Australian Government
National Health and Medical Research Council

NHMRC

Iodine evidence summary report

Summary of the evidence used to inform development of Iodine Nutrient Reference Values for Australia and New Zealand

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Contents

Purpose

This report has been prepared to inform the review of the Australian and New Zealand Nutrient Reference Values for iodine. It aims to summarise the body of evidence considered by the Iodine Expert Working Group and document the process for deriving NRV recommendations.

The report includes evidence from the following sources:

- Studies identified during an NHMRC-commissioned review (see 'Appendix D - Outcomes from review of primary studies')
- Evidence reviews commissioned or conducted by comparable international bodies for the purposes of establishing iodine nutrient reference values:
  - Nordic Nutrition Recommendations (2023) - *Iodine: a scoping review for Nordic Nutrition Recommendations 2023* (Blomhoff et al. 2023)
  - EFSA (2014) - *Scientific Opinion on Dietary Reference Values for Iodine*
  - EURRECA (2013) - *Estimating Iodine Requirements for Deriving Dietary Reference Values* (Ristić-Medić 2013)
- Other reports published by key international bodies relevant to establishing iodine nutrient reference values:
  - UK SACN
    - *SACN Statement on Iodine and Health* (2014)
    - *Statement on the potential effects that excess iodine intake may have during preconception, pregnancy and lactation* (2022)
  - WHO & FAO (2004) - *Vitamin and mineral requirements in human nutrition*
  - WHO (2013) - *Urinary iodine concentrations for determining iodine status in populations*
- Relevant systematic reviews published within the previous 10 years, with an emphasis on high quality, more recent systematic reviews (see 'Appendix C'
- Primary evidence or data relevant to the Australian and New Zealand context

Further information about the approach for identifying evidence is presented in 'Appendix A - Methods for identifying evidence'.

Iodine background

Function, physiology and metabolism

Iodine is a mineral that is found in soil and ocean waters and is naturally present in certain foods as inorganic iodide. It is an essential nutrient required for synthesis of thyroid hormones such as thyroxine (T4) and triiodothyronine (T3). These hormones are involved in regulating cellular processes including metabolism, cellular oxidation and thermoregulation. They also play an essential role in early development, growth and maturation of organs including the brain, muscles, heart, pituitary gland, kidneys reproductive system and bones (EFSA 2014). Consequently, it is imperative that individuals are iodine sufficient during pregnancy and lactation, to ensure healthy growth and development.

Iodine ingested from food is reduced to iodide in the gut, with absorption occurring primarily in the small intestine. Iodide transport into the thyroid gland and extrathyroidal tissue is mediated by an intrinsic plasma membrane protein known as the sodium/iodide symporter (NIS) (Dohán et al 2003). Once in the thyroid gland, iodide is concentrated, converted to iodine and combined with tyrosine residues of thyroglobulin (Tg) to form iodinated Tg. Iodinated Tg accumulates in the thyroid, providing for the storage of iodine and Tg - a precursor for thyroid hormone synthesis. This complex process - involving the thyroid, pituitary, brain and peripheral tissues - involves removal of iodinated tyrosines from Tg via proteolytic enzymes, releasing T4 into circulation (Kidd et al 1974). Deiodination of T4 then produces T3 or reverse T3 - an inactive form. Excess iodine is excreted through urine, with small amounts also excreted via faeces and sweat (Lamberg 1993).

Dietary sources of iodine

Iodine is found in both food and water, predominantly as iodide. The use of sanitising solutions and iodophores during food production may also contribute significant amounts of iodine in the food supply (EFSA 2014). The level of iodine in cereal and grain foods varies depending on the iodine content of soil in which the food is grown. A 2024 Australian study identified that the elevation and region (State) in which Australian wheat was grown predicted iodine concentration, along with rainfall and topsoil texture interactions (Penrose et al 2024). Iodine is water-soluble and leaches out of surface soils in geographical areas prone to high rain, snow fall or floods (Küpper et al 2011). Consequently, low soil iodine levels are typical for New Zealand and in some parts of Australia such as Tasmania (AIHW 2016).

Iodine-rich foods include sea and marine products such as fish, shellfish and seaweed (Barkley and Thompson, 1960, Blikra et al 2022), eggs and milk and their products, and iodised salt (EFSA 2014). The levels of iodine in animal products such as meat, dairy and eggs varies based on the iodine content of feed. Australian food composition data suggests that the predominant sources of iodine in food include iodised salt, seafood, egg and dairy products[1], although iodine levels in the latter have declined with ceasing use of iodine-based sanitisers in dairy production (AIHW 2016).

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[1] Australian food composition database Release 2.0, available from: https://afcd.foodstandards.gov.au/foodsbynutrientsearch.aspx?nutrientID=I

In 2009, Australia and New Zealand introduced mandatory fortification requirements for the addition of iodine (via iodised salt) to bread. Subsequent analytical surveys conducted post-fortification found that cereal and cereal products were the main contributor to estimated iodine intake in Australians aged 17 and older, and the second greatest contributor to dietary iodine in children aged 2 - 16 years (FSANZ, 2016). Similarly, the 2023 National Nutrition and Physical Activity Survey (NNPAS) identified cereals (18.1%), milk (13.7%) and bread/bread rolls (11.6%) as major contributors to iodine intake (ABS, 2025c). These findings were echoed by New Zealand analyses, which found that bread was the main contributor to dietary iodine in children aged 5 to 14 post-fortification (NZ MPI, 2014, Skeaff & Lonsdale-Cooper, 2013).

Bioavailability factors

Previous work has estimated the absorption efficiency of iodine at between 90 and 92% (Thomson et al 1996, IOM 2001, Jahreis et al 2001, Aquaron et al 2002, EFSA 2014). However, iodine absorption is not fully understood, and evidence suggests that this assumption may not hold where intakes are very high (UK SACN 2014).

A range of factors have been identified that reduce the absorption of iodide, including humic acid in drinking water (Gaitan 1990), and thiocyanates, isothiocyanates, nitrates, fluorides, calcium, magnesium and iron present in food or water (Ubom 1991). Perchlorate compounds in food and water also reduce iodine uptake (Lisco et al 2020). However, the 24th Australian Total Diet Study did not detect perchlorates in any tap water samples across the eight jurisdictions, leading FSANZ to conclude that perchlorate contamination is unlikely to pose an appreciable health risk in Australia (FSANZ 2014).

Some compounds - known as goitrogens - impair or prevent iodine transport in the body, resulting in impaired iodide uptake, iodine deficiency and - subsequently - goitre formation. Known goitrogens in food include cassava, millet, maize, and cruciferous vegetables (Gibson, 1991). However, the consumption of goitrogenic foods is not expected to materially impact iodine intake, where iodine intake is adequate and for those who consume a wide variety of foods (Zimmermann et al. 2008).

Thiocyanates in tobacco cigarette smoke are also goitrogenic, competitively inhibiting iodine uptake, and impacting thyroid hormone production (Colzani et al 1998, Knudsen et al 2002, Shields et al 2009). Electronic cigarette users may be similarly impacted, with studies reporting levels of thiocyanates in saliva similar to that of tobacco cigarette smokers (Flieger et al. 2019)

Deficiencies in some micronutrients - including selenium, iron and zinc- have been reported to affect iodine absorption (Yang et al 1997, Kohrle 1999, Thomson 2004, Zimmermann et al 2000, O'Kane et al 2018). More broadly, other nutritional factors may affect thyroid metabolism or impair iodide uptake. For example, reduced thyroid peroxidase (TPO) enzyme activity due to iron or selenium deficiency, or impairment of T3 and T4 function due to vitamin A deficiency (Hess 2010).

The bioavailability of iodine is also mediated by intake, with high iodine intakes associated with reduced thyroid utilisation of iodine (Teng et al. 2011), likely achieved through downregulation of active transport proteins that deliver iodide into the thyroid (Eng et al 2001).

Health effects of insufficiency or excess

Both iodine insufficiency and excess are associated with thyroid dysfunction and disease, including sub-clinical and overt hyper- or hypo-thyroidism, goitre, and potentially thyroid cancer and thyroid autoimmunity (UK SACN 2014).

Iodine deficiency disorders

Insufficient iodine intake is associated with a range of adverse health and developmental outcomes, collectively termed 'iodine deficiency disorders' (Hetzel 1983). Table 1 describes the spectrum of health effects arising from iodine deficiency (adapted from Eastman and Zimmermann 2018 and Hetzel 1983). Iodine deficiency disorders affect individuals of all ages[2], with the range effects varying depending on the developmental stage at which exposure occurs.

Severe deficiency during pregnancy and infancy is of particular concern, due to the potential for serious and irreversible effects on child neurocognitive development, including intellectual impairment, hearing loss, and psychomotor disorders (EFSA 2014). Iodine deficiency is the primary cause of preventable child cognitive impairment world-wide (Ristić-Medić 2013). Although the relationship between severe iodine deficiency during pregnancy and global impairments in child neurocognitive development is well-established, the evidence for mild iodine deficiency is less certain. Robust supportive evidence of consistent adverse neurocognitive effects associated with mild-to-moderate iodine deficiency are lacking, with the evidence base limited by inconsistent findings and significant heterogeneity (Monaghan 2021).

Chronic iodine deficiency can also result in progressive thyroid gland enlargement (goitre) as a compensatory measure to increase iodine storage and support thyroid hormone production (UK SACN 2014). This may progress to hyperthyroidism and can also increase the risk of thyroid cancer (EFSA 2014). Hypothyroidism can also occur due to thyroid hormone dysfunction, affecting metabolic rate, body weight and cognitive function.

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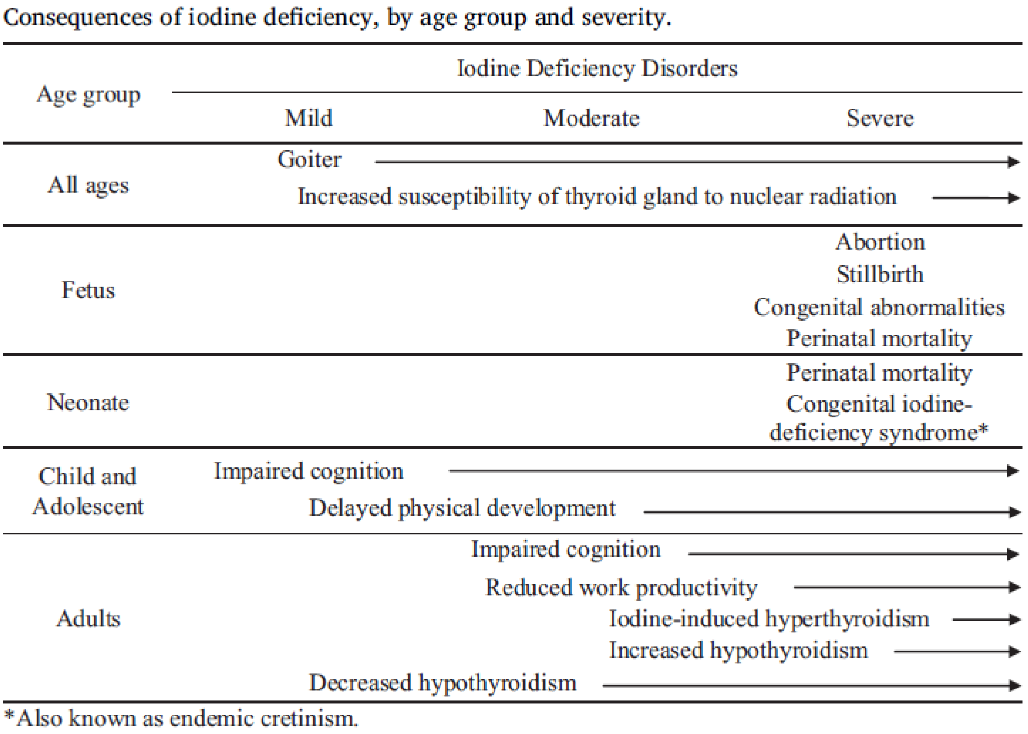
[2] Recommendations and individual studies in this NRV report population groups by relevant age-range, and 'male' or 'female'. The distinction between male and female is based on sex not gender, as nutrient intake and metabolism are physiological processes impacted by hormones. The definitions of 'sex' and 'gender' used to make this distinction come from the NHMRC Statement on Sex, Gender, Variations of Sex Characteristics and Sexual Orientation in Health and Medical Research (2024), where 'sex' relates to biological characteristics (i.e. hormones, chromosomes, reproductive organs) and 'gender' is a social and cultural concept. People who are transgender, gender diverse, who have innate variations of sex characteristics or who do not identify with the biological definition should consult a health practitioner who can consider their individual needs.

Table 1. Iodine deficiency disorders, by age group and severity (from Brough & Skeaff 2024)



Consequences of iodine deficiency, by age group and severity.

Age group	Iodine Deficiency Disorders: Mild	Moderate	Severe
All ages	Goiter	→	→
	Increased susceptibility of thyroid gland to nuclear radiation	→	→
Fetus			Abortion Stillbirth Congenital abnormalities Perinatal mortality
Neonate			Perinatal mortality Congenital iodine-deficiency syndrome*
Child and Adolescent	Impaired cognition	→	→
		Delayed physical development	→
Adults		Impaired cognition	→
		Reduced work productivity	→
		Iodine-induced hyperthyroidism	→
		Increased hypothyroidism	→
	Decreased hypothyroidism	→	→

*Also known as endemic cretinism.

Sensitive or at-risk groups

Due to the critical role of iodine in early neurocognitive development, the fetus and neonate are particularly sensitive to the effects maternal deficiency during pregnancy and lactation. Individuals with low income, and those with limited access to public health systems - including migrants - may be at greater risk of iodine deficiency, due to lower iodised salt consumption or poor adherence to supplementation recommendations during pregnancy (Magri et al 2019).

Vegans and vegetarians have lower intakes of iodine-containing foods such as meat, seafood, dairy and eggs, and may be at greater risk of deficiency. A systematic review examining modern vegan or vegetarian diets and iodine status found a strong association between vegan diet and iodine deficiency ($p<0.001$), although this association did not remain when analysis was limited to countries with mandatory salt iodisation (Eveleigh 2023). While vegetarian intakes were also consistently associated with lower UIC than omnivore diets, this difference was not significantly significant. Consumption of dairy milk alternatives has also been associated with reduced iodine intake compared with cows' milk (Dineva et al 2021, Lundquist et al 2024).

Given the role of mandatory iodine fortification of bread in preventing iodine deficiency in Australia and New Zealand, the impact of vegan/vegetarian or dairy-free diets on status may be minimised for individuals who consume bread. Individuals with low commercial bread intake may be at greater risk of deficiency in Australia and New Zealand.

Due to the goitrogenic effects of tobacco smoke and e-cigarettes, smokers and vapers are at greater risk of iodine deficiency. Similarly, individuals with high intakes of goitrogenic foods may be at increased risk of deficiency, although the risk may be negligible where iodine intake is adequate and a wide variety of foods are consumed (Zimmermann et al. 2008).

Excess iodine

High iodine intakes result in a transient stunning of the thyroid - known as the Wolff-Chaikoff effect - which halts thyroid hormone synthesis. However, in healthy adults, intrinsic regulatory mechanisms within the thyroid facilitate an 'escape' from the Wolff-Chaikoff effect and hormone synthesis recommences after a few days. As a result of these regulatory mechanisms, high intakes of iodine are generally well-tolerated in individuals without underlying disease or sensitivity. However, in some individuals - most commonly those with underlying thyroid disease or abnormalities - high iodine intakes can result in hypothyroidism or hyperthyroidism, depending on the nature of underlying thyroid dysfunction (Sohn et al. 2024, Katagiri et al 2017). This typically occurs via chronic high levels of exposure, although it may also occur from acute high exposure such as that arising from use of iodinated contrast media.

An increased risk of both overt and subclinical hypothyroidism is observed in regions with excess intakes (Katagiri et al 2017), with high habitual intakes arising from diets high in seaweed, high levels of iodine in drinking water or excessive salt iodisation. Subclinical hypothyroidism is a risk for progression to overt hypothyroidism, predominantly due to underlying autoimmune thyroid disease, indicated by higher TSH (> 10 mU/L) and positive antithyroid antibodies. Epidemiological data also suggest that chronic subclinical hypothyroidism is associated with an increased risk of cardiovascular disease (Razvi et al 2010, Delitala et al 2017, Inoue et al 2020).

Elevated TSH has previously been used as a marker for establishing recommendations for the Upper Level of iodine intake, in the absence of more robust biomarkers for iodine excess. However, there is uncertainty surrounding the clinical significance of TSH values outside of normal reference ranges, with a range of factors identified that can influence TSH levels and significant individual variation in thyroid hormone levels observed (Razvi et al 2019). An Australian study found that extending the upper TSH reference range by an additional 1-2 mU/L before initiating FT4 testing had little effect on case finding, furthering questions about the sensitivity of TSH and measures of sub-clinical hypothyroidism as markers of latent thyroid dysfunction (Henze 2017). Nevertheless, in the absence of more sensitive markers or a well characterised relationship with iodine exposure, the association between iodine intake and elevated TSH provides the most suitable end point for establishing Upper Level recommendations. Although the normal reference range is between 0.1-4.0 or 5.0 mU/L (depending on the assay used), a 2006 study reported the lowest incidence of thyroid dysfunction when TSH was between 1.0 and 1.9 mU/L (Teng et al 2006).

Chronic exposure to excess iodine has also been associated with autoimmune thyroid disease (Wang et al 2019) and thyroid cancer, although the latter is likely to be multi factorial and a clear relationship with iodine exposure is not well-established (Cao et al 2017, Lee et al 2017, Weng et al 2017). Excessive habitual iodine intake may also have adverse effects on child intellectual development (Li et al 2022).

Sensitive or at-risk groups

Individuals with diets high in seaweed (including the use of seaweed-containing herbal medicines or supplements) may be at greater risk of excess due to the high iodine content in certain seaweed species or products (EFSA 2023) - in particular for dry, unprocessed brown seaweed (Blikra et al. 2022, Blikra et al. 2024). Further research is required to understand the effects of seaweed intake on iodine status and health, including the risks associated with frequent versus occasional consumption (Blikra et. al 2024). High iodine exposure may also occur through exposure to iodinated contrast media, or antiseptics containing iodine (Gunnarsdóttir and Brantsæter 2023).

Individuals with a recent history of iodine deficiency are more sensitive to the effects of high iodine intake, particularly where intake increases suddenly (Sohn et al. 2024). Such groups may experience adverse health outcomes at lower levels of intake than those without a recent history of deficiency. Such effects may endure for several years post-fortification, with rates of thyrotoxicosis declining to below baseline within 7 to 8 years (Braverman and Pearce, 2024).

Iodine excess can also disrupt normal thyroid function in people with underlying thyroid disease. This includes autoimmune thyroid disease - a common form of thyroid disease primarily affecting adult women (Mammen and Cappola 2021) - or nodular thyroid disease, most common in the elderly or in people with a previous history of iodine deficiency (Miller et al 2016).

