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Elevated sodium concentrations in Australian drinking water supplies

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Elevated sodium concentrations in Australian drinking water supplies

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Abstract. Salt in the drinking water of many Australian water supplies could be adversely contributing to the ill-health of many people. Health care professionals often recommend low-sodium diets for patients with kidney disease, heart disease and cardiovascular disease. It is recommended that people on a low-sodium diet drink water with less than 20 mg/L of sodium. The sodium concentration of water supplies in many regional and remote regions of Australia often had water with elevated sodium (more than 20 mg/L) in their water supplies. In NSW 17 of the 21 regional water supplies tested had higher than 20 mg/L sodium. The issue of elevated sodium in many Australian drinking water supplies needs to be recognised more prominently. Sodium needs to be sampled more frequently and the results shared openly with consumers and health professionals. All water authorities that provide drinking water with sodium concentrations higher than 20 mg/L should be advising their customers of this fact as a high priority. People on low-sodium diets that have >20 mg/L sodium in their water supply should consider options to obtain low-sodium water.

1. Sodium in drinking water

The United Nations Sustainable Development Goals (SDGs) include ‘Clean water and sanitation’ as a ‘Sustainable Development Goal #6’ [1]. The United Nations estimate that 30% of people worldwide do not have access to safely managed drinking water [1]. The most important international guidelines for safe drinking water are produced by the World Health Organisation (WHO) [2]. WHO has comprehensive guidelines for the safe management of drinking water [2]. The guidelines include a risk-based framework for protecting and managing safe drinking water supplies. Australia has developed its own drinking water guidelines, called the Australian Drinking Water Guidelines [3], often based on the international WHO guidelines [2].

People are encouraged to drink water as part of a healthy diet. Australian dietary guidelines recommend 2.6 L per day for adult males and 2.1 L per day for adult females [4]. A common water quality issue across Australia is that many drinking water supplies have elevated salt and mineral contents. This may be unpalatable, and it may also cause issues with enriched mineral content causing the build-up of minerals and often the corrosion of electrical appliances. Salt in drinking water can also potentially have human-health consequences [5].

This is a particularly important issue for people who suffer health issues that require a low-sodium diet. A key component of ‘salt’ in drinking water is sodium [5]. It is also widely identified as a quantifiable element of our diets that is also an important contributing factor to many chronic health conditions. Australia’s National Health and Medical Research Council (NHMRC) identify dietary



sodium as a priority given the critical link between dietary sodium intake and blood pressure [6]. Currently NHMRC recommended that Australians consume less than 2,000mg of sodium per day [6]. Hypertension is high blood pressure and is a major health issue in Australia. It is a well-established risk factor for cardiovascular disease, kidney disease and strokes [6]. Medical and health care professionals may recommend low-sodium diets for people with a range of health conditions, including high blood-pressure, kidney disease and cardiovascular disease [6]. People suffering high blood pressure, cardiovascular disease or kidney disease need to consider all sources of dietary sodium, including drinking water [7]. It is generally recommended that people on low sodium diets drink water with less than 20 mg/L of sodium [7].

WHO do not provide a health guidelines for sodium in water [2]. They quote the uncertain link between elevated sodium in water and hypertension. They quote:

No firm conclusions can be drawn concerning the possible association between sodium in drinking-water and the occurrence of hypertension. Therefore, no health-based guideline value is proposed. However, concentrations in excess of 200 mg/L may give rise to unacceptable taste (see chapter 10)

Australian water supplies are managed to achieve compliance with the Australian Drinking Water Guidelines [3]. They have adopted a similar approach to WHO and their advice on sodium in drinking water states:

'Based on aesthetic considerations (taste), the concentration of sodium in drinking water should not exceed 180 mg/L. No health-based guideline value is proposed for sodium. Medical practitioners treating people with severe hypertension or congestive heart failure should be aware if the sodium concentration in the patient's drinking water exceeds 20 mg/L.'

The aim of this study was to explore the issue of elevated sodium concentrations across a selection of Australia water supplies. The information gap that we wanted this research to address was the lack of awareness regarding the health risks of elevated sodium in Australian drinking water supplies. We sought to gain an overview of concentrations of sodium in major city and also in smaller regional town and city water supplies. We believe that this information gap is partly due to inappropriate water quality guidelines being used for sodium in Australian drinking water. The current study is a pilot study for a larger future and more comprehensive study. We investigated water supplies across all Australian capital cities and also from a range of regional settlements in two states, New South Wales (NSW) and Western Australia (WA).

