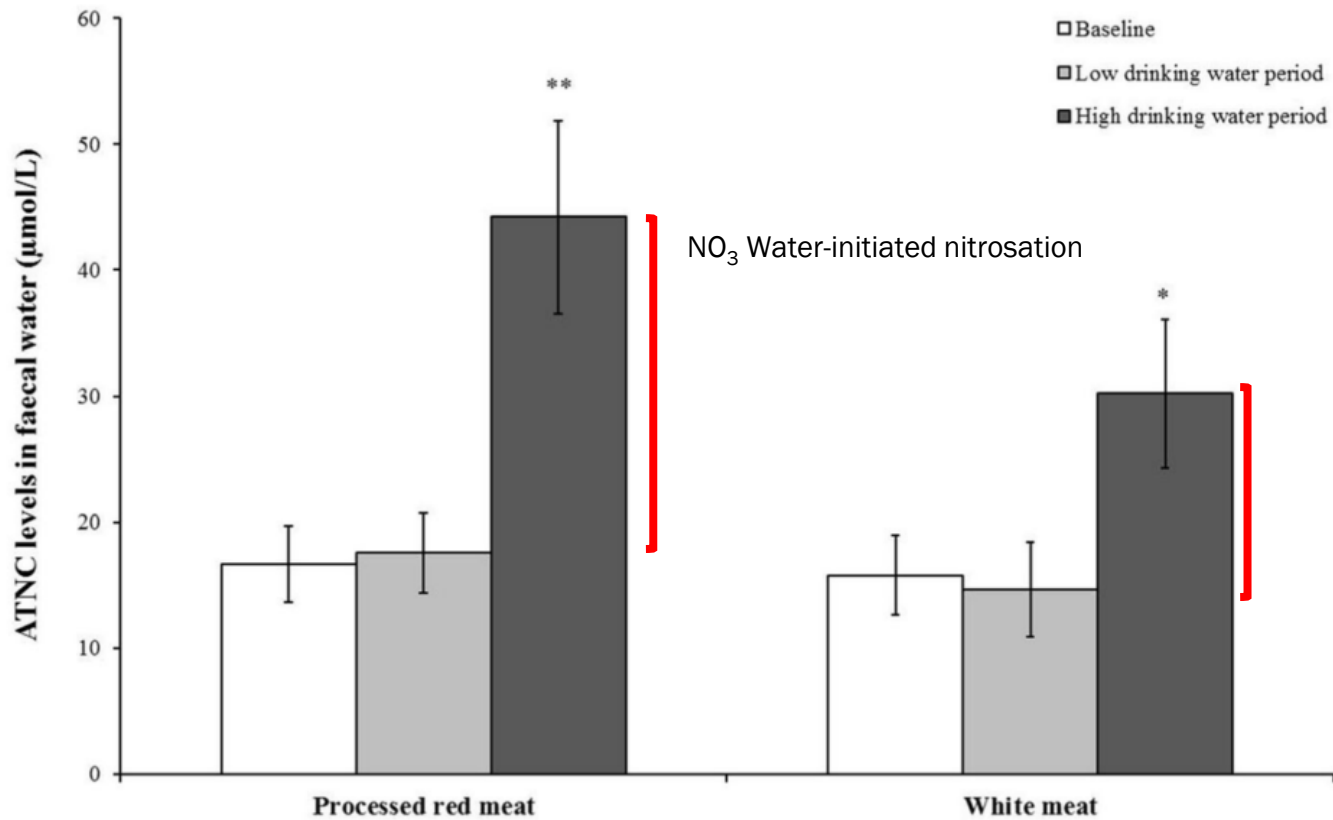
N-Nitroso Compounds

Form N-Nitroso Compounds – “NOC” (90% tested are known carcinogens)

Proteins + nitrosating agents (e.g. nitrite + nitric oxide)