Premature neonates and the developing foetus are particularly sensitive to the effects of excess iodine, as they lack the mechanism to escape from the Wolff-Chaikoff effect which begins to develop at around 36 weeks gestation (Sohn et al. 2024), fully maturing during the early neonatal period (Berbel and de Escobar 2011).

Measuring intake or status

Iodine intakes vary substantially day-to-day, which presents a challenge for quantifying individual intakes and for inferring information about individual status from short-term measures of intake.

Dietary assessment methods

Food frequency or 24-hour dietary recall approaches are frequently used in research, and present affordable options with low participant burden for completion. However, these self-reported measures are prone to bias including recall and social desirability response bias. More robust measures have been developed to address these limitations, such as duplicate diets and weighed food records, however these methods present their own challenges.

It is also difficult to ascertain individual status based on dietary intakes which reflect intakes at a specific point in time. In people with iodine replete diets, iodine is incorporated into thyroglobulin and this can provide up to 3 months of thyroid hormone, even during periods of low iodine intake (Vanderpas, 2003).

Dietary assessment methods also rely on accurate food composition databases (FCDBs) that reflect contemporary iodine content of foods relevant to the local food supply. Developing comprehensive, up to date FCDBs has been a global priority, with FCDBs now established - and maintained - in most developed countries. However, challenges in establishing and maintaining food FCDBs in developing countries remain, including in reliance on incomplete or outdated data, or data from other jurisdictions to estimate nutrient intakes (Al-Balushi et al 2023).

Some FCDBs may not include iodine data, due to the cost and complexity associated with deriving estimates where there is substantial geographic and seasonal variability of iodine content in food (Ershow et al 2018). Finally, difficulty in quantifying iodine intake from use of iodised salt at the table and in cooking also present challenges. Consequently, studies that assess iodine intake using dietary assessment methods should be carefully appraised to consider the robustness of the methods used for estimating intake.

A 2019 review examined the accuracy of various measures for estimating iodine intake in children, comparing dietary methods (24-hour dietary recall; duplicate diets) and 24-hour urine (Peniamina et al 2019). It found that 24-hour dietary recall measures may underestimate intake, whereas duplicate diets and 24-hour urine provided similar estimates.

Urinary assessment methods

Measures of urinary iodine are used as established biomarkers for iodine intake and status, although these measures have limitations.

As more than 90% of dietary iodine is excreted in the urine, urinary iodine is used as an indicator of recent iodine intake (Thomson et al 1996, IOM 2001, Jahreis et al 2001, Aquaron et al 2002, EFSA 2014). Urinary iodine can be measured over 24-hours urinary iodine excretion (UIE) or in a spot urine sample urinary iodine concentration (UIC). Corrected measures of UIC are also often reported, for example, correcting for urinary creatinine (I:Cr ratio), to address variation in urinary volume with spot sample collection. Both 24-hour UIE and UIC are associated with inter- and intra-individual variation, thus neither should be used to assess individual iodine status, but rather to assess the iodine status of a group or population. Sufficiently large sample sizes are required to account for individual variation and estimate population iodine status with sufficient precision.

Urinary iodine excretion (UIE)

Iodine status can be approximated from 24-hour urinary iodine excretion (UIE). The collection of 24-hour urine samples can account for diurnal variation in iodine excretion and is the reference standard for measuring population status. However, this measure has a high respondent burden, and is contingent on patient adherence to sampling protocols, with results impacted by incomplete sampling or storage among other limitations (Bottini et al 2020). There is no internationally accepted method to determine if all urine voided during the 24-hours was collected (i.e. completeness).

Furthermore, the relationship between UIE and dietary iodine intake is not well characterised across a broad range of intakes. In steady state conditions, urinary excretion reflects recent intake, which may vary significantly over time and may not reflect habitual intake. Furthermore, UIE may not be a reliable measure of recent intake or status following a change in iodine intake, with wide variation in the time taken to achieve a steady state, ranging from one to two weeks in iodine replete subjects to 7 to 9 months for infants and young children in mildly deficient areas, or adults with goitre due to iodine deficiency (EFSA 2014). Consequently, UIE may not be a reliable measure of intake or status in populations where iodine intake has recently changed.

Furthermore, it has been suggested that the association between UIE and intake - and the assumption that 90-92% of ingested iodine is absorbed - may apply in a narrow range of intakes that is not yet fully characterised (UK SACN 2014). Evidence from Japan suggests that homeostatic processes result in reduced iodine uptake in those with high habitual intake (Miyai et al 2008, Nagataki et al 1967). UIE may also underestimate iodine intake at low exposure levels, as iodine excretion is reduced in these circumstances, owing to homeostatic adaptations associated with low circulating T3 and T4 and elevated TSH (SACN 2014). Finally, absorption during pregnancy may deviate from the observed 90-92% rate due to physical alterations including:

- increased iodine uptake through hormonal stimulation of the iodine transport system (Arturi et al 2002, Glinoer 2001)

- increases in the glomerular filtration rate of iodine, resulting in and renal iodine output has also been shown to vary over the course of pregnancy (Stilwell et al 2008; Dafnis and Sabatini 1992).

This is supported by findings from several studies, which suggest there may be poor correspondence between maternal UIC and iodine intake during pregnancy, particularly with initiation of iodine supplementation (Abel et al 2018, Mridha et al 2017).

Despite these limitations, UIE currently represents the best available biomarker for inferring iodine intake in non-pregnant adults. Iodine intake can be estimated from 24-hour UIE using the formula:

Daily iodine ingested (µg/day) = UIE (µg/day) ÷ 0.92 (absorption efficiency)

Urinary iodine concentration (UIC)

The use of spot urine samples is simpler and consequently, more frequently measured and reported in the literature and public health monitoring. Furthermore, the epidemiologic criteria described in Table 2 is based on UIC (µg/L). However, there are limitations to spot urine samples including that they fail to account for diurnal variation in excretion and are subject to individual variation in urinary volume and may be misleading regarding status. For example, high urine volumes will result in lower UIC values which may be misinterpreted as poor iodine status; conversely, low urine volumes will result in raised UIC values, suggesting adequate iodine status where this may not be the case (Als et al 2000, Moreno-Reyes et al 2011, Oblak et al 2024, Rasmussen et al 1999, Johner et al 2010). It has been suggested that between 10 and 12 repeat collections of UIC would be required to estimate individual intakes with 20% precision (König et al. 2011).

Notwithstanding these limitations, UIC is a widely used and accepted biomarker of population status. The World Health Organization (WHO) have developed epidemiologic criteria for assessing population iodine status in school-age children using median urinary iodine concentration (UIC), shown in Table 2. It also recommends that the proportion of the population with UIC below 50 µg/L should not exceed 20% (WHO, 2007). The cut-offs for children were subsequently extended to include adults (except during pregnancy).

Table 2. **WHO epidemiologic criteria for assessing iodine nutrition using Median UIC (Source: WHO 2013)**

Population	Median UIC (µg/L)	Iodine intake	Iodine status
School-aged children (6 years and up)	<20	Insufficient	Severe iodine deficiency
	20 - 49	Insufficient	Moderate iodine deficiency
	50 - 99	Insufficient	Mild iodine deficiency
	100 - 199	Adequate	Adequate iodine nutrition
	200 - 299	Above requirements	Slight risk of more than adequate iodine intake
	≥300	Excessive*	Risk of adverse health consequences
During pregnancy	<150	Insufficient	
	150 - 249	Adequate	
	250 - 499	Above requirements	
	≥500	Excessive*	
During lactation	<100	Insufficient	
	≥100	Adequate	

* In this context, the term 'excessive' denotes an intake in excess of that required for prevention and control of iodine deficiency. It is not synonymous with an 'Upper Level' at which there is an increased risk of toxicological effects.

The WHO epidemiologic criteria (WHO 2013) use UIC as an approximation of 24-hour UIE on the basis that school-age children (6 to 12 years) produce 1 litre of urine per day. This enables UIC (µg/L) and UIE (µg/day) measures to be used interchangeably, despite their differing denominators (UK SACN 2014). However, this equivalency only applies where daily urinary output is equal to 1L/day.

It has previously been suggested that urine output for adults and older children may be closer to 1.5 L/ day (UK SACN, 2014). However, more recently a systematic review of urinary output among children and adolescents found that output in children aged 2 to 12 years was below 1L/day, undermining the assumption of equivalency between UIC and UIE in this age group (Beckford et al 2019). This raises the potential for iodine intake to be misclassified based on UIC. Similarly, a recent systematic review in adults estimated daily urinary volume at 1.77 L/day - greater than the 1.5 L/day upon which previous iodine NRVs have been developed (Noble et al 2024). Estimates of intake based on single spot urine may be inaccurate and should be interpreted with caution (Mackerras 2011).

Assuming 90% excretion and daily urinary output of 1.5 litres, iodine intake can be estimated based on UIC using the formula:

Daily iodine intake (μg/day) = UIC (μg/L) x 0.0235 x bodyweight (kg)

Using this approach, a daily intake of 150 μg is derived from median UIC of 100 μg/L in adults.

As an alternative approach, intake can be estimated by adjusting for daily urinary volume and absorption using the formula:

Daily iodine intake (μg/day) = UIC (μg/L) x urinary volume (Litres) ÷absorption rate (assumed 90-92% unless otherwise indicated)

Creatinine: Iodine Ratio (I:Cr)

The iodine-to-creatinine ratio (I:Cr) - measured in μg/g - has been proposed as a method for estimating individual iodine status from UIC, by adjusting for urinary dilution and variations in daily urinary volume (Oblak et al 2024). However, this measure is sensitive to the effects of sex, age, diet and renal function and it has therefore been suggested that estimates should adjust for age and sex when calculating I:Cr for urinary iodine measures (Konno et al 1993, Rasmussen et al 1999, Knudsen et al 2000). Furthermore, in its 2012 report on biochemical indicators of nutrition, the US CDC found that Creatinine-adjusted UIC was no more reliable than UIC alone (CDC, 2012).

Breast milk iodine concentration during lactation

A 2022 systematic review examined the relationship between breast milk iodine concentration (BMIC) and urinary iodine concentration. This review aimed to evaluate the potential use of BMIC as a biomarker for iodine status during lactation and in breastfed children <2 years of age (Liu et al 2022). Although the authors concluded that BMIC shows promise as a potential biomarker of iodine status, the body of evidence is not sufficiently robust to derive an optimal BMIC or to inform thresholds for sufficiency.

Secondary biomarkers of status

A limitation of urinary iodine measures is that they reflect more recent dietary intake. A range of thyroid function and disease parameters are used to estimate longer-term status. However, these measures may be restricted in their sensitivity for identifying mild iodine deficiency (Leung, 2019). Although serum levels of thyroid hormones primarily reflect thyroid function, these can be used as indirect markers of iodine status.

Thyroid hormones

Thyroglobulin (Tg) is a protein produced by thyroid follicular cells and is the main precursor for synthesis of the thyroid hormones triiodothyronine (T3) and thyroxine (T4). Elevated Tg is a sensitive indicator of long-term population status and has been suggested as a potential biomarker of excess (Gunnarsdóttir and Brantsæter 2023). However, validated reference values in adults have not been established (Ma et al 2017, Ma et al 2018) and its validity as an individual marker is uncertain, due to significant variability in day-to-day measures (Farebrother et al 2018). A 2020 systematic review examining the suitability of Tg as a biomarker of status during pregnancy found that Tg may be a sensitive indicator of iodine deficiency where median UIC is less than 100 μg/L.

However, the sensitivity of Tg for detecting mild population deficiency in the MUIC range of 100-150 µg/L during pregnancy remains unclear (Nazeri et al. 2020a)

In children and adolescents, serum thyroid stimulating hormone (TSH) and thyroglobulin (Tg) are both useful biomarkers, with normal TSH typically within the range 0.1- 5 mU/L and a serum Tg below 10 µg/L indicative of adequacy (Vejbjerg et al., 2009; Ristić-Medić et al., 2009, EFSA 2014). Free Triiodothyronine (FT3) and Free Thyroxine (FT4) lack sensitivity and are not reliable biomarkers of iodine status.

Neonatal TSH

WHO guidelines recommend the use of neonatal TSH screening at 3 to 4 days post-birth as an indicator of population status. Population sufficiency is indicated when newborn TSH levels >5 mU/L are observed in in less than 3 % of those sampled (WHO 2007).

However, it has been suggested that this approach may not be sufficiently reliable for classifying population status (Li and Eastman 2011). However, a 2019 systematic review found better agreement between neonatal TSH and goitre prevalence, than when MUIC was compared with goitre prevalence (Wassie et al 2019). The authors emphasised the importance of adhering to WHO-recommended sampling - within 3 to 4 days of birth - with sampling outside this period (including from cord blood) found to be unreliable.

Elevated neonatal TSH is also used as an indicator of iodine deficiency in newborns and may be informative regarding maternal iodine status during pregnancy. Beyond the neonatal period, TSH is not a sensitive indicator of individual deficiency due to the wide range of values within the limits of normal function.

Goitre prevalence

Goitre prevalence in children aged 6 to 12 years is an established measure of long-term population iodine status, with prevalence >5% indicative of population-level deficiency (WHO 2007). However, it should be noted that thyroid volume can take months or even years to return to normal after deficiency is corrected. Consequently, goitre prevalence may be an unreliable measure, in populations where deficiency has been recently corrected, and thyroid volumes have not yet returned to normal volume.

Furthermore, thyroid volume is only a reliable indicator of goitre prevalence in areas of moderate or severe deficiency, and as such these measures are not sensitive markers of mild iodine deficiency (NNR 2023).

When combined with urinary iodine measures, goitre prevalence can be used to infer a level of intake sufficient for preventing abnormal thyroid volume and goitre in most of the population. That is, by measuring median urinary iodine associated with goitre prevalence <5% within a given population. When this approach is used, the primary source of uncertainty arises from back-converting urinary iodine measures (expressed is µg/L or µg/day) into a daily iodine intake (EFSA 2014).

Current recommendations and international comparisons

The current Australian and New Zealand Nutrient Reference Values (2006 NRVs) for iodine were developed in 2006 and adapted from values published by the US Institute of Medicine in 2001. Subsequently, several international jurisdictions have published updated NRVs for iodine. Although there is variation in local context - including population iodine status and dietary patterns - and in the age groupings used across jurisdictions, NRVs developed using comparable approaches are informative for comparison purposes. In particular, where reference values have been updated to reflect contemporary evidence review methods and recently published research.

Nutritional adequacy recommendations

Basis for current recommendations

The 2006 NRVs specify an Estimated Average Requirement (EAR) and Recommended Dietary Intake (RDI) for each population and age group (see Table 1). The basis for deriving each of these values is presented below.

Adults

Values for adults were based on studies reporting average thyroid iodine accumulation and turnover between 91.2 and 96.5 µg/day in euthyroid adults (Fisher and Oddie 1969a, Fisher and Oddie 1969b). Values were rounded to 100 µg/day to reflect New Zealand data on urinary iodide to thyroid volume (Thomson et al 2001). The RDI was established applying a 20% co-efficient of variation (CV), being half of the 40% CV reported by Fisher and Oddie (1969a). This adjustment reflected the assumption that half of the variation observed by Fisher and Oddie (1969a) was due to the complexity of the experimental design and calculations used to estimate turnover (US IOM 2001).

Pregnancy

Values for pregnancy were based on adult requirements, adjusted to account for additional requirements during pregnancy. Daily fetal thyroid iodine uptake was estimated at 75 µg/day based on 100% daily turnover of iodine in the newborn thyroid, and an estimated thyroid content of 50-100 µg in newborns (Delange, 1989; Delange and Ermans 1991). Assuming an EAR of 95 µg/day for non-pregnant women (based on the EAR identified by the US IOM), a preliminary EAR of 170 µg/day during pregnancy was calculated. This estimate was reduced to 160 µg/day in view of the following supportive evidence:

- a balance study which reported neutral balance among pregnant women with iodine intakes of around 160 µg/day (Dworkin et al., 1966); and

A. studies on the effect of iodine supplementation on maternal thyroid volume, with daily intakes of 250 to 280 µg/day found to prevent goitre during pregnancy (Pedersen et al 1993), whereas intakes of 150µg/day were insufficient to prevent increased thyroid volume (Glinoer 1998).

The RDI during pregnancy was estimated at 220 µg/day, based on an EAR of 160 µg/day and applying a 20% CV.

Lactation

The EAR was set at 190 µg/day, based on the adult EAR (100 µg/day) plus replacement of iodine secreted in breast milk estimated at 90 µg/day. The replacement value of 90 µg/day was lower than the 114 µg/day estimated by the US IOM (based on Gushurst et al 1984) as the panel considered a broader range of studies on the topic (Delange e al 1984, Gushurst et al 1984, FAO:WHO 2001, Johnson et al 1990). The RDI was set at 270 µg/day assuming a CV of 20% for the EAR.

Children and adolescents

1 - 3 years of age

The EAR for children aged 1 to 3 years was based on a 4-day balance study in seven children aged 1.5 to 2.5 years (Ingenbleek and Malvaux 1974). Children were previously malnourished but had been nutritionally rehabilitated. Mean average iodine balance was positive (19 µg/day) with a median iodine intake of 63.5 µg/day. This estimate was favoured over an estimate of 36 µg/day obtained when adult recommendations were extrapolated based on body weight. The RDI was calculated by applying a 20% CV.

4 - 8 years of age

The EAR for children aged 4 to 8 years was derived from a 1969 balance study, based on the results from two 8 year-old children with intakes of 20 or 40 µg/day, which resulted in negative balance (-23 or -26µg/day respectively) (Malvaux et al. 1969). On this basis, the EAR was set to 65µg/day and the corresponding RDI established at 90µg/day using a 20% CV.

9 - 13 years of age

Several studies were considered when setting the EAR and RDI for children aged 9 to 13 years, although these resulted in substantially different estimates of requirements. Data from a study on goitre prevalence in European children aged 6 to 15 years (Delange et al 1997) suggested an RDI of 125 µg/day, and assuming median urine volume of 1.15L/day and 92% excretion (US IOM, 2001). Conversely, balance data from a subset (N=16) of participants aged 9 to 13 years in a 1969 balance study were also examined. Average iodine intake was 31 µg/day and average balance was -24 µg/day, suggesting an EAR of approximately 55 µg/day (Malveaux et al 1969).

Ultimately, the EAR for 9 -13 year-olds was developed by extrapolating values from adults - using metabolic body weight ratios - to arrive at an EAR of 75 µg/day and RDI of 120 µg/day established using a 20% CV.

14-18 years of age

In setting the EAR for children and adolescents aged 14 to 18 years, it was noted that negative balance (-24 µg/day) was found in a subset of participants (N=10) aged 14 to 18 with an average daily intake of 34 µg (Malvaux et al. 1969). This resulted in a calculated average requirement of 58 µg/day. However, the EAR in this age group was instead derived by extrapolating values from adults using metabolic weight ratios, which yielded an estimated EAR of 95 µg/day. RDI was established at 150 µg/day based on a 20% CV.