2. Methodology

We collected publicly available information on the sodium content of drinking water in Australian capital cities (see figure 1). We were fortunate that many of Australia's largest water supply authorities had extensive drinking water quality information freely available, which included sodium information (table 1). However, water quality data reported often failed to include sodium, particular for water suppliers in smaller settlements who often did not provide detailed water quality data. When data was not available for capitals cities, we directly approached water authorities for representative data on water sodium concentrations (table 1).

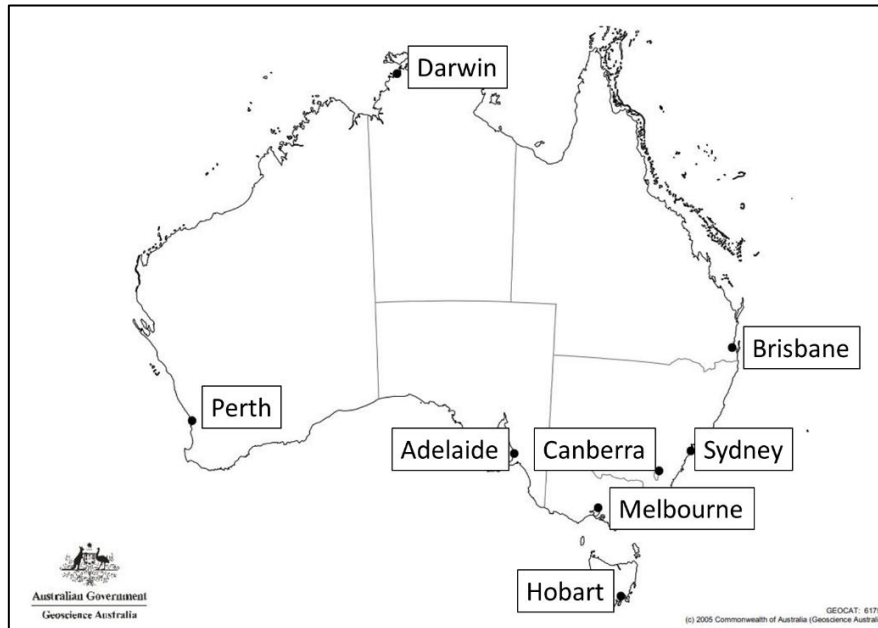


Figure 1. Map of Australia showing capital cities.

Table 1. Source of sodium data for Australian capital cities.

City	Water authority	Name of report / other source of information	Sodium statistics (mg/L)
WA / Perth	Water Corporation	Water Corporation Drinking Water Quality Annual Report 2016-17 [8]	See figure 2
Darwin	Power and Water Corporation	Annual Drinking Water Report 2016 [9]	3.0 (Mean)
Melbourne (1)	South East Water	Annual Drinking Water Quality Report 2016-17 [10]	4.5 (mean)
Melbourne (2)	City West Water	Drinking Water Quality Report 2017 [11]	6.1 (mean)
Melbourne (3)	Yarra Valley Water	Drinking Water Quality Report 2016/17 [12]	6.0 (mean)
Canberra	Icon Water	Annual Drinking Water Quality Report 2016-17 [13]	3.4 (mean)
Brisbane	Queensland Urban Utilities	Drinking Water Quality Management Plan Report 2016/17 [14]	40 (median)
Adelaide	SA Water	https://www.sawater.com.au/community-and-environment/water-quality/in-your-area-whats-in-your-water/central-metro (For Central Metro Adelaide)	51.5
Hobart	TasWater	Data was provided on request	4.5 (mean)
Sydney	Sydney Water	Data was provided on request for the main supply (Prospect)	16.1 (mean)