Antioxidants (Vitamin C, Green tea)





van Breda SG, Mathijs K, Sági-Kiss V, Kuhnle GG, Van der Veer B, Jones RR *et al.* Impact of high drinking water nitrate levels on the endogenous formation of apparent N-nitroso compounds in combination with meat intake in healthy volunteers. *Environmental Health*. 2019;18(1):87. <https://doi.org/10.1186/s12940-019-0525-z>

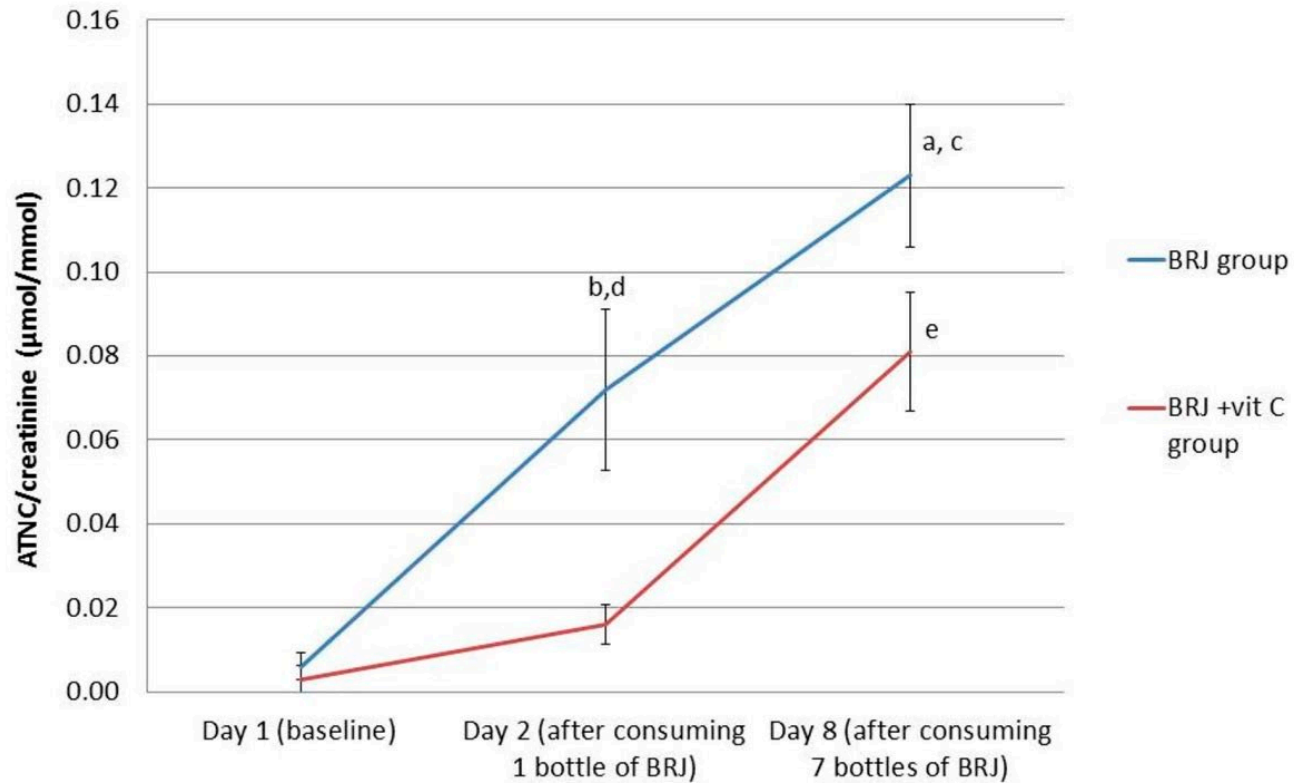


Figure from Randomised control trial by Berends 2019 – 1000mg Vitamin C

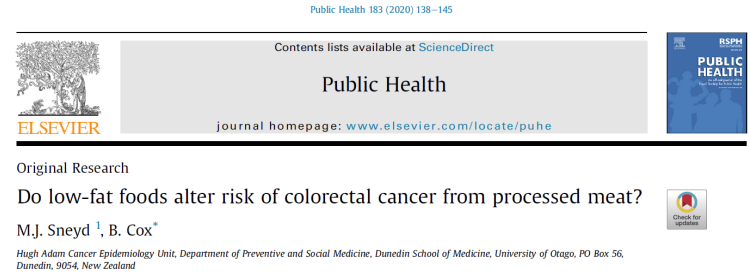
In NZ - 99mg Vitamin C per day (NZ Nutrition Survey 2008)