Table 3. **Estimated Average Requirement and Recommended Dietary Intake, or equivalent, by population and jurisdiction**

Population group	Age range (years)	US-Canada (IOM 2001)		UK (1991)*		Australia-NZ NHMRC (2006)		WHO (2007)*		Germany-Austria-Switzerland D-A-CH (2013)*	
		EAR (µg/d)	RDI (µg/d)	EAR (µg/d)	RDI (µg/d)	EAR (µg/d)	RDI (µg/d)	EAR (µg/d)	RDI (µg/d)	EAR (µg/d)	RDI (µg/d)
Adults	19+	95	150	NS	140	100	150	-	150	-	180[1] 200[2]
Pregnancy	14-50	160	220	NS	140	160	220	-	250^	-	230
Lactation	14-50	209	290	NS	140	190	270	-	250	-	260
Children/ adolescents	14-18	95	150	NS	130-140	95	150	-	250	-	200[3]
	9-13	73	120	NS	110[4]	75	120	-	150[5]	-	180[6]
	4-8	65	90	NS	100[7]	65	90	-	120[8]	-	120-140[9]
	1-3	65	90	NS	70	65	90	-	90[10]	-	100

*Variation in age ranges across jurisdictions: [1] 51+ years; [2] 19-51 years; [3] 13-17 years; [4] 7-10 years; [5] 13-18 years; [6] 10-12 years; [7] 4-6 years; [8] 6-12 years; [9] 4-9 years; [10] 1-5 years

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Comparison with international values

In contrast to the approach adopted by the US IOM (2001) and 2006 NRVs (NHMRC, 2006), the 2014 European Food Safety Authority (EFSA) review of nutrient requirements determined that there was insufficient evidence to derive an EAR and associated RDI[3]. This decision reflected concerns about:

- the generalisability of studies on thyroid iodine accumulation to the European context, in view of the high UIE reported in those studies (410 and 280 µg/day respectively)
- the accuracy of balance studies for quantifying intake and losses, including that observed requirements under ‘balance’ conditions may reflect adaptive changes rather than a true ‘steady state’, if studies are of inadequate duration; and
- that observed ‘balance’ may reflect requirements that only apply in a narrow range of contexts.

Instead, EFSA established an Adequate Intake (AI) for iodine, with recommendations based on a large European study in school-aged children that reported low goitre prevalence (<5%) with urinary iodine concentrations above 100 µg/L (Delange et al 1997; EFSA, 2014).

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[3] EFSA uses the terms Average Requirement (AR) and Population Reference Intake (PRI) instead of EAR and RDI.

The 2023 Nordic Nutrition Recommendations (NNR) also replaced the previous 2012 EAR-equivalent with a provisional AR[4] and AI instead, with recommendations based on goitre prevalence per the EFSA 2014 recommendations (Blomhoff et al. 2023).

Despite differences in both the type of nutritional adequacy NRVs developed (EAR + RDI vs AI), and the underpinning evidence used to derive these values (balance studies vs thyroid volume/goitre prevalence), there is substantial agreement between the 2006 NRVs and subsequent AI values set by EFSA (2014) and NNR (2023), as shown in Table 1 and Table 2.

Table 4. **Adequate intake or equivalent, by population and jurisdiction**

Population group	Age range (years)	Nordic Nutrition Recommendations (NNR 2023)		European Commission (EFSA 2014)
		AI (µg/d)	Provisional AR (µg/d)	AI (µg/d)
Adults	18+	150	120	150
Pregnancy	NS	200	160	200
Lactation	NS	200	160	200
Children/ adolescents	15-17	120 (F) 140 (M)	100 (F) 110 (M)	130
	11-14	120 (F) 130 (M)	100	120
	7-10	100	80	90
	4-6	100	80	90
	1-3	100	80	90

Upper Levels

Basis for current recommendations

The 2006 NRVs also specify Upper Levels (UL) for iodine for each population group. The UL in adults was derived from data for challenged thyroid function (measured as elevated TSH concentrations). A LOAEL of 1700 µg/day was set, based on two studies of supplemental iodine which showed increased TSH (over baseline) at 1,800 µg/day and 1,700 µg/day (Gardner et al. 1988, Paul et al. 1988). Both studies were small, examining varying iodine doses in 30 and 32 participants respectively.

NHMRC (2006) applied an uncertainty factor of 1.5 to arrive at a rounded adult UL of 1100 µg/day.

The adult UL was also adopted for pregnancy and lactation on the assumption that there was no evidence of increased sensitivity in these populations. Values for children and adolescents were extrapolated from adult ULs, based on metabolic body weight.

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[4] The provisional AR is defined as: *The average daily nutrient intake level that is suggested to meet the requirements of half of the individuals in a particular life-stage group. The provisional AR, which is an approximation of AR, has larger uncertainty than AR.*

The provisional AR was derived from the AI, calculated by multiplying AI by a factor of 0.8(NNR 2023).

Comparison with international values

Adults

There is substantial variation across international ULs, most notably between the current (2006) and US/Canadian UL of 1,100 µg/day and the UL of 600 µg/day established by the European Commission (EFSA 2002) and 2023 Nordic Nutrition Recommendations (Blomhoff et al. 2023). However, these ULs have all been developed based on the same end point data, and using a LOAEL of 1700 µg/day. The variation in recommendations is explained by the application of differing uncertainty factors by each jurisdiction. For example, NHMRC (2006), the US and Canada (US IOM 2001) applied an uncertainty factor of 1.5 to arrive at a rounded adult UL of 1100 µg/day; the European Commission applied an uncertainty factor of 3 to arrive at its UL of 600 µg/day. This lower value was adopted by the 2012 Nordic Nutrition Recommendations and retained in the recent 2023 update.

A comparison of ULs across jurisdictions is presented in Table 5.

The WHO specifies upper limits that are "probably safe" in its 2004 recommended vitamin and mineral requirements for human nutrition (WHO 2004). The ULs provided are in the units of µg/kg/day and are in the order of 15 to 20 times higher than recommended intakes, reflecting the high tolerance of healthy, iodine-replete, euthyroid adults to high doses of iodine. These values have been transposed to µg/day using Australian and New Zealand reference weights (based on 'ideal' body weight) in Table 6, to facilitate comparison with other international values.

Pregnancy

The WHO epidemiological criteria for assessing iodine nutrition based on median UIC in pregnant women defines UIC > 500 µg/L as an excess intake (WHO 2007). However, in this context the WHO is referring to intakes that are "in excess of the amount required to prevent and control iodine deficiency" and accordingly, the 500 µg/L threshold should not be interpreted as describing an UL. The WHO Upper Level recommendations use the units of µg/kg/day, with UL recommendations during pregnancy or lactation equating to 2800 µg/day for a 70 kilogram adult.

In 2022, the UK Food Standards Agency's (FSA) Committee on Toxicity examined the effects of excess iodine intake on maternal and child health. It found there was insufficient evidence to inform a risk assessment. The Committee concluded there were no toxicological concerns with iodine exposure in the general population - which was found to be within recommended limits - although individuals with diets high in seafood may be at risk of toxicological effects (UK FSA COT 2022).

Table 5. **Upper Levels, by population and jurisdiction**

Population group	Age range (years)	US-Canada (IOM 2001)	UK (1991)	Australia & NZ (NHMRC 2006)	Nordic Countries (NNR 2023)	European Commission (2002)*	Germany-Austria-Switzerland D-A-CH (2015)
		UL (µg/d)	UL (µg/d)	UL (µg/d)	UL (µg/d)	UL (µg/d)	UL (µg/d)
Adults	19+	1100	1000	1100	600	600	500^
Pregnancy	19-50	1100	-	1100	600	600	
	14-18	900	-	900	600	600	
Lactation	19-50	1100	-	1100	600	600	
	14-18	900	-	900	600	600	
Children/ adolescents	14-18	900	-	900	-	450-500[1]	
	9-13	600	-	600	-	300[2]	
	4-8	300	-	300	-	250[4]	
	1-3	200	-	200	-	200	

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* Variation in age ranges across jurisdictions: [1] 13-17 yrs; [2] 7-10 yrs; [3] 7-12 years; [4] 4-6 yrs; [5] up to 6 years

^ Due to longstanding deficiency and prevalence of thyroid abnormalities within the population, in 2015 the D-A-CH adopted a UL of 500µg/day for adults.

Table 6. **WHO Upper Limits by group, converted to µg/day based on 2006 NRVs reference weights**

Population group	Age range (years)	WHO UL (2007) (µg/kg/day)	Reference Weights - 2006 NRVs (kg)	WHO ULs based on ANZ weights (µg/d)
Adults	19+	30	70	2100
Pregnancy	Not specified	40	70	2800
Lactation	Not specified	40	70	2800
Children/ adolescents	14-18	30	60.5^	1815
	9-13	50	40	2000
	4-8	50	22	1100
	1-3	50	13	650

^15-17 years age grouping for 2006 NRVs. 18-64 years. Value presented is average of values for males (64kg) and females (57kg)

Australian and New Zealand context

Population status and intakes

Australia

This section reports the following data from national surveys:

- Median UIC data from the 2022-24 Australian National Health Measures Survey (NHMS; ABS, 2025a) and the 2011-12 Australian National Health Measures Survey (NHMS; ABS, 2013) - shown in Table 7.
- Dietary intake data from the 2023 National Nutrition and Physical Activity Survey (NNAPAS; ABS, 2025c), shown in Table 8. At the time of writing, the 2023 NNPAS data release does not report the proportion of the population with intakes less than the EAR, nor does it report the confidence interval range for intakes, and consequently this data from the Australian Health Survey 2011-13 (ABS, 2015) is shown in Table 9.

In late 2009, Australia mandated the use of iodised salt in bread, to address the re-emergence of iodine deficiency. Median UIC findings from the 2011-12 National Health Measures Survey (NHMS) confirmed that median UIC had increased across all population groups following fortification, with values well within the WHO range for iodine sufficiency (ABS, 2013) except in pregnant and lactating women where concerns about population deficiency remain (AIHW, 2016). More recent summary data from the 2022-24 NHMS suggests that the population remains sufficient, although median UIC in adults aged 18 years and over decreased from 124 µg/L in 2011-12 to 112 µg/L.

In contrast to median UIC data, comparison of dietary intake data from the NNAPAS suggests that iodine intake has increased across all populations between 2011 and 2023. However, the ABS advises that this comparison should be interpreted with caution, owing to changes in data processing across survey periods.

Adults

2022-24 National Health Measures Survey

In 2022-23, the adult population (aged 18 years and over) was found to be iodine sufficient based on WHO criteria (WHO 2007), with a median UIC of 112 µg/L and 17.4% of the population with UIC <50 µg/L. Intakes in males were higher than in females (123 µg/L vs 101 µg/L), with values for women marginally within the 100 µg/L range of sufficiency.

2011-12 National Health Measures Survey

In 2011-12, the population median UIC for Australian adults was 124.0, with 12.8% of those sampled with a UIC <50 µg/L - well within WHO recommended ranges for population sufficiency. Intakes in men were significantly higher than for women (131µg/L vs 118 µg/L), with deficiency also more prevalent in women than men (15.8% of women vs 9.6% of men with UIC <50 µg/L) (ABS, 2013).

Iodine status of adults also varied geographically across Australia, with median UIC highest in adults living in Western Australia (157.4 µg/L) and lowest in those residing in Tasmania (108.0 µg/L). Similarly - and despite the early introduction of voluntary fortification in 2001 and mandatory fortification in 2009 - Tasmania also had the highest proportion of deficiency (UIC <50 µg/L), affecting 14.9% of those measured.

Regional variation in iodine status has also been observed, with those residing in inner regional Australia having lower median UIC (114.0 µg/L) and more likely to be deficient (15.4%) compared with those in major cities (median UIC 128.0 µg/L; 11.9% deficient).

Children and adolescents

2022-24 National Health Measures Survey

The 2022-24 NHMS reported that children aged 5 to 17 years were iodine-sufficient, with a median UIC of 171 µg/L and only 8% with UIC <50 µg/L. Urinary iodine measures were highest in children aged 5 to 11 years (median UIC 185 µg/L for males; 188 µg/L for females).

2011-12 National Health Measures Survey

Similarly to the 2022-24 NHMS, 2011-12 data found that median UIC was highest among young children aged 5 to11 years (176.7 µg/L), followed by people aged 12 to17 year (149.0µg/L). These groups also had the lowest rates of deficiency, with only 5.9% of young children with UIC <50µg/L.

Similarly to adults, iodine status in children varied by State with median UIC highest in Western Australia and lowest in South Australia, although data are only reported for children aged 8 to 10 years and do not include Tasmania the Northern Territory or Australian Capital Territory (ABS, 2013). Notably, a median UIC of 261.30 µg/L was observed in children aged 8 to 10 years in Western Australia - well above the recommended dietary intakes of 90 and 120 µg/d for this age range.

A Food Standards Australia New Zealand (FSANZ) analysis undertaken post-fortification found that children aged 2 to 3 years were most likely to have excessive intakes, with 20% estimated to have intakes above the UL post-fortification, compared with 7% pre-fortification (FSANZ 2016). Despite this significant proportion, the report notes that evidence suggests that these intakes are unlikely to have adverse health effects, in view of the safety margins used to derive an UL and given the reversible nature of the clinical end point on which ULs are based (sub-clinical hypothyroidism). Furthermore, the period of excessive intake is expected to be transient, with less than 1% of children expected to exceed the UL at the age of 4 years.

Aboriginal and Torres Strait Islander populations

Data from the 2011-12 National Aboriginal and Torres Strait Islander Health Measures Survey (NATSIHMS) reported higher median UIC for Aboriginal and Torres Strait Islander populations across all age groups - with the exception of young adults aged 18-24 years - compared with the median UIC of all Australians (AIHW, 2016). Although median UIC for Aboriginal and Torres Strait Islanders aged 18 - 24 years was slightly lower than that of all Australians (135 vs 138 µg/L) it remained well within WHO recommended range for sufficiency.

More recently, a 2019 study compared iodine status among young adult participants in the Aboriginal Birth Cohort study with the non-Indigenous Top End Cohort prior to and post mandatory fortification (Singh et al 2019). While this study also found that median UIC had increased across all groups following mandatory fortification, it reported lower median UIC values than those of national surveys. For some groups - in particular Indigenous and non-Indigenous

Australians residing in remote areas, or pregnant women and those of child-bearing age - median UIC remained below the recommended 100 µg/L threshold, indicating mild deficiency.

Pregnancy and lactation

2022-24 National Health Measures Survey (NHMS)

The currently available 2022-24 NHMS data do not report measures of UIC in pregnancy or lactation, although pregnant and breastfeeding women were not excluded from the survey. However, median UIC in females of child-bearing age (aged 16 to 44 years) was 101 µg/L; marginally within the range for sufficiency in non-pregnant adults. However, 2022-24 NHMS data suggests mild population deficiency in females aged 25 to 34 years and 35 to 44 years, with median UIC of 87 µg/L and 97 µg/L respectively, and more than 20% of individuals with UIC <50 µg/L in both age groups. Furthermore, the median UIC in females aged 16 to 44 years was well below the recommended 150 µg/L for sufficiency during pregnancy.

2011-12 National Health Measures Survey (NHMS)

The 2011-12 NHMS reported median UIC for pregnant and breastfeeding women aged 16-44 years of 116 µg/L and 103 µg/L respectively (ABS, 2013). These values were lower than the median UIC for all Australian women of that age reported in the 2011-12 NHMS (121 µg/L) and -while within the WHO criteria for adult sufficiency and for sufficiency during lactation - are indicative of population insufficiency during pregnancy (ABS, 2013, WHO 2013).

Table 7. **Median UIC (µg/L) by age for Australia and New Zealand (Source: ABS, 2013; NZ MoH 2020)**

Age groups (years)	Australia (NHMS 2022-24)	Australia (NHMS 2011-12)	New Zealand (2014/15)
	Median UIC (µg/L) in males (M) and females (F)	Median UIC (µg/L)	Median UIC (µg/L)
5-11	185 (M) 188 (F)	176.7	
12-17*	137 (M) 172 (F)	149.0	112*
18-24*	134 (M) 109 (F)	138.2	112*
25-34	122 (M) 87 (F)	124.0	104
35-44	124 (M) 97(F)	122.0	102
45-54	114 (M) 101 (F)	119.0	100
55-64	126 (M) 100(F)	119.0	104
65-74	130 (M) 104 (F)	125.0	98
75 +	126 (M) 112 (F)	129.0	91

**New Zealand data for ages 15-24 were aggregated in a single group.*

Table 8. Intake (µg/day) by age for Australia (Source: ABS, 2025c, 2023 NNPAS)

Age groups (years)	Australia (NNPAS 2023, ABS 2025c) Males Intake (µg/day) Mean	Females Intake (µg/day) Mean
2 to under 5	152.1	142.8
5 to under 12	176.2	164.8
12 to under 18	220.2	160.5
18 to under 30	194.2	144.6
30 to under 50	197.3	160.0
50 to under 65	199.6	158.2
65 to under 75	190.9	167.1
75+	193.1	164.6

Table 9. Table 1 - Intake (µg/day) by age for Australia (Source: ABS, 2015, 2011-13 AHS)

Age groups (years)	Australia (AHS 2011-13, ABS 2015) Males Intake (µg/day) Mean (95% CI)	% less than EAR	% exceeding UL	Females Intake (µg/day) Mean (95% CI)	% less than EAR	% exceeding UL
2-3	157 (100 - 222)	0.1%	12.9%	141 (88 - 202)	0.5%	5.6%
4-8	164 (106 - 231)	0.1%	0.1%	148 (93 - 210)	0.3%	0%
9-13	190 (111 - 285)	0.3%	0%	169 (102 - 247)	0.5%	0%
14-18	205 (123 - 303)	0.8%	0%	153 (91 - 229)	6.4%	0%
19-30	202 (120 - 299)	1.5%	0%	146 (86 - 218)	11.7%	0%
31-50	200 (119 - 297)	1.6%	0%	152 (91 - 226)	9.0%	0%
51-70	182 (106 - 274)	3.5%	0%	149 (89 - 221)	10.5%	0%
71 and over	178 (103 - 270)	4.2%	0%	151 (91 - 224)	9.2%	0%

A 2019 review of studies evaluating iodine status in pregnant and lactating women post-fortification found that mild deficiency remains an issue among the Australian population (Hurley et al 2019). Of the 7 studies identified, the majority (N=4) reported median UIC <150 µg/L. Of the three studies that indicated iodine replete status (median UIC >150 µg/L) two reported population sufficiency without use of an iodine supplement.

A 2016 study comparing breast milk iodine concentration (BMIC) in lactating women pre- and post- fortification (Huynh et al 2016) found a significant increase in both BMIC and the percentage with BMIC <100 µg/L (the epidemiological threshold for adequacy). However, the percentage of women with BMIC <100 µg/L was significantly lower with use of an iodine supplement during pregnancy, suggesting an ongoing role of iodine supplementation in Australian women during pregnancy - and potentially lactation - to ensure that intakes are sufficient.