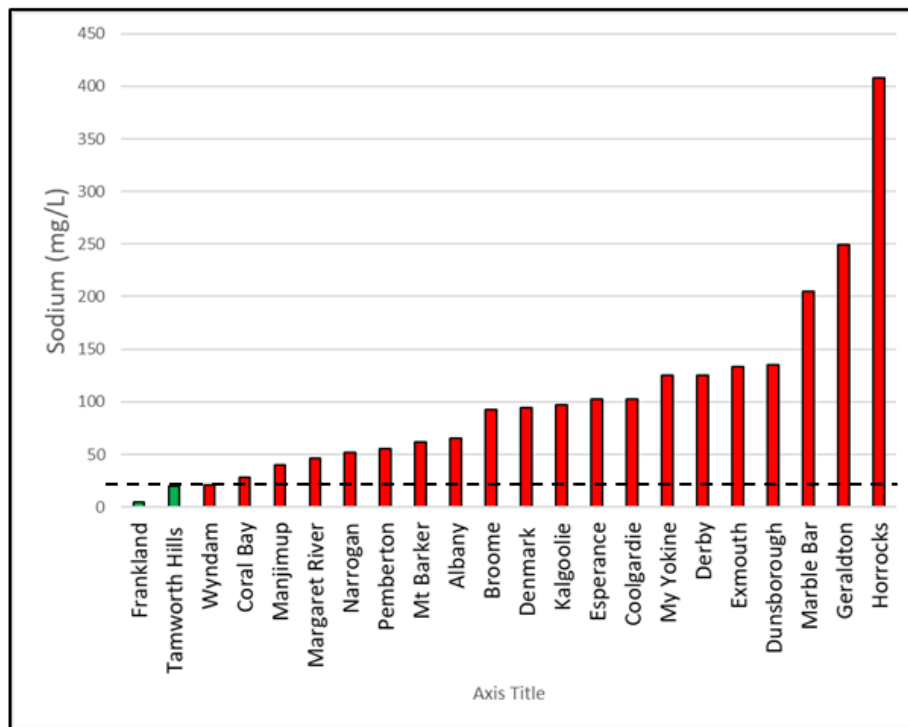


Figure 2. Mean sodium concentrations from Western Australian water supplies. They were chosen to represent the largest settlements across the state, and results for supplies with the highest and lowest sodium concentrations. The sodium results are shaded green if they are if they are equal or less than 20 mg/L. They are shaded red if they are higher than 20 mg/L (indicated by dotted line).

We also compared sodium concentrations in regional water supplies across two Australian states; NSW in south eastern Australia and western Australia (WA). There was particularly comprehensive water quality data available for WA regional water supplies. This was contained in the WA Water Corporation's Drinking Water Quality Annual Report 2016-17 [8] and we selected sodium results for the largest settlements across Western Australia and a range of locations representing the lowest to the highest concentrations [8].

It was not possible to source publicly available data on sodium concentrations from regional settlements in NSW. Most of the water supplies in regional NSW are owned and managed by local Government and many did not report sodium concentrations. To gather comparative data, we collected samples directly from a range of NSW settlements. Single (or duplicate) water samples were collected from taps from western NSW (Broken Hill), the Riverina in southern NSW (Wagga Wagga), the Southern Highlands (Berrima) and many settlements across Central Western and North Western NSW (Dubbo, Orange, Coolah). We deliberately collected water from taps to represent water quality that was being consumed by people. Rather than collect and test many samples from a few locations, we chose to collect a few samples from many locations. We did this to increase the spatial scope of the study. The current study, particularly for drinking water across NSW, is a pilot study for a more detailed future study. Samples were collected from taps in plastic containers and analysed for major cations, including sodium, using standard methods at a commercial National Association of Testing Authorities (NATA) accredited laboratory (figure 3).

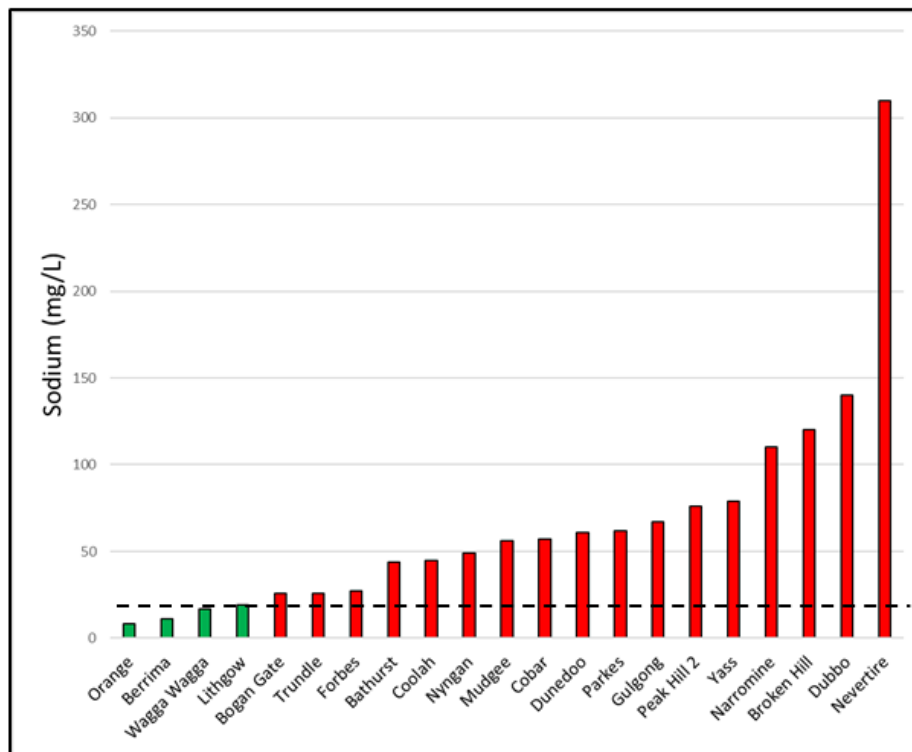


Figure 3. Sodium concentrations obtained from samples collected from 20 water supplies from NSW regional settlements. Results are shaded green if they are equal or less than 20 mg/L. They are shaded red if they are higher than 20 mg/L (indicated by dotted line).