Nitrate and bowel cancer

Established case-control study of ~800 bowel cancer cases

Test the association between nitrate and bowel cancer, adjusting for established risk factors including alcohol and tobacco use, diet, body mass index and physical activity.

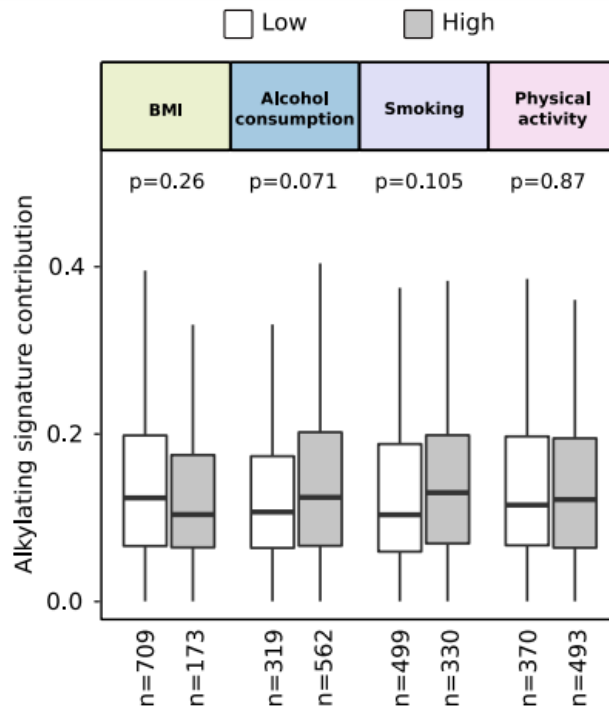
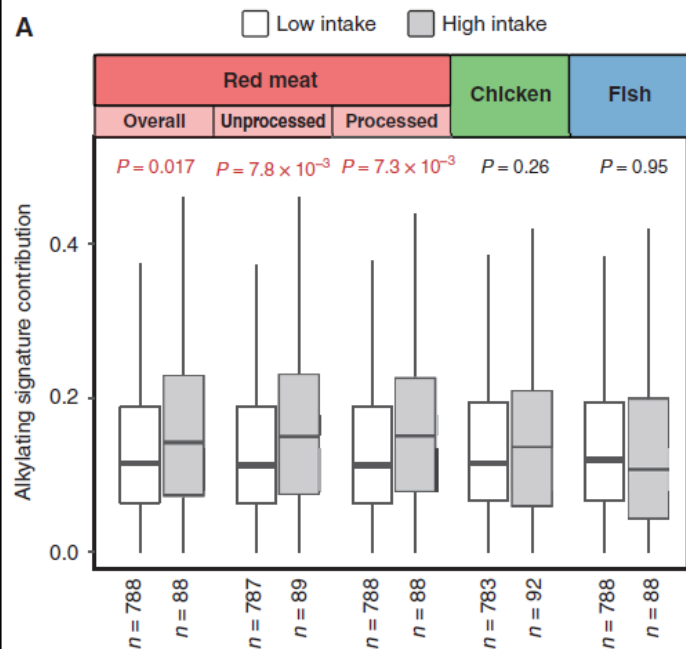
Biopsies of cases are still available and could be re-analysed to investigate whether nitrate exposure was associated with a specific type of DNA damage



Discovery and Features of an Alkylating Signature in Colorectal Cancer



A



Nitrate and preterm births

Meta-analysis 2023 Lin