These findings were echoed in a 2016 analysis of BMIC in 55 lactating women in Western Australia, which found that BMIC of most women indicated sufficiency. More than half of participants were taking an iodine supplement (57.4%), with supplementation associated with higher BMIC (Jorgensen et al 2016).

Sensitive or at-risk groups

Plant-forward diets

A recent pilot study examined median UIC in 57 women aged 18 to 50 years, comparing urinary iodine in those consuming a plant-based (vegan) diet with omnivorous diets (Whitbread et al 2021). Both groups had median UIC less than the 100 µg/L threshold for population sufficiency, with median UIC in vegan women <50 µg/L. Urinary iodine was significantly lower in vegan women compared with those who ate an omnivorous diet (44 µg/L vs 64 µg/L, p=0.04). This study suggests that women who eat a plant-based (vegan) diet in Australia may be at greater risk of iodine deficiency. The authors suggested that further research was warranted to explore potential iodine deficiency in Australian women, particularly in those of reproductive age.

Data also suggests that consumers of plant-based milks may also be at increased risk of iodine deficiency, with 13.7% of dietary iodine intake from milk (ABS, 2025c). A recent analysis of Australian plant-based milks found significantly lower levels of iodine compared with cows milk (Harmer et al 2025).

Ensuring that these groups achieve intakes aligned with recommendations is increasingly important, with growing interest in plant-forward diets with lower animal product consumption (Riverola et al. 2023).

Low bread intake

Recent national data suggests that bread consumption is in decline, with apparent consumption of breads and bread rolls 4.4g/day lower (down by 7.7%) in 2023-24 compared with 2018-19 data (ABS, 2025b). These findings are echoed by results from the 2023 NNPAS (ABS, 2025c), which reported bread and bread roll consumption of 33.9g/day for 2 - 17 year olds and 31.7g/day for adults aged 18 years and older. This is significantly lower than consumption reported in the 2011-12 NNPAS (ABS, 2015) of 66.8g/day in 2 - 18 year olds and 69.8g/day in adults aged 19+ years. [5] This downward trend in consumption patterns may have implications for the success of Australia's mandatory iodine fortification program.

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[5] It should be noted that the 2023 and 2011-12 applied differing age groupings for children and adults and the groups are therefore not directly comparable.

Socioeconomic status

A 2016 study examining BMIC in 55 lactating women in Western Australia found a significant, negative correlation between low household income (<A$50,000) and iodine supplement usage (Jorgensen et al 2016). Several studies have suggested that supplementation is critical for ensuring maternal iodine requirements are met, even with iodine fortification in Australia. This finding suggests that mothers from low-income households may be at increased risk of deficiency, due to financial barriers to accessing supplementation.

New Zealand

As in Australia, mandatory iodine fortification was introduced in New Zealand in 2009. Comparison between the 2008/09 and 2014/15 New Zealand Health Surveys (NZHS) found that iodine levels for all ages, genders and ethnic groups had almost doubled following the introduction of fortification (NZ MoH 2020). At the time of writing, data from 2014/15 NZHS are the most up to date national data on iodine status and intakes available for New Zealand. Available data are presented in Table 7.

Adults

The 2014/15 NZHS found that the median UIC for all adults was 103 µg/L - marginally above the threshold for sufficiency of 100 µg/L (NZ MoH, 2020). One in five (20.3%) of those surveyed had UIC <50 µg/L, slightly above ICCIDD recommended threshold of 20% (WHO, 2007). However, this value represents a marked decrease from the 2008/09 survey, which found that 46.8% of adults had UIC <50 µg/L and almost half (48.3%) had UIC <100 µg/L. The ICCIDD recommends that no more than 50% of the population have UIC in this range (WHO, 2007).

Median UIC varied by gender, with men recording values >100 µg/L across all ages and ethnic groups. In contrast, median UIC for women remained below the WHO threshold for sufficiency at 93 µg/L, with only those women aged 15-24 years or of Māori, Pacific and Asian ethnicities reporting concentrations >100 µg/L (NZ MoH, 2020).

These findings were echoed by a 2014 study examining the iodine status of 309 residential aged-care residents in New Zealand, aged 65 to 107 years (Miller et al 2016). Overall, the population was mildly deficient with median UIC of 72 µg/L, and 29% of those analysed with a UIC <50 µg/L. A 2012 study in also reported similar results, with median UIC of 73 µg/L observed in 301 New Zealand adults aged 18 to 64 (Edmonds et al 2016). Although median UIC was lower than the recommended WHO threshold of 100 µg/day, the authors noted that this parameter may not be appropriate for the population, in view of higher urinary volumes (2 litres per day). Instead, the authors suggested that median UIE of 127 µg/day was indicative of population adequacy.

Children

The New Zealand National Children's Nutrition Survey examined measures of population (UIC) and individual (thyroid hormones) biomarkers of iodine status in a representative sample of 1,153 children aged 5 to 14 years (Skeaff et al 2012). Median UIC was 68 µg/L and 29% of those sampled had UIC <50 µg/L, indicating mild population iodine deficiency. Median Tg concentration also suggested mild deficiency, although mean TSH, FT4 and FT3 concentrations were all within normal reference ranges.

The impact of iodine fortification on status in children was evaluated in a 2011 sub-National study of 147 New Zealand schoolchildren aged 8 to 10 years (Skeaff & Lonsdale-Cooper, 2013). It reported that - following fortification - population urinary iodine was within recommended WHO ranges, with a median UIC of 113 µg/L, and 12% of children with UIC <50 µg/L and 39% with UIC <100 µg/L. However, it noted that elevated thyroglobulin concentrations pointed to residual insufficiency in children and recommended further fortification be considered.

A 2015 study in 415 children aged 8 to 10 also reported population sufficiency, with median UIC of 116 µg/L and 5% of those sampled having UIC <50 µg/L (Jones et al 2016). However, more recently, a smaller study in 84 children aged 9 to 11 measured intake using dietary assessment methods and 24-hour urine. Intake based on UIE was estimated at 74 µg/day; below the recommended dietary intake of 120 µg/day for this age group (Peniamina et al 2019).

Māori

Median UIC reported in the 2014/15 NZHS indicated sufficient intakes in Māori men and women (117 µg/L and 108 µg/L respectively). For Māori women of childbearing age (16-44 years) the median UIC was 114 µg/L.

Pregnancy and lactation

Only a small number of pregnant women (N=110) were included in the 2014/15 NZHS, with median UIC of 114 µg/L (95% CI: 87, 141 µg/L). This result is below the recommended 150 µg/L and indicates that intakes are inadequate to meet increased requirements during pregnancy and lactation.

Although the overall median UIC in women of childbearing age (16-44 years) of 104 µg/L indicates sufficiency for non-pregnant populations, this value is inadequate to meet the needs during pregnancy and lactation, with the WHO defining sufficiency as UIC >150 µg/L. Furthermore, although iodine concentrations for Māori and Pacific women of childbearing age were within the recommended range (with median UIC of 114 µg/L and 117 µg/L respectively), the median UIC for those of European origin was 96 µg/L, indicating deficiency in this group.

A New Zealand cohort study in 87 breastfeeding mother-infant pairs enrolled at 3 months postpartum and followed up to 12 months found that two thirds had no- or low- iodine knowledge (Jin et al 2021). This knowledge was a key predictor of iodine supplement consumption, which was associated with significantly higher median UIC compared with non-users of supplements.

Sensitive or at-risk groups

A recent study examined the iodine status of 46 mid-life women (40-63 years) living in New Zealand who consume less than 1 slice per day of iodine fortified bread (Finlayson 2019). It found that New Zealand women who avoid bread were at risk of inadequate dietary intakes, with median UIC of 49 µg/L and UIE of 108 µg/day, corresponding to an estimated median intake of 120 µg/day; below the RDI of 150 µg/day. Furthermore, 91% of those sampled had intakes below the EAR of 100 µg/day.

Individuals with diets low in animal products are also expected to be at increased risk of deficiency, although there is conflicting data on the prevalence of plant-forward diets in New Zealand adults (Roy Morgan 2016; Kantar 2022, Greenwell et al 2023)

Key health outcomes of relevance to the Australian and New Zealand context

Both the Australian and New Zealand populations have a history of mild deficiency, with iodine fortification introduced in 2009 to address this public health issue. However, post-fortification studies show some subgroups may still be mildly deficient, particularly women of child-bearing age. Accordingly, the primary outcomes of relevance to the Australian and New Zealand context relate to iodine deficiency disorders and associated health effects. Although uncommon, a small proportion of the population will have usual dietary intakes exceeding the UL. It is therefore important to consider a range of health outcomes in the Australian and New Zealand context, when developing recommendations for nutritional adequacy and preventing excess, to optimise health. This includes outcomes relating to thyroid function, thyroid disease and neurocognitive development.

Thyroid disease in Australia and New Zealand

A study conducted between 1997 and 2000 (pre-fortification) identified the prevalence of thyroid disease in Australians aged 49 years or older at 14%, with 4% of those having an undiagnosed thyroid disorder (Empson et al 2007). These findings are echoed by a 2017 study in community living adults aged 49 years or older, which reported thyroid disease prevalence of 13.6%, approximately a third of whom had not been previously diagnosed (Hickman et al. 2017).

Thyroid autoimmunity has also been estimated to occur in 10-15% the Australian population, with women more commonly affected than men (O'Leary et al 2006). However, these estimates are based on data from a single locality in WA collected in 1981 and may not reflect the current population prevalence.

AIHW data suggest that thyroid cancers are strong contributors to increases in cancer incidence in those aged 30 to 49 years and affect women significantly more than men, with 70% of cases in women (AIHW, 2024). The age-adjusted incidence of thyroid cancer has increased significantly in Australia between 2000 and 2024, up from 8.5 to 22 cases per 100,000 females and from 3.3 to 10.0 cases per 100,000 males. However, the extent to which this represents a true increase in prevalence, or improved detection, is unclear. Improved detection is unlikely to account for the full increase observed (Pandeya et al 2015). There are multiple aetiologic factors that may be associated with this increase. Overweight and obesity - rather than iodine status - have been identified as significant contributors in the Australian context (Laaksonen et al 2021).

Despite this increase, age-adjusted mortality from thyroid cancer has remained stable, and thyroid cancer remains a high survival cancer. While males account for only 30% of cases, they are overrepresented in thyroid cancer mortality, with approximately 50% of deaths occurring in males (AIHW, 2024).

In New Zealand, thyroid cancer accounts for 1% of all cancer cases, with papillary thyroid cancer the dominant subtype, accounting for 80% of all thyroid cancers. Thyroid cancer has a low mortality burden in New Zealand, with a 98% survival rate (IARC 2022, Te Aho o Te Kahu, 2025). Some groups are at increased risk of thyroid cancer, including Pacific populations and women.

Although increasing incidence of congenital hypothyroidism was noted in New Zealand between 1993 and 2010, this change has been attributed to changes in the ethnic composition of the population, with ethnic-specific indices of congenital hypothyroidism remaining stable (Albert et al 2012).

Beyond data on thyroid cancer, data on thyroid disease prevalence in New Zealand is largely from studies conducted prior to mandatory fortification (Thomson et al 2001, Gibbons et al 2008) and may not reflect current population prevalence.

Thyroid disorders and disease are prevalent within both the Australian and New Zealand populations. However, the aetiology of disease is multifactorial and is unlikely to be directly related to population iodine status. Nevertheless, the prevalence of thyroid diseases in Australia and New Zealand underscores the importance of developing NRVs based on the best available evidence, to optimise population health.

Studies have reported increased incidence of thyroid disease in Pacific and Māori populations compared with European populations (Meredith et al 2014, Tamatea et al 2020, Angelo et al 2020). Whilst aetiology has not been fully explored, determinants of health including stress and smoking history have been proposed as factors. A relationship between dietary sources of iodine, or iodine status and higher rates of thyrotoxicosis amongst Māori has not been proposed and is not indicated by the available population data which suggests median UIC in the sufficient range for Māori adults (NZ MoH, 2020). Nevertheless, the increased prevalence of thyrotoxicosis and thyroid eye disease (Tamatea et al 2020, Rapata et al 2023) in this population should be considered when making recommendations about iodine intakes to optimise thyroid function and health.

Child neurocognitive development

Supplementation during pregnancy

It is recommended that those who are pregnant and breastfeeding take a supplement containing 150 µg of daily iodine to ensure sufficient intake (NHMRC 2010). However, studies suggest that Australians' knowledge of - and adherence to - recommendations is low (El-mani et al 2014, Lucas et al 2014, Martin et al 2014, Malek et al 2016, Guess et al 2017, Hine et al 2018, Nolan et al 2022). Affordability of supplements has also been identified as a barrier to use (Nolan et al 2022). Furthermore, although iodine supplementation has been associated with adequate iodine status in pregnant Australian women (Hurley et al 2019), some studies suggest that supplementation may not address deficiency during pregnancy, unless commenced during pre-conception and continued throughout pregnancy (Hynes et al 2019).

Similar to findings in Australian women, a 2017 study reported low adherence to iodine supplementation recommendations during pregnancy and breastfeeding, with only 52% of 535 New Zealand women sampled adhering to recommendations (Reynolds and Skeaff 2017). This highlights the importance of ensuring iodine sufficiency in women of childbearing age, before they enter pregnancy.

Summary of Evidence

Physiological requirements

Balance and thyroid accumulation studies

Previous analysis of balance and thyroid accumulation studies suggests that neutral iodine balance is achieved at intakes of around 100 µg/day, and not below 40 µg/day (US IOM 2001, NHMRC 2006). However, studies of thyroid iodine accumulation may not be sufficiently reliable, with evidence suggesting that downregulation of thyroid iodine capture occurs as iodine intake increases (EFSA 2014, Bernard et al 1970; Hooper et al 1980; Tovar et al 1969; Follis et al 1962; Milakovic et al 2006). Thyroid accumulation studies upon which previous recommendations were based were conducted in populations with average urinary iodine excretion of 410 µg/day and 280 µg/day (Fisher and Oddie, 1969a, Fisher and Oddie, 1969b), suggestive of higher iodine intakes. These studies may underestimate requirements for nutritional adequacy.

EFSA (2014) have also raised concerns about the reliability of balance studies for estimating requirements, concluding that evidence from balance studies was insufficient to derive an NRV. In view of concerns about the suitability of balance studies for estimating requirements (see 'International comparisons' for a summary of concerns raised by EFSA) we sought balance studies published since 2014 that comprehensively measured iodine losses and included an adequate 'run in' period. One balance study was identified in adults (Tan 2019). Total iodine intake (including food, water and air) and excretion (urine, faeces, respiration and sweat) were measured in 25 young Chinese women (mean age 22 years) over a 4 week period. Median (IQR) UIC at baseline was 129.4 µg/L (102.1 - 149.1). Non-iodised salt was provided for the first 3 weeks of the intervention period, followed by 1 week with iodised salt provision. Analysis was restricted to the last 3 days of each 7 day intervention period, to account for the effects of preceding days' intake on UIC. Neutral balance was calculated by regression to zero, calculated to occur with iodine intakes of 110.5µg/day, equating to a RDI of 154·7µg/day, when a 20% co-efficient of variation (CV) was applied.

Despite the comprehensive approach to measuring losses, concerns remain about the duration of intervention, as the study included no run-in period and the dietary iodine intake varied between weeks 1 - 3 (period 1) and week 4 (period 2). The study was conducted in young female students and may be limited in generalisability to males and older adults within the Australian and New Zealand populations. Overall, while evidence from balance studies may provide supportive evidence for recommendations, the evidence remains insufficient for the purposes of deriving an NRV.

Requirements to support thyroid hormone synthesis and basal losses

Studies suggest that thyroid hormone synthesis (T3 and T4) in adult euthyroid subjects requires approximately 50 to 70 µg/day of bioavailable iodine (EFSA 2014, Nicoloff et al 1972, Chopra 1976, Kirkegaard et al 1990, Bregengard et al 1987, Cardoso and Rosenthal 1987, Faber et al 1988, Gavin et al 1977). This value represents the amount of iodine required for thyroid hormone production and does not account for unabsorbed iodine excreted via faeces, saliva, urine or sweat. EFSA

(2014) estimated these losses at approximately 60 µg of iodine per day, although substantial uncertainty surrounds these estimates.

Allowing for an absorption efficiency of 92%, a required iodine intake of 130 µg/day can be derived, using the factorial approach (EFSA 2014). This value can guide recommendations about daily iodine requirements in adults. However, it should not be used to establish an EAR due to uncertainty in the evidence for underlying inputs.

Requirements during pregnancy

Neutral balance during pregnancy

One balance study in 93 pregnant Chinese women examined iodine intakes from usual diet and measured excretion via urine and faeces (Chen et al 2023). The home-based study involved participants maintaining their usual diet and recording food intake using the duplicate portion method. Participants were also trained to collect urine and faecal samples for the duration of the study period. Estimated excretion via sweat was also accounted for based on body surface area and assuming sweat iodine concentration of 37µg/L based on BMI and (estimated) sweat. Simple linear regression was used to examine the association between intake and retention/excretion for the whole population, and for two subpopulations from areas with a lower (Hebei and Tianjin) and higher (Shandong) habitual intake. The authors noted that negative balance occurred with iodine intakes <150µg/day, with positive balance observed with intakes >550µg/day. Neutral balance occurred at intakes of 343µg/day, although this figure reduced to 202µg/day (N=40) when the Shandong population with high habitual intake was excluded. This corresponded with a RDI of 280µg/day when applying a 20% CV.

This balance study overcame some limitations of classical iodine balance studies, with participants maintaining their typical diet, rather than implementing an experimental diet. This negated the requirement for adequate 'run in' periods, provided that participants did not alter their diets in response to the experimental conditions. Nevertheless, this approach also has some limitations, including that participants may alter their diet - or omit some foods from the duplicate portions - due to social desirability bias. Furthermore, while participants were trained in sample collection methodology, there is no information provided about adherence to these protocols. Consequently, the potential for sampling errors cannot be ruled out.

Similarly, the authors note that experimentally derived estimates of iodine balance have been found to increase with higher habitual iodine intake - potentially due to in increased iodine storage with high habitual intake. Consequently, the lower estimate of neutral balance (202µg/day) derived from 40 pregnant women in Tianjin and Hebei likely provides a more accurate estimate of minimum requirements for preventing deficiency. The intake at which neutral balance occurred was also higher in the third trimester compared with the first trimester, suggesting that iodine requirements may vary during pregnancy. Finally, the authors noted that missing data due to loss to follow-up or missed sample collection may have impacted findings, with only 55 of the 85 enrolled participants providing samples across all 7 days.