3. Results and discussion

The sodium concentration in Australian Capital city water supplies (table 1; figures 2-4) were generally lower than regional WA and NSW water supplies. The majority of Australian Capital city water supplies (Darwin, Hobart, Melbourne, Sydney and one Perth supply) had water of 20 mg/L (or less) of sodium. The sodium content of Capital cities varied from a low of 3 mg/L in Darwin (Northern Territory), then Canberra 3.4 mg/L. Melbourne mean sodium levels ranged from 4.5 to 6.1 mg/L in water supplies managed by their three water retailers. The sodium level was 16.1 mg/L for Sydney, and Tamworth Hill supply in Perth was 20 mg/L. This indicates that most of Australia's largest [15] urban populations (Sydney, Melbourne, Canberra, Hobart and Darwin) have sodium in drinking water of less than 20 mg/L (figure 4). The other major urban populations (Brisbane, Adelaide, and most of Perth) have much higher sodium concentrations in their water supply (figure 4). Brisbane and Ipswich had a sodium concentration of 40 mg/L and Adelaide's Central Metropolitan supply was 51.5 mg/L. Perth has multiple water supply locations [8]. They had a range of sodium concentrations ranging from Tamworth Hills (mean 20 mg/L) to Mt Yorkine (mean 125 mg/L), which was the highest Australian sodium concentration [8].

Generally, the sodium content was much higher in regional NSW (figure 3) and WA (figure 2) water supplies than it was in Australian Capital cities (figure 4). The sodium concentration of samples from NSW water supplies (figure 3) varied from a low of 8.4 mg/L from Orange (figure 3). Three other regional NSW water supplies (Berrima, Wagga Wagga and Lithgow) also had sodium concentration less than 20 mg/L (figure 3). 13 of the 20 NSW water samples had intermediate sodium levels, ranging from 26 mg/L at Bogan Gate to 79 mg/L from Yass. There were four samples that had the most highly elevated sodium concentrations, ranging from Narromine (110 mg/L), then Broken Hill (120 mg/L) and Dubbo (140 mg/L; figure 3). The sodium content may have been increased due to

drought as Dubbo Regional Council report that its water generally has a sodium level less than 60 mg/L [16].

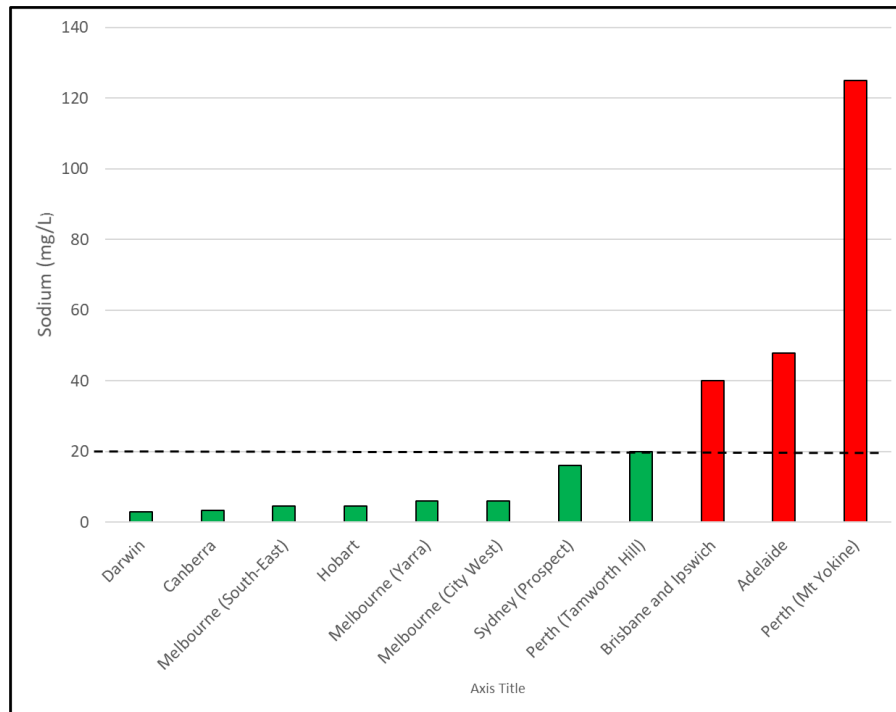


Figure 4. Sodium concentrations obtained for Capital City water supplies in Australia. Melbourne is represented by three water retail supplies (Yarra Water; South East Water and City West Water). Perth is represented by Tamworth Hill and Mt Yorkine which were the two supplies within Perth containing their lowest and highest sodium concentrations.