Additional requirements during pregnancy

Iodine intake during pregnancy must be sufficient to support maternal thyroid function and fetal development. Production of maternal thyroid hormones increase during pregnancy, with studies suggesting increased requirements of 40 to 60 µg/day of exogenous thyroxine in fully T4-substituted patients, equating to approximately 20 - 29 µg/day of iodine capture (EFSA 2014, Mandel et al 1990, Alexander et al 2004, Kaplan 1992, Yassa et al 2010). To meet this need, EFSA (2014) estimated additional thyroid iodine capture to be 25 µg/day, equating to an increase of 44 µg/day in iodine intake. Additional iodine is also required to support fetal development, including production of thyroid hormone for storage in the fetal thyroid, placenta and amniotic fluid, although these requirements are estimated to be very low, equating to 1µg/day throughout pregnancy (EFSA 2014).

Requirements during lactation

Neutral balance in infants

A 2016 crossover study examining iodine balance in 11 healthy, formula-fed infants aged 2 to 5 months found that null balance occurred with intakes of 70µg/day (Dold et al 2016). However, it has been suggested that intakes should exceed that required for nutritional adequacy of infants during this life stage, to support accumulation of thyroidal iodine (Dror & Allen 2018).

Breast milk composition

The linear relationship between maternal iodine intake and breast milk iodine concentration (BMIC) in the range 50 - 400 µg/L (Azizi and Smyth, 2009) suggests that BMIC varies with maternal intake, rather than reflecting infant requirements. Nevertheless, an understanding of the levels of iodine excreted in breast milk is informative for determining intake requirements during lactation. In populations with adequate thyroid status and iodine intakes, EFSA (2014) iodinated Tg reserves mean that intake is not required to fully compensate for iodine losses in breast milk. Furthermore, in the Australian and New Zealand context - in which many women of childbearing age enter pregnancy in a state of mild deficiency - thyroidal iodine stores may be limited, and recommendations may need to approach full replacement to avoid deficiency states.

There is no established reference range for breast milk iodine concentration (BMIC), and significant variation in BMIC is noted both between populations, and over the course of lactation (Dror & Allen 2018). A systematic review of the iodine content in human breast milk found that - in the first 6 months of lactation - infant requirements would be met with BMIC of 150µg/L (Dror & Allen 2018). This finding supports the conclusions of EFSA (2014) which suggested that positive balance was reached with BMIC between 100 and 200 µg/L. Assuming an average breast milk volume of 0.8L / day, EFSA suggested that an additional 120 µg/day of iodine would be required to achieve BMIC of 150µg/L (EFSA 2014).

Intake, status and health relationships

Intake and status

Goitre prevalence

We sought studies that measured median UIC (MUIC) and goitre prevalence, to identify MUIC levels associated with population sufficiency (goitre prevalence <5%) (WHO 2007). Substantial variation in the MUIC values and prevalence rates reported across studies was noted. This may be explained by a range of variables including differing geographic or nutrition contexts and related factors such as historical intakes (and delays in thyroid volume adjusting to adequacy where history of deficiency), methods for assessing goitre prevalence or thyroid volume, or failure to account for body surface area or age during thyroid volume assessment. For this reason, consideration was limited to studies conducted in regions comparable to the Australian or New Zealand context, for which robust measurement methods were reported. Studies in populations with UIC > 100 and a recent history of deficiency were not considered, given the prolonged duration required for thyroid volume to return to normal following chronic deficiency.

EFSA (2014) recommendations are based on a study in 7,599 European school children across 57 sites in 12 countries (Delange et al 1997). Participants were aged 6 to 17 years, including a broader range of age groups than the WHO recommended school aged children of 6 to 12 years old (WHO 2007). Total goitre prevalence was more than 5% even in countries with median UIC >100µg/L. However, when adjusted for age and body-surface area, the 5% prevalence cut off was associated with median UIC of between 60 and 70µg/L. On this basis, the reference UIC value of 100µg/L was selected from which AI values were derived.

In the Australian and New Zealand context, studies measuring median UIC and total goitre prevalence in children have reported mixed results. One study in 324 Australian children aged 5 to 13 years residing on the Central Coast of NSW reported a goitre prevalence of 0 with median UIC of 82 µg/L (Guttikonda et al. 2003). During a similar time period, but in Melbourne, a study in 577 older school children aged 11 to 18 years reported a goitre prevalence of 19% with median UIC of 70µg/L (McDonnell et al 2003).

Health outcomes in adults

Thyroid function

Iodine deficiency

Iodine is an essential nutrient for thyroid hormone synthesis, and consequently severe deficiency affects thyroid hormone production ad thyroid function. However, the association between mild-to-moderate deficiency and thyroid function is less well-established. A recent systematic review explored this relationship, and found that comparative studies including individuals with both mild-to-moderate deficiency and adequate iodine status were lacking (Aarsland et al 2025). A total of 20 cross-sectional studies were identified that examined the effects of mild-to-moderate deficiency on thyroid function in the general adult population. Narrative synthesis was performed, with no consistent evidence of an effect reported across studies for the various thyroid function parameters reported (TSH, T3 and T4). These findings accorded with those of a 2020 analysis undertaken by the Norwegian Scientific Committee on Food and Environment (VKM, 2020) which found insufficient evidence to determine whether mild-to-moderate iodine deficiency was associated with thyroid dysfunction in nonpregnant adults.

Excess intakes

Evidence scoping (see 'Appendix D - Outcomes from review of primary studies') identified five interventional studies in healthy, euthyroid adults that explored the effect of supplementation with iodine on status and thyroid function measures. However, studies were not combined in analysis due to significant heterogeneity in the setting, baseline and historical iodine status, and challenges with combining estimates of effect across varying urinary iodine measures. One study (Sang 2012) assessed a broad range of supplementation doses and reported both the supplementation amount and a measure of dietary iodine intake to enable calculation of overall iodine intakes. Data from this publication was analysed further to inform nutrient recommendations for iodine.

Sang et al. (2012) evaluated the effect of varying levels of supplementation (0 - 2000 µg/day) on thyroid function parameters in 256 young, euthyroid Chinese adults aged 19 to 25 years. Participants with thyroid dysfunction, TPOAb, TGAb or low urinary iodine (<100 µg/L) were excluded from participation.

The trial was performed in two phases, with the initial phase conducted in 2004 (iodine supplement >500 µg/day) and the second phase (iodine supplement 0-400 µg/day) in 2008. Participants were randomised to one of twelve interventions of iodine supplementation ranging from 0-2000 ug/day for a four week period.

Dietary iodine intake was assessed with self-administered 24-hour recalls. Most participants obtained their food from cafeteria at the Tianjin Medical University, limiting the range of foods reported. Iodine content of reported foods consumed was calculated from Chinese food composition tables and informed by sampling 169 samples of 36 commonly reported foods as well as 15 drinking water and salt samples from University cafeterias. UIC from spot urine also measured at each timepoint.

Serum concentrations of FT_4, FT_3, and TSH were measured by automated chemiluminescent immunoassay, with reference ranges of: 11.5-23.5 pmol/L (FT_4); 3.5-615 pmol/L (FT_3) and 0.3- 5.0 mU/L (TSH). Baseline median UIC was 272 and 304 µg/L in 2004 (phase I) and 2008 (phase II), respectively.

We extracted numerical data and plotted it to show associations between total iodine intake (supplementation and dietary sources) and measures of thyroid function and size with a locally weighted regression curve (or bar graph for incidence of subclinical hypothyroidism). The resulting graphs for other thyroid function measures are shown at Appendix B - Supplementary analyses, Sang et al (2012), with results for elevated TSH and subclinical hypothyroidism shown here. Measures of variance, either confidence intervals or 25th/75th percentiles, are shown as dashed lines around the regression line. The mean results for the twelve iodine interventions that inform the line are shown as grey circles.

Overall, the results from Sang et. al. (2012) demonstrate significant capacity for the thyroid to adapt to high intakes of iodine - including intakes substantially exceeding current UL recommendations. However, elevated TSH and increasing rates of subclinical hypothyroidism were observed with iodine intakes of 869 µg/day or greater. At this level of intake, cases of subclinical hypothyroidism became significantly increased, and the upper bound of the 95% CI for TSH was elevated beyond the top of the reference range, which Sang et. al. (2012) stated to be 0.3-5.0 mU/L for the TSH assay used.

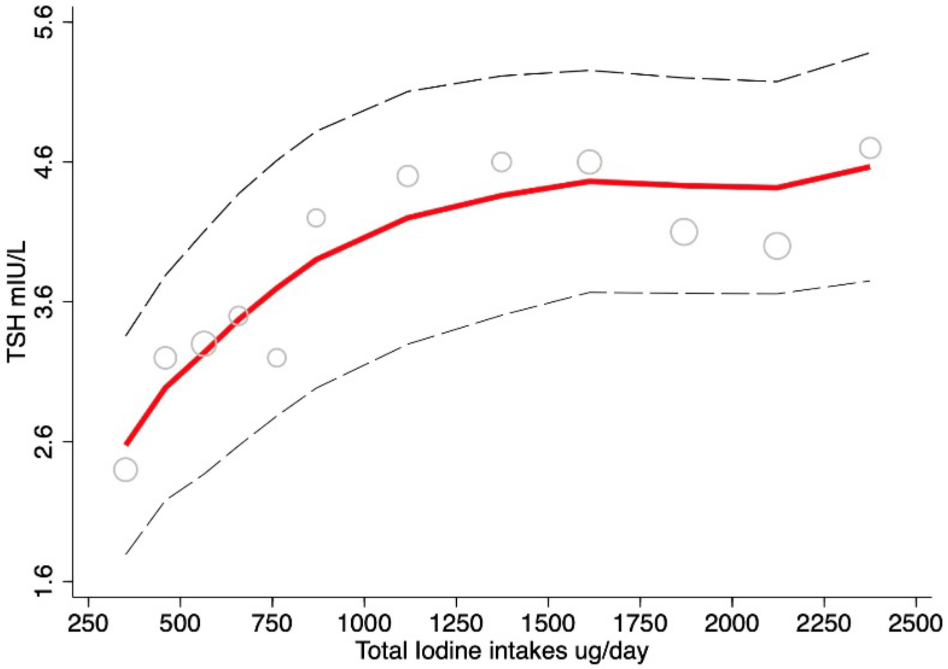

Figure 4. Mean TSH concentration with 95% confidence intervals and total Iodine intakes from 256 euthyroid adults after being randomized to one of twelve Iodine supplementation levels (0-2000ug) for four weeks.

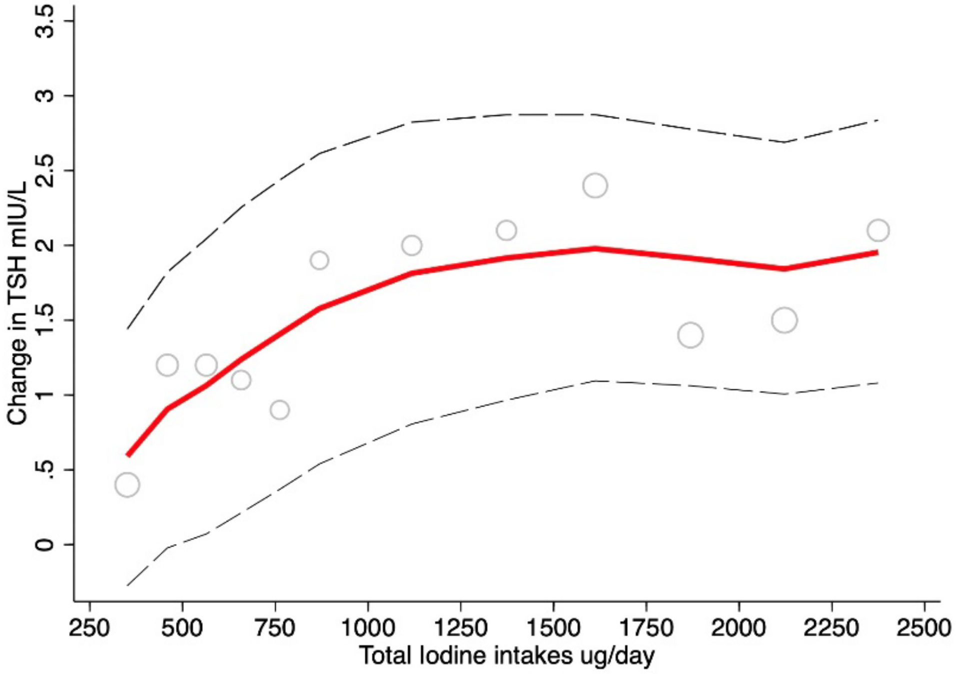

Figure 5. Change in TSH concentration with 95% confidence intervals and total Iodine intakes over four weeks in 256 euthyroid adults randomized to one of twelve Iodine supplementation levels (0-2000ug).

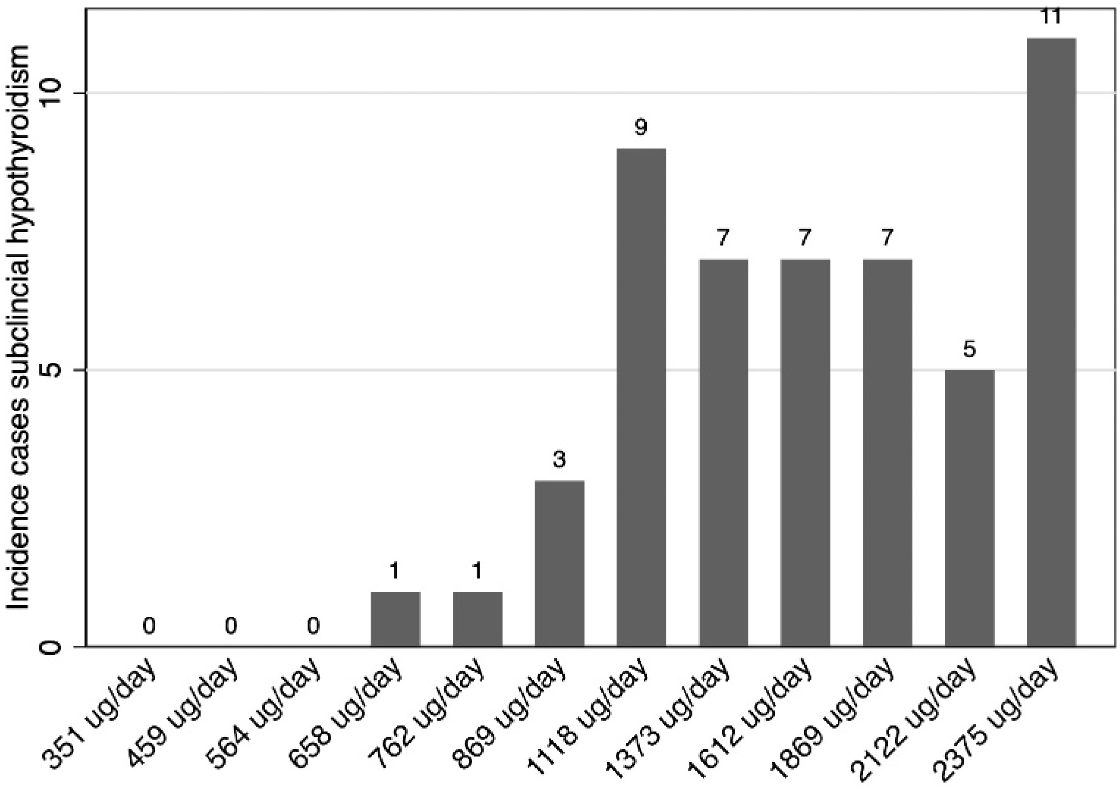

Figure 8. **Incidence cases subclinical hypothyroidism by total Iodine intakes within four weeks in 256 euthyroid adults randomized to one of twelve Iodine supplementation levels (0-2000ug).**

Thyroid disease

A 2017 systematic review and meta-analysis evaluating the relationship between iodine intake and thyroid disease (including thyroid cancer, nodules, hyperthyroidism and hypothyroidism) found that thyroid disease (any) prevalence was lowest when median UIC was between 100 - 299 µg/L (Weng et al 2017).

Reviews examining the effect of iodine intake on thyroid cancer report mixed results. Cao et al (2017) sought case-control or cohort studies examining the effects of excess iodine intake (≥300 µg/day) or deficient intake (≤74mg/day) on odds of thyroid cancer. Only three studies were identified that reported iodine intake. Meta analysis of 2 studies found that odds of thyroid cancer were reduced with excess iodine intake (OR 0.74; 95% CI 0.60, 0.92; p=0.007). No significant effect was observed when for deficient intakes and thyroid cancer odds (OR 1.22; 95% CI 0.94, 1.58; p=0.13).

Weng et al (2017) identified four studies examining the prevalence of thyroid cancer among groups with low (UIC <100 µg/L), medium (UIC 100 - 299 µg/L), and high (UIC ≥300 µg/L) iodine groups. No significant difference in thyroid cancer prevalence was observed between the medium or high iodine groups (no studies were identified in low iodine groups).

Finally, Lee et al (2017) examined the relationship between iodine exposure and papillary thyroid carcinoma. Iodine exposure was determined using a range of measures including UIC, population median UIC based on geographic location, regional salt iodization status, or dietary intake assessment. Overall, 16 studies evaluating iodine exposure and PTC odds were identified and pooled in meta-analysis. High iodine exposure was associated with increased odds of PTC (OR 1.418; 95% CI 1.054,1.909; p=0.02). However, subgroup analyses stratifying by iodine exposure measurement revealed inconsistent effects, with effects greatest when exposure was assessed by UIC or salt iodization. Consistent with the findings of Cao et al (2017), subgroup analyses revealed an inverse association between high iodine intake (based on dietary intake) and PTC (OR 0.842; 95% CI 0.608, 1.177; p=NR). Results from subgroup analysis were not statistically significant for any group.

Health outcomes during pregnancy and lactation

Maternal thyroid parameters

Iodine deficiency

A recent systematic review (Aarsland et al 2025) examined the relationship between mild-to-moderate deficiency in pregnant and lactating women (Aarsland et al 2025). A total of 43 studies were identified, comprising 30 cross-sectional studies, 12 repeated cross-sectional studies, and 1 cohort study. Studies comparing thyroid function data in mild-to-moderately deficient and adequate groups were included in a meta-analysis. No significant differences were found between groups for TSH (8 studies), T3 (4 studies) or T4 (6 studies). Narrative synthesis across studies also found inconsistent results across the thyroid function parameters reported (TSH, T3, T4 and thyroid dysfunction).

Supplementation and maternal thyroid function

A 2024 systematic review identified 4 studies that examined the effect of iodine supplementation on thyroid measures in post-partum women (Nazeri et al 2024). Two of the four studies were conducted in New Zealand, with the remaining studies in Morocco and Germany. Iodine dose varied from 75 to 300 µg /day oral iodine or a single 400 mg dose of iodised oil. No significant difference in thyroid measures was reported between iodine supplementation and control groups.

Excess intakes

Data from cross-sectional studies suggest that intakes >500 µg/day during pregnancy may be associated with maternal thyroid dysfunction (Wu et al 2023, Sang et al 2012, Guo et al 2025). However, a systematic review on the effects of excess iodine on thyroid disease reported inconsistent findings across studies (Katigiri 2018). In many studies, iodine intake is estimated from urinary iodine concentration from spot urine, or UIE. These estimates rely on the assumption that the rate of iodine uptake is 90-92% based on observations under steady state conditions, which may not hold during pregnancy (see 'Urinary iodine excretion (UIE)' above).

Furthermore, pregnancy results in transient fluctuations in thyroid hormone levels - particularly early in gestation - and gestation-specific reference intervals for both UIC (Stilwell et al 2008) and thyroid measures (Gilbert et al 2008; Stricker et al 2007) should be adopted to account for such variation. Cross-sectional studies typically include women at varying gestational stages, which may lead to confounding of thyroid measures if analyses fail to account for gestational age (along with other important confounders). Finally, these studies rely on urinary iodine measures for estimating iodine intake, including single spot urine analysis. This may lead to imprecise or inaccurate estimates of intake, because the rate of iodine uptake observed under steady state conditions (around 90-92%) may not hold, due to associated physical alterations during pregnancy (NNR 2023, Stilwell et al 2008). Consequently, the evidence for adverse effects with intakes >500 µg/day during pregnancy is not compelling, for the purposes of establishing an UL for the Australian and New Zealand population.

The evidence for the relationship between maternal iodine status and thyroid function in lactating women is also limited. A 2024 systematic review of cross sectional and cohort studies found no significant differences in thyroid hormone levels (except for TSH) when comparing studies with median UIC < 50, 50-100, 100-200, and > 200 µg/L in post-partum women (Nazeri et al 2024). However, although some studies were reported as being in lactating women (or inferred, through inclusion of BMIC data), it was unclear whether the review included both lactating and non-lactating post-partum women. Although median UIC >200 µg/L was associated with significantly higher TSH concentrations compared with median UIC of 50- 100 µg/L or <50 µg/L, TSH remained within the normal range. Similarly, no significant difference in thyroid measures were reported in post-partum women with BMIC <100 µg/L compared with BMIC ≥100 µg/L, with measures within the normal ranges. However, these findings should be interpreted with caution, due to the methodological limitations of cross-sectional and cohort studies, significant heterogeneity across studies, wide variability in intakes and status (median UIC ranging from 23 to 504 µg/L) and in the background nutrition setting of countries.

Child neurocognitive development

The association between severe iodine deficiency during pregnancy and global impairments in child cognitive development has long been established. More recently, concerns have been raised about the potential effects of mild iodine deficiency on neurocognition. Researchers have proposed the concept of 'Gestational Iodine Deficiency Processing Disorder (GIDPD)' as a nosological entity describing the more subtle effects of mild-to-moderate iodine deficiency (Hay et al 2019). The authors analysed four recent, robust, longitudinal studies in mild to moderate deficiency, to identify common patterns in the neurodevelopment of children born to mothers with mild-to-moderate gestational iodine deficiency. Key features identified included difficulties with processing speed and working memory, and difficulties with attention and response inhibition, manifesting as disorders such as Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), learning disabilities and dyslexia. However, this study aimed to present a conceptual, phenomenological examination of the literature, and findings are not based on a systematic examination of the literature. The risk of bias of underlying studies, and quantitative synthesis of studies, was not undertaken.

Robust supportive evidence of consistent adverse neurocognitive effects associated with mild-to-moderate iodine deficiency are lacking. A recent systematic review exploring the association between maternal UIC, dietary iodine intake and child neurodevelopment identified 12 reports of 9 studies, comprising large sub-national or national cohorts (Monaghan 2021). While lower urinary iodine was associated with reduced performance across a range of neurodevelopmental measures in some studies, others found no significant effects. Where findings were significant, these were inconsistent across measures. The authors noted significant heterogeneity in the body of evidence, including in the cognitive outcomes measured.

It has also been suggested that excess habitual iodine intake may have adverse effects on child intellectual development, although evidence for this relationship is also limited (Li et al 2022).

Finally, a 2023 review examined the effects of iodine exposure during pregnancy on development of hearing in children (Dineva et al 2023). Four studies were identified comprising 1 RCT in 302 participants (low RoB) and 1 cohort study in 45 mother-child pairs (good quality)- both in mild to moderately deficient populations. No significant effects were observed, except for one measure (binaural integration) with deficiency associated with significantly lower scores for one ear but not the other, when compared with the sufficient group. Notably, the sample size was small (N= 15 participants in the sufficient group). Two case reports were also described, documenting excessively high iodine intake during pregnancy, with one case resulting in sensorineural hearing loss, whilst the other - treated with intra-amniotic levothyroxine during pregnancy - resulting in a euthyroid fetus with neonatal hearing screenings results within the normal range.

Supplementation and neurocognitive development

Several systematic reviews have examined the relationship between iodine supplementation during pregnancy and child neurocognitive development (Harding 2017, Dineva 2020, Machamba 2021, Nazeri 2021). Meta-analysis of the limited available evidence found that supplementation does not significantly improve neurocognitive development outcomes (Nazeri 2021). However, the authors suggested that these findings may reflect the late introduction of supplementation, along with variation in the degree of sufficiency prior to supplementation. These reviews generally concluded that there was a lack of high-quality evidence on the effect of supplementation on child neurocognitive development (Dineva 2020, Harding 2017).

The importance of pre-conception iodine supplementation has previously been noted, including in a 2019 Australian study which reported significantly higher UIC with pre-conception supplementation compared with those who commenced supplementation during pregnancy (Median UIC 196 (98 - 315) µg/L vs 137.5 (82.5 - 233.5) µg/L, p = 0.032) (Hynes 2019). Accordingly, although evidence suggests that child neurocognitive development outcomes may not improve with maternal iodine supplementation, this may relate to the timing at which supplementation occurred. Further research is required to characterise the relationship between maternal iodine intake and status, and child neurocognitive development in greater detail.

Australian and New Zealand studies

The Australian Gestational Iodine Cohort study followed children born to mothers during a period of mild population iodine deficiency who then grew up in an iodine replete environment. It found that children born to mothers with UIC <150 µg/L had lower school performance scores (NAPLAN) across all tests at every time point (school year 3, 5, 7 and 9) compared with those with UIC ≥150 µg/L (Hynes et al 2013, Hynes et al 2017). When adjusted for confounders, these effects remained significant for spelling at all time points. Significantly higher scores were associated with UIC ≥150 µg/L up to year 9 for grammar, and in years 3 and 5 for reading.

A subset of this cohort were traced and assessed for language development using the Comprehensive Evaluation of Language Fundamentals (CELF-4) tool. Although the sample was small (N=46), adjusted regression modelling reported that children born to mothers with UIC <150 µg/L had reduced scores for language across all indices, however the differences were not statistically significant (Hynes 2017).

In contrast, a 2019 Australian study examining the association between mild iodine deficiency and child neurodevelopment at 18 months found no association between UIC <150 µg/day during pregnancy and Bayley Scales of Infant and Toddler Development, Third Edition (Bayley-III) scores (Zhou et al 2019). The authors suggested that these differing findings may be explained by the failure of Hynes (2013) to adjust for key confounders including maternal IQ and home environment. The authors also note that this lack of association may also reflect the unsuitability of UIC as a marker of individual habitual intakes, rather than a lack of association between maternal intake and child neurocognitive development. Notably, although no association was observed between mild deficiency (MUIC <150 µg/day) and child neurocognitive outcomes, analysis comparing intake - measured using a validated food frequency questionnaire - and Bayley-III scores reported lower cognitive, language and motor scores and higher odds of cognitive developmental delay with maternal intakes in the lowest and highest quartiles (<220µg/day or >390µg/day) compared with intakes between 220 µg/day and 390 µg/day (Q2 and Q3).

More recently, Sullivan et al (2024) published a re-analysis of 2013 data from an Australian cohort of 699 pregnant women and their offspring, with the aim of identifying the range of iodine intakes associated with optimal neurocognitive development. Analysis was restricted to participants for whom data on child neurocognitive assessment at 18 months were available, with models adjusted for maternal factors including IQ, age, parity, smoking, educational status, and quality of maternal caregiving. Maternal intake was measured using a validated dietary assessment questionnaire at 16 and 28 weeks gestation, with cognitive and language development measured at 18 months using the Bayley-III. A curvilinear relationship between iodine intake during pregnancy and cognitive ($p=0.001$) and language scores ($p=0.004$) was reported, with lower scores observed in the lowest and highest quartiles. This observation remained when multiple imputation analysis was performed to address missing data.

The authors reported that iodine intakes between 185 and 365 µg/day during pregnancy were optimal for cognitive and language development.

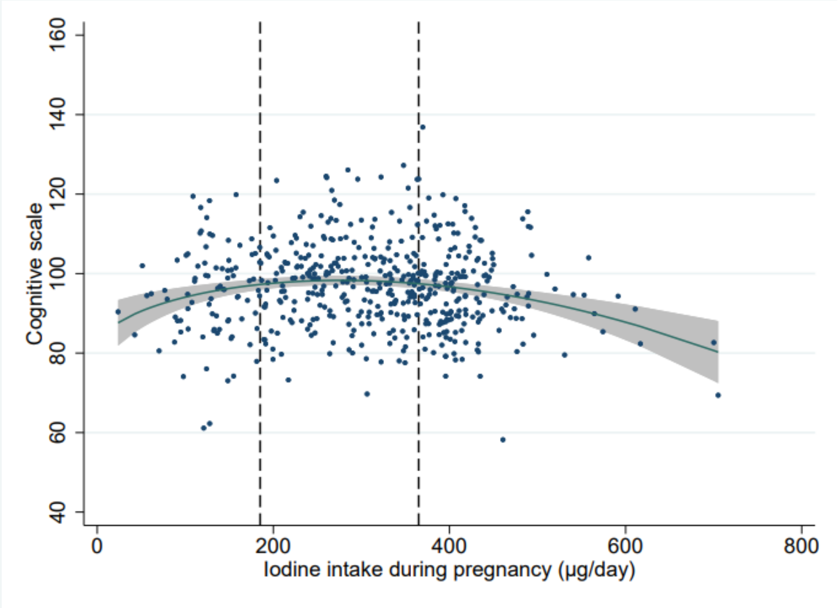

Figure 9. **Figure from Sullivan et al (2024) showing curvilinear relationship between iodine intake during pregnancy and Bayley-III cognitive scores.**

Shaded area is a 95% confidence interval around the fitted curve, whereas the vertical dashed lines are the proposed thresholds for iodine intake. Adjustments were made for maternal IQ, age, parity, smoking in pregnancy, years of education, and Home Screening Questionnaire score. Analysis based on n ¼ 524 participants with complete data.

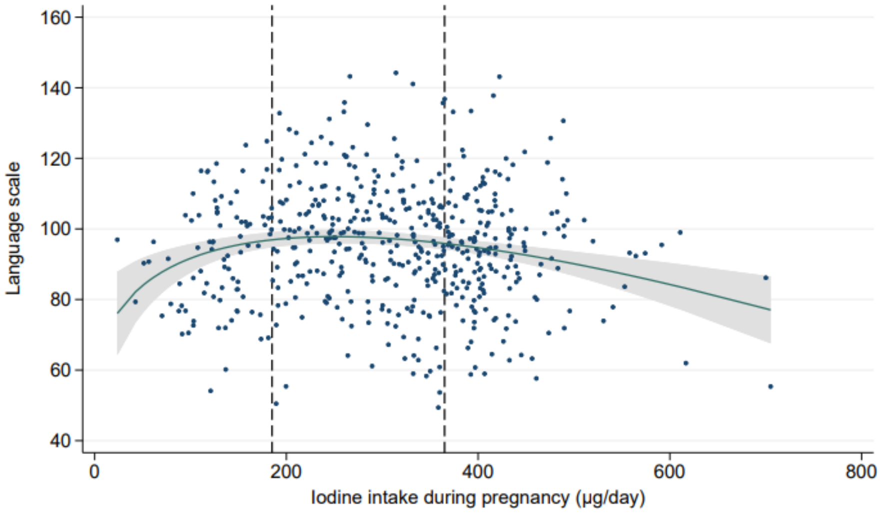

Figure 10. **Figure from Sullivan et al (2024) showing curvilinear relationship between iodine intake during pregnancy and Bayley-III language scores. The shaded area represents the 95% confidence interval around the fitted curve, with vertical dashed lines showing the proposed thresholds for iodine intake. Based on N = 522 participants with complete data. (Sullivan et al 2024)**

These findings underscore the need to ensure that women of childbearing age enter pregnancy in a state of sufficiency and that this status is maintained throughout pregnancy and lactation.

Although the available evidence for maternal intake during pregnancy and child neurocognitive development is insufficient to derive a NRV for pregnant women, it provides complementary data that can inform decision-making when setting iodine recommendations.

Birth outcomes

Several recent systematic reviews have examined the relationship between urinary iodine concentration and birth outcomes, including birth parameters (weight, length, head circumference) and pregnancy outcomes (pre-eclampsia, miscarriage, pre-term birth, still birth, infant mortality). These reviews compared the effect of various levels of urinary iodine including UIC ≥150 µg vs <150 µg (Nazeri et al 2020b, Greenwood et al 2023, Businge et al 2021, Bolfi et al 2025), UIC < 100 vs 100-149 vs 150-249 vs > 250µg/L (Nazarpour et al 2020 and iodine supplementation vs control (Nazeri et al 2021) on a range of birth outcomes. No consistent association between higher urinary iodine and improved birth outcomes were reported across reviews.

Bolfi et al (2025) assessed the certainty of evidence using the GRADE approach, noting that evidence was low or very low certainty across all outcomes, although reasons for downgrading were not reported. Limitations in the evidence base include failure of observational studies to measure or account for all relevant confounders, and heterogeneity in population status - with the review including sufficient (34 studies), mildly deficient (9 studies) and moderately deficient (15 studies) populations - and timing of exposure (UIC) measurement.

Further, whilst WHO epidemiologic criteria define UIC <150 µg/day as insufficient, this is a population measure and is not a reliable indicator for determining individual status.

The available evidence for the relationship between urinary iodine and birth outcomes is not sufficiently sensitive to inform recommendations about iodine intake.

Health outcomes in children and adolescents

Thyroid function

Iodine deficiency

A recent systematic review identified 7 studies examining the relationship between mild-to-moderate deficiency and thyroid function in children and adolescents (Aarsland et al 2025). Studies were all cross-sectional in design, with one study a repeated cross-sectional design. Most studies were in school-aged children (5 studies), with one in infants and one including children up to <18 years. Most studies grouped participants as deficient (UIC <100 µg/L) vs adequate (UIC>100 µg/L), and data for mild-to-moderately deficient populations were not specifically reported. Six of seven studies found no association between UIC and TSH, with one study reporting a decrease and subsequent increase in TSH with higher UIC in school-aged children. Similarly, only one of four studies reported decreased T3 with UIC <100 µg/L, although T3 values remained within the normal reference range. Four studies found no clear association between UIC level and T4. Overall, the authors graded the evidence as ‘limited—no conclusion’ under the World Cancer Research Fund criteria for judging the certainty of evidence (WCRF 2018). Limitations included the predominance of cross-sectional studies and a lack of robust study designs, inconsistent results between studies including in the direction and significance of effects.

Excess intakes

There is a lack of data on the effects of iodine excess on thyroid function in children and adolescents, with studies reporting inconsistent findings about the association between high iodine intakes and thyroid function in children (Sohn et. al. 2024). Concerns have been raised about the effects of exposure to high acute doses of iodine via iodinated contrast media on thyroid function in children, with studies reporting increased TSH and reduced FT3 and FT4 in exposed groups (Sohn et al 2024). However, these exposures typically involve administration of doses substantially exceeding recommendations (some 150 times the recommended daily intakes) and consequently, they are of limited utility when seeking to establish safe tolerable upper limits for intake within the general population.

Child development

Few studies have been published examining the effects of iodine exposure in children, with studies on child development predominantly evaluating the effects of maternal iodine exposure during pregnancy and lactation.

One review was identified exploring the effects of iodine exposure in childhood on hearing (Dineva et al 2023). It identified 9 studies comprising 1 RCT, 2 NRSIs and 6 cross-sectional studies in severely deficient (4 studies), severe-to-moderately deficient (1 study), mildly deficient (1 study) or iodine sufficient (3 studies) children. Iodine exposure was determined from UIC - along with thyroid volume / goitre or Tg where available - in the absence of dietary intake data. Studies were generally assessed as being at high (RCT) or serious risk of bias (NRSIs), or of poor quality (cross-sectional studies). The generally poor quality of studies, and heterogeneity in study designs and iodine measurement methods limited comparability across studies. Overall, the authors concluded the available evidence was limited and further research on the effects of iodine status on hearing development in children is required.

Derivation of draft NRVs

Nutritional adequacy recommendations

Adults

Current recommendations for adults are based on studies reporting average thyroid iodine accumulation and turnover between 91.2 and 96.5 µg/day in euthyroid adults (Fisher and Oddie, 1969a, Fisher and Oddie, 1969b). Values were rounded to 100 µg/day to reflect New Zealand data on urinary iodide to thyroid volume (Thomson et. al. 2001).

The RDI was established by applying a 20% co-efficient of variation (CV), being half of the 40% CV reported by Fisher and Oddie (1969a). This adjustment was made on the basis that half of the observed variation was considered to be due to the complexity of the experimental design and calculations used to estimate turnover (US IOM, 2001).

A 2014 balance study (Tan, 2019) found that neutral balance was achieved with an iodine intake of 111 µg/day, which equates to an RDI of 155 µg/day when a 20% CV is applied. The balance study had several limitations including no run-in period, and it was conducted in a small sample (N=25) of iodine replete, euthyroid female students. Consequently, findings may not be broadly generalisable to the Australian and New Zealand context.

More recently, concerns have been raised about the reliability of balance and thyroid accumulation studies for estimating requirements (EFSA 2014, Blomhoff et al. 2023), including:

- methodological limitations of balance studies (eg. inadequate run-in periods, accuracy of methods for measuring intake and losses)
- that observed ‘balance’ may reflect requirements that only apply in a narrow range of contexts, or reflect transient adaptive changes rather than steady state requirements
- wide variation in the iodine intakes associated with ‘null’ balance reported across studies
- poor generalisability of estimates based on thyroid accumulation studies, noting that thyroidal iodine capture is downregulated with increasing iodine intake. Thyroid accumulation studies upon which current NRVs are based (Fisher and Oddie, 1969a, Fisher and Oddie, 1969b) measured UIE at 410 µg/day and 280 µg/day respectively, suggestive of higher iodine intakes.

Despite this uncertainty in the evidence base, the thyroid accumulation studies and recent balance study (Tan 2014) collectively estimate requirements between 90 and 110 µg/day. Therefore, the available evidence - although limited - supports maintaining the current EAR of 100 µg/day.