The highest sodium concentration obtained from a regional NSW supply was a sample from Nevertire, with 310 mg/L, which was suspected as being elevated due to the use of a water softening agent (figure 3) [17]. Water softening agents add sodium and reduce calcium and magnesium to reduce the hardness of water. Use of water softening has been shown to increase sodium content of water by 2.5 times [17].

The sodium concentration of WA water supplies (figure 2) varied from a low of 5 mg/L from Frankland and Tamworth Hill (20 mg/L). These were the only two less than 20 mg/L. The others ranged from Wyndam with 21 mg/L to Geraldton 249 mg/L. The highest result was obtained for Horrocks with 408 mg/L (figure 2).

This is not the first study to highlight the issue of elevated sodium in drinking water supplies. For example, research in coastal Bangladesh have found that both pregnant women and the wider population consuming water with higher sodium content had significantly higher blood pressure [18-20]. It has been suggested that rising salinity in water supplies will be a growing global issue due to climate change, rising ocean levels and saline intrusion into groundwater [20]. Elevated dietary sodium has a strong association with rising incidence hypertension in many global populations [5]. The health risks associated with elevated concentrations of sodium in diet through food is very well known [5], but elevated sodium in water supplies is not as well understood, yet deserves further recognition [18-20].

4. Conclusions

This case study demonstrates that sodium levels in Australian water supplies vary widely. Despite being such an important attribute of drinking water, it was very difficult to source freely available data on sodium in many water supplies, particularly in regional locations in NSW. The data presented in this study shows that many water supplies had water containing more than 20 mg/L of sodium. Whilst water may only form a small proportion of dietary sodium for many people, it is an important issue for those suffering hypertension, cardiovascular disease or kidney disease [5-7]. Cardiovascular disease was an underlying cause of approximately 29% of all deaths in Australia in 2015 [21]. Every aspect of dietary sodium plays a role in this enormous burden of disease in modern society, including the consumption of water (> 20 mg/L sodium) by people with underlying health issues. People suffering from cardiovascular disease, kidney disease or high blood pressure are advised to have a low sodium diet and drink water with less than 20 mg/L [5-7]. We are concerned that the Australian Drinking Water Guidelines categorise sodium as an 'aesthetic' attribute of water quality as it can impart a salty taste at highly elevated concentration [3]. This translates into an Australian guideline of 180 mg/L [3]. One of the consequences of the ADWG guideline for sodium is that water authorities regard it as a low priority. This reduces its frequency of measurement and often sodium results are not published. And worst of all, people consuming water with elevated sodium are often doing so without realising that it may be very harmful. We believe that this pilot study demonstrates that many water supplies are providing water with elevated sodium content that contributes to the ill-health of many people. We suggest that the issue of elevated sodium in many water supplies is an inadequately studied environmental health issue. It deserves wider and more prominent recognition across all sectors of society, including water consumers, the water industry and the health industry.

5. Recommendations

We recommend that the following actions are implemented by water supply authorities and relevant agencies within Government and the wider community:

- The United Nations Sustainable Development Goals #3 (Good Health and Wellbeing), #6 (Clean Water and Sanitation) [1] should be adopted as guiding principles for the supply of clean and safe drinking water for all Australian water supplies.
- Dietary sodium is a well-established risk factor for common illnesses including hypertension, cardiovascular disease and kidney disease. As many people require low-sodium diets they need to be aware of sodium in drinking water.
- Water testing of all public water supplies should be regularly tested for sodium (at weekly or monthly intervals).
- All water supplies that supply water with higher than 20 mg/L need to notify residents and also medical and health professionals (within the supply district) of the risk to people with health conditions requiring low-sodium diets.
- People living in water supply districts with elevated sodium (>20 mg/L) who are on low-sodium diets should consider drinking treated, or bottled water, with lower sodium concentrations (<20 mg/L).
- Cardiovascular disease is a leading cause of death in Australia [21] and excessive sodium in the diet is a major contributing factor. The water industry needs to acknowledge its important role and treat sodium as a key health-related attribute of water quality.

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