Furthermore, the RDI of 150 µg/day - derived by applying a CV of 20% to the EAR of 100 µg/day - is supported by observational data suggesting that intakes of 150 µg/day intake in adults corresponds with a low population prevalence of goitre (EFSA 2014).

Pregnancy

The current (2006) values for pregnancy were based on adult requirements, adjusted to account for additional requirements during pregnancy. Daily fetal thyroid iodine uptake was estimated at 75 µg/day based on 100% daily turnover of iodine in the newborn thyroid, and an estimated thyroid content of 50-100 µg in newborns (Delange and Burgi, 1989; Delange and Ermans, 1991). Assuming an EAR of 95 µg/day for non-pregnant women (based on the EAR identified by the US IOM), a preliminary EAR of 170 µg/day during pregnancy was calculated.

This estimate was reduced to 160 µg/day in view of the following supportive evidence:

- a balance study which reported neutral balance among pregnant women with iodine intakes of around 160 µg/day (Dworkin et al., 1966); and
- studies on the effect of iodine supplementation on maternal thyroid volume, with daily intakes of 250 to 280 µg/day found to prevent goitre during pregnancy (Pedersen et al., 1993), whereas intakes of 150 µg/day were insufficient to prevent increased thyroid volume (Glinoer, 1998).

The RDI during pregnancy was estimated at 220 µg/day, based on an EAR of 160 µg/day and applying a 20% CV.

More recently, a 2023 balance study found that neutral balance was reached with iodine intake of 202 µg/day in a subset of 40 pregnant Chinese women (Chen et al 2023). However, Chen et al (2023) noted that estimated iodine balance was higher with increasing habitual intake and also varied by trimester. The authors also noted that missing data may have impacted findings, with 35% of participants lost to follow up by day 7. These findings correspond with an EAR of 200 µg/day and RDI of 280 µg/day - compared with the EAR of 160 µg/day and RDI of 220 µg/day suggested by Dworkin et al (1966).

Additional requirements during pregnancy have been estimated at 50 µg/day, in iodine-sufficient individuals with adequate thyroidal iodine stores (EFSA, 2014). However, data suggests that Australian and New Zealand women of childbearing age may be mildly deficient, and adequate thyroidal iodine cannot be assumed. The total requirements for daily fetal thyroid iodine uptake is estimated at 75 µg/day based on 100% daily turnover of iodine in the newborn thyroid, and an estimated thyroid content of 50-100 µg in newborns (Delange, 1989; Delange and Ermans, 1991).

Although there is substantial uncertainty in the evidence, these additional data suggest that the current EAR of 160 µg/day and RDI 220 µg/day remain suitable for the Australian and New Zealand population.

Lactation

The current (2006) EAR during lactation was set at 190 µg/day, based on the adult EAR (100 µg/day) plus replacement of iodine secreted in breast milk estimated at 90 µg/day. The replacement value of 90 µg/day was lower than the 114 µg/day estimated by the US IOM (based on Gushurst et al 1984) as the panel considered a broader range of studies on the topic (Delange e al 1984, Gushurst et al 1984, FAO:WHO 2001, Johnson et al 1990). The RDI was set at 270 µg/day assuming a CV of 20% for the EAR.

A 2018 systematic review found significant variation in BMIC is noted both between populations, and over the course of lactation (Dror & Allen 2018). It concluded that a BMIC of 150µg/L would meet- and potentially exceed - infant requirements in the first 6 months of lactation. This finding supports the conclusions of EFSA (2014) which suggested that positive balance was reached with BMIC between 100 and 200 µg/L. Assuming an average breast milk volume of 0.8L / day, an additional 120 µg/day of iodine would be required to achieve BMIC of 150 µg/L.

A 2014 study found that lactating women with a BMIC of 112 µg/L had median UIE of 87 µg/L, putting them below the 100 µg/L threshold for sufficiency (Andersen et al 2014). Based on this finding, and assuming an average breast milk volume of 0.8L / day, EFSA (2014) estimated daily losses to be 90 µg/day.

A 2016 crossover study examining iodine balance in 11 healthy, formula-fed infants aged 2 to 5 months found that null balance occurred with intakes of 70 µg/day (Dold et al 2016). However, it has been suggested that intakes should exceed that required for nutritional adequacy of infants during this life stage, to support accumulation of thyroidal iodine stores (Dror & Allen 2018). Furthermore, the small sample size of this study may not adequately account for individual variability in requirements.

Collectively, these studies suggest an additional requirement of 90-120 µg/day to account for iodine losses through breast milk. In adequate populations, large stores of iodine exist (primarily as iodinated Tg) and intake is not required to fully compensate for iodine losses in breast milk. However, in Australia and New Zealand mild population deficiency persists in females of reproductive age. Consequently, adequate status should not be presumed, and recommendations may need to approach full replacement of losses to avoid deficiency states.

Although the evidence is uncertain, these recent studies suggest that the current EAR of 190 µg/day and RDI of 270 µg/day remain suitable for the Australian and New Zealand populations.

Children and adolescents

There is a lack of data on iodine requirements in childhood and adolescents, and current recommendations for younger children have been derived from very small samples - or by extracting data for a small number of individuals within a broader sample - . within balance studies of short duration. These studies may be unreliable for estimating individual requirements. These methods lack precision and methodological rigour, and are unreliable for estimating individual requirements.

Consequently, in the absence of sufficient evidence, EARs for children and adolescents were extrapolated from the adult EAR (100 µg/day) based on metabolic body weight, using the formula:

$$\text{Estimated EAR}_{\text{child}} = \text{Estimated EAR}_{\text{adult}} \times [\text{Weight}_{\text{child}} / \text{Weight}_{\text{adult}}]^{0.75} \times [1 + \text{growth factor}]$$

Inputs were as follows:

$\text{EAR}_{\text{adult}}$ = 100 µg/day

$\text{Weight}_{\text{adult}}$ = 62.9 kg

The Growth Factors (GF) and Reference Weights were as per the NHMRC Methodological Framework for the Review of Nutrient Reference Values (NHMRC, 2025). Reference Weights were derived from contemporary ‘ideal’ body weight data from the Australian Bureau of Statistics.

Calculated values were rounded up to ensure the requirements of older children within each age bracket were met, and to smooth transitions between age groups. Data inputs and extrapolated data are presented in Table 9.

Table 10. **Extrapolation of Adult EAR to child age groups**

Age group	Child reference weight (kg)	Adult reference weight (kg)	Growth Factor (GF)	Extrapolated Child EAR *µg/day*	Rounding *µg/day*	Proposed EAR *µg/day*
NRVs age groupings:						
1 to under 4 years	13.0	62.9	0.25	38.3	26.7	**65**
4 to under 9 years	22.4	62.9	0.09	50.2	14.8	**65**
9 to under 14 years	40.7	62.9	0.13	81.5	-6.5	**75**
14 to under 18 years	57.6	62.9	0.08	101.1	-6.1	**95**
Alternative age groupings by school-age:						
12 to under 24 months	10.6	62.9	0.44	37.9	27.1	**65**
2 to under 5 years	15.9	62.9	0.12	39.9	25.1	**65**
5 to under 12 years	28.6	62.9	0.12	62.0	8.0	**70**
12 to under 18 years	54.5	62.9	0.07	96.1	-6.1	**90**

The RDI was then calculated applying a CV of 20%, and rounded as follows:

Age group	$\text{EAR}_{\text{child}}$ *µg/day*	Co-efficient of variation (CV)	RDI (calculated) *µg/day*	Rounding *µg/day*	Proposed RDI (rounded) *µg/day*
NRVs age groupings:					
1 to under 4 years	65	20%	91	-1	**90**
4 to under 9 years	65	20%	91	-1	**90**
9 to under 14 years	75	20%	105	15	**120**
14 to under 18 years	95	20%	133	17	**150**
Age (grouped by school-age):					
12 to under 24 months	65	20%	91	-1	**90**
2 to under 5 years	65	20%	91	-1	**90**
5 to under 12 years	70	20%	98	12	**110**
12 to under 18 years	90	20%	126	14	**140**

This represents a change to methods for calculating the EAR and RDI for children and adolescents. However, the EAR and RDI recommendations are not materially changed, beyond the adjustments required to align with new age groupings.

Upper Level (UL)

There is a lack of sensitive end points for establishing upper levels for iodine, with the relationship between iodine intake and adverse health outcomes either not well characterised, or insufficiently sensitive or reliable to inform establishment of an NRV. In the absence of more robust biomarkers, elevated TSH has previously been used to derive Upper Level recommendations, as an early biomarker of thyroid dysfunction.

Adults

Although evidence suggests that the adult thyroid has significant capacity to adapt to high iodine intakes, some individuals may be particularly sensitive to excess iodine. The UL should aim to protect almost all individuals within a population. Consequently, the UL for adults was established based on elevated TSH using data from Sang (2012) which explored the association between varying intakes of iodine and thyroid function, including elevated TSH. Elevated TSH and increasing rates of subclinical hypothyroidism were observed with iodine intakes of 869 µg/day or greater. Accordingly, 869 µg/day was selected as the LOAEL, as the inflexion point at which cases of subclinical hypothyroidism became significantly increased, and the upper bound of the 95% CI for TSH was elevated beyond 5.0 mU/L (Sang et. al. 2012 reported a reference range of 0.3 - 5.0 mU/L for the TSH assay used).

An Uncertainty Factor of 1.5 was applied, with consideration given to:

- Substantial inter-individual variability in tolerance for high iodine intakes, noting that selection of the LOAEL can be expected to account for some level of individual variability
- The use of a LOAEL rather than a NOAEL as a reference point
- the mild and reversible nature of the end-point

This resulted in an estimated UL of 579.3 µg/day, which was rounded up to 600 µg/day.

Pregnancy

The WHO defines UIC > 500 ug/L during pregnancy as an "excess intake" (WHO, 2007). However, in this context the term excess refers to intakes that are "in excess of the amount required to prevent and control iodine deficiency". Consequently, the 500 µg/L threshold should not be interpreted as describing a UL.

There remains a dearth of good quality data on the effects of high intakes of iodine on maternal and child outcomes during pregnancy. Nevertheless, concerns have been raised about the effect of high iodine intakes during pregnancy and adverse effects on the foetus, due to the inability to escape from the Wolff-Chaikoff effect, which begins to develop around 36 weeks gestation, fully maturing during the early neonatal period.

Data from cross-sectional studies suggest that intakes >500 µg/day during pregnancy may be associated with maternal thyroid dysfunction (Wu et al 2023; Shi et al 2015; Guo et al 2025). However, the evidence is not compelling, with a 2018 systematic review reporting inconsistent findings across studies (Katagiri 2018). Concerns about imprecise estimation of intake based on urinary iodine during pregnancy and limited generalisability to the Australian and New Zealand nutritional context further limit certainty in the evidence.

In the absence of robust evidence for the effects of excess iodine intake during pregnancy, it is proposed that the adult UL of 600 µg/day be adopted.

The overwhelming public health concern in Australia and New Zealand continues to be iodine deficiency during pregnancy. Any changes to the UL during pregnancy should be carefully communicated to ensure that the need for supplementation during pregnancy continues to be a core message.

Lactation

Concerns have been raised about the effect of high maternal iodine intake on fetal development for pre-term neonates. The developing fetus is particularly vulnerable to excess iodine, as the Wolff-Chaikoff escape mechanism does not develop until around 36 weeks gestation, or after birth in pre-term neonates. However, data in this cohort are lacking.

In the absence of data, the UL for lactating women should be set based upon the recommendation for during pregnancy.

The overwhelming public health concern in Australia and New Zealand continues to be iodine deficiency during pregnancy and lactation. Any changes to the UL during lactation should be carefully communicated to ensure that the need for supplementation during pregnancy and throughout lactation continues to be a core message.

Children and adolescents

In the absence of evidence in children and adolescents, recommendations can be extrapolated from the adult UL, based on metabolic body weight using the following formula:

$UL_{child} = UL_{adult} \text{ x } (Weight_{child}/Weight_{adult})^{0.75}$

Reference weights used were based on 2022 ‘ideal’ weight data from the Australian Bureau of Statistics, as per the current Methodological Framework (NHMRC, 2025).

Calculated values were rounded up to the nearest 50 (children aged <12 years) or rounded to the nearest 100 (children aged >12 years) to arrive at final values. When rounding values, consideration was given to smoothing transitions between age groupings per the Methodological Framework (NHMRC, 2025).

Inputs for extrapolation and the raw calculated UL value are shown at Table 10.

Table 11. **Extrapolation of Adult UL to child age groups**

Age group	UL_{adult} (µg/day)	Child Ref Weight (kg)	Adult Ref Weight (kg)	Calculated UL_{child} (µg/day)	Rounding (µg/day)	Proposed UL (µg/day)
NRVs age groupings:						
1 to under 4 years	600	13	62.9	183.9	16.1	200
4 to under 9 years	600	22.4	62.9	276.6	23.4	300
9 to under 14 years	600	40.7	62.9	432.9	17.1	450
14 to under 18 years	600	57.6	62.9	561.7	-11.7	550
Age (grouped by school-age):						
12 to under 24 months	600	10.6	62.9	157.8.0	42.2	200
2 to under 5 years	600	15.9	62.9	213.9	36.1	250
5 to under 12 years	600	28.6	62.9	332.2	17.8	350
12 to under 18 years	600	54.5	62.9	538.8	-38.8	500

Benchmarking

International comparisons

Nutritional adequacy recommendations

Table 11shows NRV recommendations for nutritional adequacy (preventing iodine deficiency) across comparable international jurisdictions. To account for differing age groupings across jurisdictions, values have been adjusted using a weighted average calculation, to align with NHMRC's proposed age groupings. Adjusted values are denoted by * in the table. Where a jurisdiction specifies an EAR and RDI, the RDI has been extracted for comparison purposes.

Table 12. **Comparison of proposed AIs with international nutritional adequacy recommendations from comparable international jurisdictions**

Age (years)	Proposed ANZ RDI (µg/day)	Current ANZ RDI (2006) (µg/day)	EFSA AI (2014) (µg/day)	NNR AI (2023) (µg/day)	WHO RDI (2007) (µg/day)	D-A-C-H RDI (2013) (µg/day)
Adults 18 +years:	150	150	150	150	150	200
Pregnancy (all):	220	220	200	200	230	230
Lactation	270	270	200	200	260	260
Children and adolescents (by NRVs age groups)						
1 to under 4 years	90	90	90	100	90	100 - 120
4 to under 9 years	90	90	90	100	108*	156*
9 to under 14 years	120	120	108*	115*	132*	176*
14 to under 18 years	150	150	128*	129*	150	200
Children and adolescents (grouped by school-age)						
12 to under 24 months	90	90*	90	100	90	100
2 to under 5 years	90	90*	90	100	90	107*
5 to under 12 years	110	103*	94*	103*	120	146*
12 to under 18 years	140	140*	125*	128*	145*	197*

Upper Levels

Table 12 shows NRV recommendations for iodine upper levels across comparable international jurisdictions. To account for differing age groupings across jurisdictions, values have been adjusted using a weighted average calculation, to align with NHMRC's proposed age groupings. Adjusted values are denoted by * in the table. Where a jurisdiction specifies an EAR and RDI, the RDI has been extracted for comparison purposes.

Table 13. Comparison of proposed ULs with international Upper Level recommendations from comparable international jurisdictions

Age (years)	Proposed ANZ UL (μg/day)	NHMRC (2006) Current UL (μg/day)	US/ Canada (2001) UL (μg/day	EFSA (2002) UL (μg/day)	NNR (2023) UL (μg/day)	WHO (2004) UL^ (μg/day)	D-A-C-H (2015) UL (μg/day)
Adults 18 +years:	600	1,100	1,100	600	600	1,875	500
Pregnancy (all):	600	1,00	1,100	600	600	-	-
Lactation (all)	600	1,100	1,100	600	600	-	-
Children and adolescents (by NRVs age groups)							
1 to under 4 years	200	200	200	200	-	-	-
4 to under 9 years	300	300	300	280*	-	-	-
9 to under 14 years	450	600	600	390*	-	-	-
14 to under 18 years	550	900	900	488*	600^	-	-
Children and adolescents (grouped by school-age)							
12 to under 24 months	200	200	200	200	-	-	-
2 to under 5 years	250	233*	233*	217*	-	-	-
5 to under 12 years	350	429*	429*	307*	-	-	-
12 to under 18 years	500	800*	800*	475*	600^	-	-

^ NNR (2023) specifies a UL for 14 - 18 year olds during lactation or pregnancy only

Food system and foundation diet modelling

Data from the food modelling system developed to inform revision to the Australian Dietary Guidelines (NHMRC 2011) were extracted for comparison with NRV recommendations. Extracted data are presented in Table 9 (adults), Table 10 (during pregnancy), Table 11 (during lactation), and Table 12 (children and adolescents). Estimates of dietary iodine intake that are lower than the proposed NRV are highlighted orange.

Adults

Table 14. Estimated iodine intake in adults from food modelling (Source: NHMRC 2011)

	Estimated intake from food modelling (µg/day)						
Population	Core food groups	Aust. Guide to Healthy Eating 1998 (AGTHE98)^	Foundation diets - overall	Omnivore	Rice-based	Pasta-based	Lacto-ovo-vegetarian
Persons 19+ years	148	NR	NR	NR	NR	NR	NR
Males 19 - 30 years	NR	NR	197	NR	213	181	177
Males 31 - 50 years	NR	NR	210	NR	224	192	190
Males 51 - 70 years	NR	NR	219	NR	229	198	198
Males 70+ years	NR	NR	256	NR	275	249	215
Females 19 - 30 years	NR	178-275^	210	NR	204	187	173
Females 31 - 50 years	NR		211	NR	210	197	178
Females 51 - 70 years	NR	178-236^	275	NR	290	229	233
Females 70+ years	NR		260	NR	289	223	218

^Age groupings for AGTHE98 are 19 - 60yrs and 60+ yrs.

Pregnancy

Table 15. Estimated iodine intake during pregnancy from food modelling (Source: NHMRC 2011)

	Estimated intake from food modelling (µg/day)						
Population	Core food groups	Aust. Guide to Healthy Eating	Foundation diets - overall	Omnivore	Rice-based	Pasta-based	Lacto-ovo-vegetarian
Pregnant persons (age not specified)	161	NR	NR	NR	NR	NR	NR
Pregnant females 14 - 18 years	NR	NR	233	NR	NR	NR	NR
Pregnant females 19 - 30 years	NR	NR	258	NR	NR	NR	NR
Pregnant females 31 - 50 years	NR	NR	261	NR	NR	NR	NR

Lactation

Table 16. Estimated iodine intake during lactation from food modelling (Source: NHMRC 2011)

	Estimated intake from food modelling (µg/day)						
Population	Core food groups	Aust. Guide to Healthy Eating	Foundation diets - overall	Omnivore	Rice-based	Pasta-based	Lacto-ovo-vegetarian
Lactating persons (age not specified)	187	NR	NR	NR	NR	NR	NR
Lactating females 14 - 18 years	NR	NR	253	NR	NR	NR	NR
Lactating females 19 - 30 years	NR	NR	251	NR	NR	NR	NR
Lactating females 31 - 50 years	NR	NR	251	NR	NR	NR	NR

Children and adolescents

Table 17. Estimated iodine intake in children and adolescents from food modelling (Source: NHMRC 2011)

Population	Estimated intake from food modelling (µg/day)						
	Core food groups	Aust. Guide to Healthy Eating	Foundation diets - overall	Omnivore	Rice-based	Pasta-based	Lacto-ovo-vegetarian
Persons 4 - 7 years	112	188 - 227	NR	NR	NR	NR	NR
Persons 8 - 11 years	132	214 - 273	NR	NR	NR	NR	NR
Persons 12 - 18 years	163	247 - 365	NR	NR	NR	NR	NR
Males 13 - 23 months	NR	NR	95	NR	NR	NR	NR
Males 2 - 3 years	NR	NR	117	NR	NR	NR	124
Males 4 - 8 years	NR	NR	143	NR	NR	NR	132
Males 9 - 11 years	NR	NR	173	NR	200	163	170
Males 12 - 13 years	NR	NR	235	NR	245	215	224
Males 14 - 18 years	NR	NR	209	NR	230	203	236
Females 13 - 23 months	NR	NR	96	NR	NR	NR	NR
Females 2 - 3 years	NR	NR	119	NR	NR	NR	102
Females 4 - 8 years	NR	NR	133	NR	NR	NR	109
Females 9 - 11 years	NR	NR	189	NR	195	158	169
Females 12 - 13 years	NR	NR	221	NR	234	211	215
Females 14 - 18 years	NR	NR	212	NR	223	200	244

Proposed Recommendations

Population	EAR (μg/day)	RDI (μg/day)	AI (μg/day)	UL (μg/day)	Comment
Infants					
0 - 6 months			90	Not possible to establish	*Unchanged - not updated in 2025 review*
7 - 12 months			110		
Children and adolescents - by NRVs age groupings					
1 to under 4 years	65	90		200	
4 to under 9 years	65	90		300	
9 to under 14 years	75	120		450	
14 to under 18 years	95	150		550	
Alternative children and adolescents - by school-age groupings					
12 to under 24 months	65	90		200	
2 to under 5 years	65	90		250	
5 to under 12 years	70	110		350	
12 to under 18 years	90	140		500	
Adults					
18 to under 30 years	100	150		600	
30 to under 50 years	100	150		600	
50 to under 65 years	100	150		600	
65 to under 75 years	100	150		600	
75 years and older	100	150		600	
Pregnancy					
All	160	220		600	
Lactation					
All	190	270		600	

Comprehensive Evidence-to-Decision Frameworks documenting how the final recommendations have been determined are presented in Appendix E.

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Appendix A - Methods for identifying evidence

Consistent with the Methodological Framework (NHMRC 2025), several approaches were adopted to identify relevant evidence for physiological requirements of iodine, and explore the relationship between iodine intake/status and health outcomes. This included:

- Extracting evidence from international guidance and advice including:
    - reviews commissioned or conducted by comparable international bodies for the purposes of establishing iodine nutrient reference values
    - other reports published by key international bodies (e.g. the WHO) relevant to establishing iodine nutrient reference values
- Systematic reviews published within the previous 10 years (with an emphasis on high quality, more recent systematic reviews)
- A commissioned review of primary studies for targeted populations, exposures and outcomes
- Primary evidence or data relevant to the Australian and New Zealand context

International guidance and advice

The following international reports were reviewed, and summarised or relevant evidence extracted in the Evidence Summary Report:

- US Institutes of Medicine (US IoM) - Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc (US IoM 2001)
- Nordic Nutrition Recommendations
    - Iodine: a scoping review for Nordic Nutrition Recommendations 2023 (Gunnarsdóttir and Brantsæter 2023)
    - Nordic Nutrition Recommendations 2023 (Blomhoff et al. 2023)
- European Food Safety Authority
    - Opinion of the Scientific Committee on Food on the Tolerable Upper Intake Level of Iodine (EFSA 2003)
    - Scientific Opinion on Dietary Reference Values for Iodine (EFSA 2014)
    - Scientific Report on the dietary exposure to heavy metals and iodine intake via consumption of seaweeds and halophytes in the European population (EFSA 2023)
- EURRECA - Estimating Iodine Requirements for Deriving Dietary Reference Values (Ristić-Medić 2013)
- UK SACN
    - SACN Statement on Iodine and Health (UK SACN 2014)
    - Statement on the potential effects that excess iodine intake may have during preconception, pregnancy and lactation (UK SACN UK 2022)
- WHO
    - Vitamin and mineral requirements in human nutrition (WHO & FAO 2004) -
    - Urinary iodine concentrations for determining iodine status in populations (WHO 2013)
- Chinese Nutrition Society:
    - *Global Perspectives on China's Iodine Dietary Reference Intakes: Revisions, Public Health Implications, and Future Strategies* (Guo et al 2025)

Systematic reviews

We sought recent, high quality systematic reviews that examined one or more of the following:

- iodine requirements to maintain physiological function in humans
- the relationship between iodine intake, status and health outcomes
- related characteristics relevant to NRV derivation for the Australian and New Zealand population, such as reviews exploring biomarkers of iodine intake/status, iodine content in food or water, bioavailability or interactions with other nutrients/compounds.

Reviews not generalisable to the Australian and New Zealand context - such as those focused on incomparable, specific regional area/s or severely deficient populations - were excluded.

Eligible systematic reviews were identified by searching databases (Epistemonios, PubMed, Cochrane Database of Systematic Reviews) and via reference list searching of key international guidance published since 2015. Search parameters are documented in Table 18.

The methodological rigour and reporting quality of eligible systematic reviews was evaluated by KSR Evidence using the Risk of Bias in Systematic Reviews (ROBIS) tool (Whiting et al. 2016). KSR Evidence also extracted key characteristics of reviews. Extracted data and risk of bias assessments are presented in Appendix C.

Table 18. Searches undertaken to identify relevant systematic reviews

Method	Search parameters	No. records screened
Epistemonikos database	Keyword (Ti/Abs): iodine Category: systematic reviews Date range: 1 Jan 2015 to 9 Sep 2025	583
PubMed database	((iodine[Mesh]) AND ("systematic review"[pt])) NOT (radioiodine[ti] OR chlorhexidine[ti] OR radioactive[ti] OR contrast[ti]) Date range: 1 Jan 2015 to 4 September 2025	140
Cochrane Database of Systematic Reviews	MeSH descriptor: [Iodine] in all MeSH products Dates: 01/01/2015 - 09/09/2025	16

Method	Search parameters	No. records screened
Reference list searching	Nordic Nutrition Recommendations: • Gunnarsdóttir and Brantsæter 2023 - *Iodine: a scoping review for Nordic Nutrition Recommendations 2023* • Blomhoff et al 2023 - *Nordic Nutrition Recommendations 2023* UK Food Standards Agency: • Committee on Toxicity (2022) - *Statement on the potential effects that excess iodine intake may have during preconception, pregnancy and lactation.* Chinese Nutrition Society: • Guo et al (2025) - *Global Perspectives on China's Iodine Dietary Reference Intakes: Revisions, Public Health Implications, and Future Strategies* European Food Safety Authority: • EFSA (2023) - *Scientific Report on the dietary exposure to heavy metals and iodine intake via consumption of seaweeds and halophytes in the European population*	N/A

Primary studies/data

Evidence scoping for priority PECO criteria

NHMRC commissioned researchers from the Institute for Physical Activity and Nutrition at Deakin University to undertake a review of primary studies to inform decisions about the update of iodine NRVs. The research team comprised Professor Judi Porter, Associate Professors Susan Torres, Ewa Szymlek-Gay, Kristy Bolton, and Katherine Livingstone, Dr Miaobing Zheng, and Dr Gavin Abbott.

The evidence review employed systematic searches to identify primary studies on the relationship between iodine intake / status and health for select, priority populations, exposures and outcomes. The inclusion/exclusion criteria for the review are specified in Table 18.

Balance studies that measured total intake and losses under controlled conditions were also sought, where they:

- were published since 2000 (to complement evidence from balance studies identified in previous reviews)
- measured intake from all sources (including dietary, supplements, water and medications)
- measured losses via a minimum of three routes (urinary, faecal, sweat, dermal).

Key characteristics of eligible studies were extracted and risk of bias assessed using one of the following tools:

- RCTs: Cochrane Risk of Bias tool v.2 (ROB-2)
- NRSIs: Cochrane Risk of Bias in Non-randomised Studies of Interventions tool (ROBINS-I)
- Observational studies: Risk of bIas for Nutrition Observational Studies tool, adapted from ROBINS-I by the US Nutrition Evidence Systematic Review team to assess risk of bias in observational studies in nutrition (RoB-NObs).

The key characteristics and risk of bias of primary studies are presented in Appendix D, adapted from data provided by the IPAN evidence review contractors.

Table 19. **Inclusion criteria (Source: NHMRC commissioned evidence evaluation, conducted by Deakin University IPAN)**

	Intervention studies	Observational studies
Study designs:	• Randomised controlled trials (RCTs) with parallel, crossover or 2 x 2 factorial design • Quasi-randomised studies	• Prospective cohort studies • Case-control studies
Intervention / Exposure and	Known iodine dose either through supplementation or iodine enriched food/drink or placebo	Iodine intake from all sources (including dietary, supplements, water and medications), measured as urinary iodine excretion (µg/day), concentration (µg/L), or µg iodine/g creatinine ratio
Comparators:	One or more comparison arm/s with different intake/s of iodine	Different level of iodine exposure
Populations:	Only studies conducted in humans involving free-living, population-based recruitment, involving groups not specifically recruited on the basis of health status/condition, were included. Population groups included: • Adults (including older adults aged 70+ years) • Pregnant women *(limited to studies published since 2016)* • Children and adolescents (aged 1 to18 years)	
Outcomes:	All populations: • Iodine status, measured as UIE (µg/day), UIC (µg/L), µg iodine/g creatinine ratio *(intervention studies only)* • Elevated TSH • Thyroid function, as measured by free thyroid hormone T4, and/or thyroglobulin (TG) • Thyroid volume, as measured by ultrasound • Goitre rate, confirmed by ultrasound or palpation • Thyroid autoimmunity • Thyroid cancer Additional outcomes - children and adolescents or during pregnancy: • Child neurocognitive development (including global neurocognitive development, motor development, mental development, behavioural development, developmental disorders, and school/academic performance) Additional outcomes - pregnancy only: Pregnancy and obstetric outcomes, measured as stillbirth, pre-term birth and neonatal TSH (pregnant people only)	

Australian and New Zealand contextual evidence

To supplement the primary studies and systematic reviews obtained, primary studies and data specific to the Australian and New Zealand context were sought. This included primary studies conducted in Australia or New Zealand, or population or modeling data published by the Australian Bureau of Statistics, Australian Institute of Health and Welfare, New Zealand Ministry of Health or Food Standards Australia New Zealand.

Relevant literature was obtained via targeted searches of databases, government websites, and grey literature searches.

Appendix B - Supplementary analyses

Sang et al (2012)

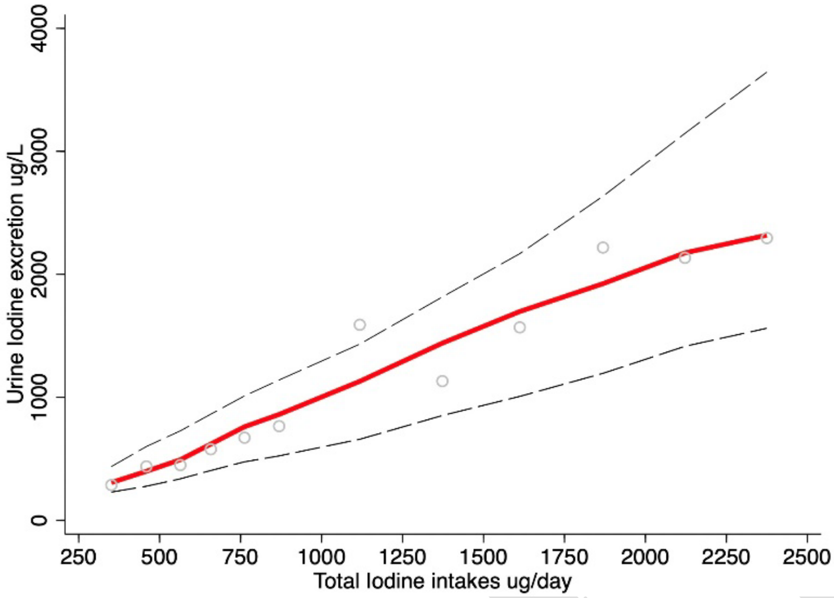

Figure 1. Mean urinary Iodine excretion with 25th/75th percentiles and total Iodine intakes from 256 euthyroid adults after being randomized to one of twelve Iodine supplementation levels (0-2000ug) for four weeks.

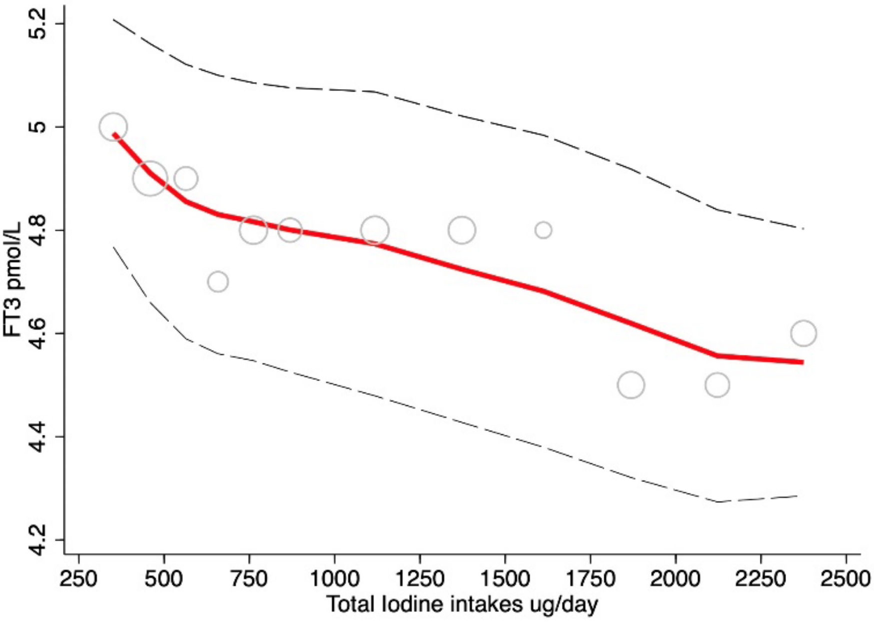

Figure 2. Mean FT3 concentration with 95% confidence intervals and total Iodine intakes from 256 euthyroid adults after being randomized to one of twelve Iodine supplementation levels (0-2000ug) for four weeks.

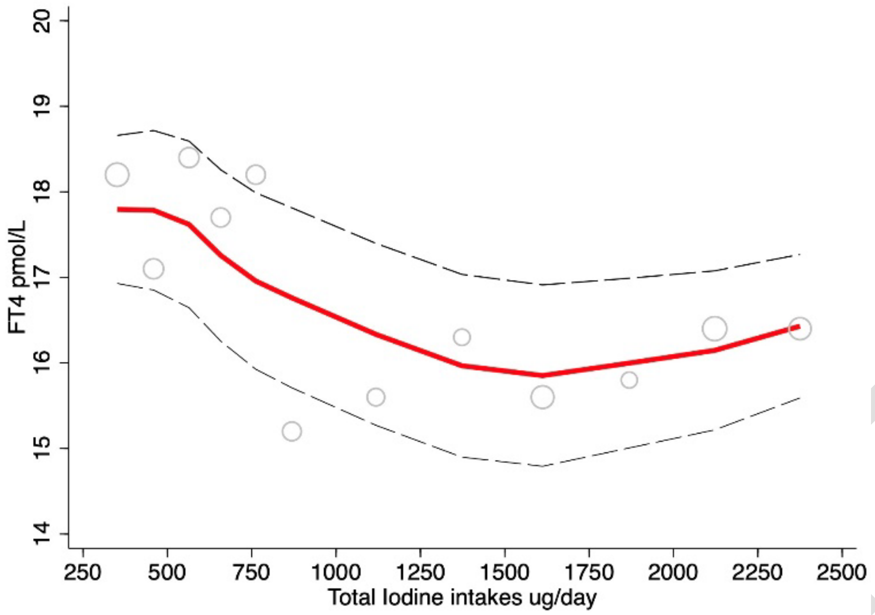

Figure 3. Mean FT4 concentration with 95% confidence intervals and total Iodine intakes from 256 euthyroid adults after being randomized to one of twelve Iodine supplementation levels (0-2000ug) for four weeks.

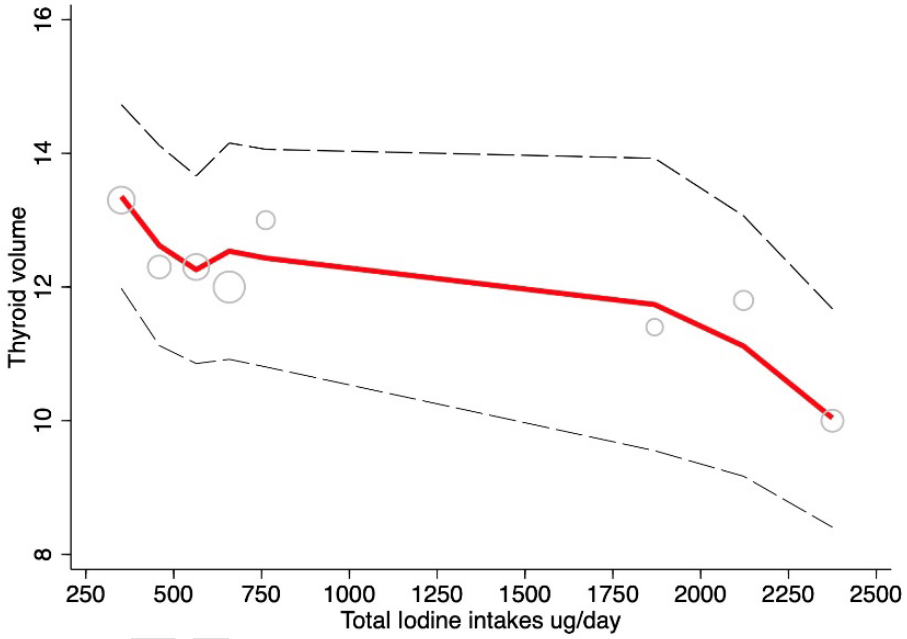

Figure 6. Mean thyroid volume (ml) with 95% confidence intervals and total Iodine intakes from 179 euthyroid adults after being randomized to one of eight Iodine supplementation levels (0-2000ug) for four weeks.

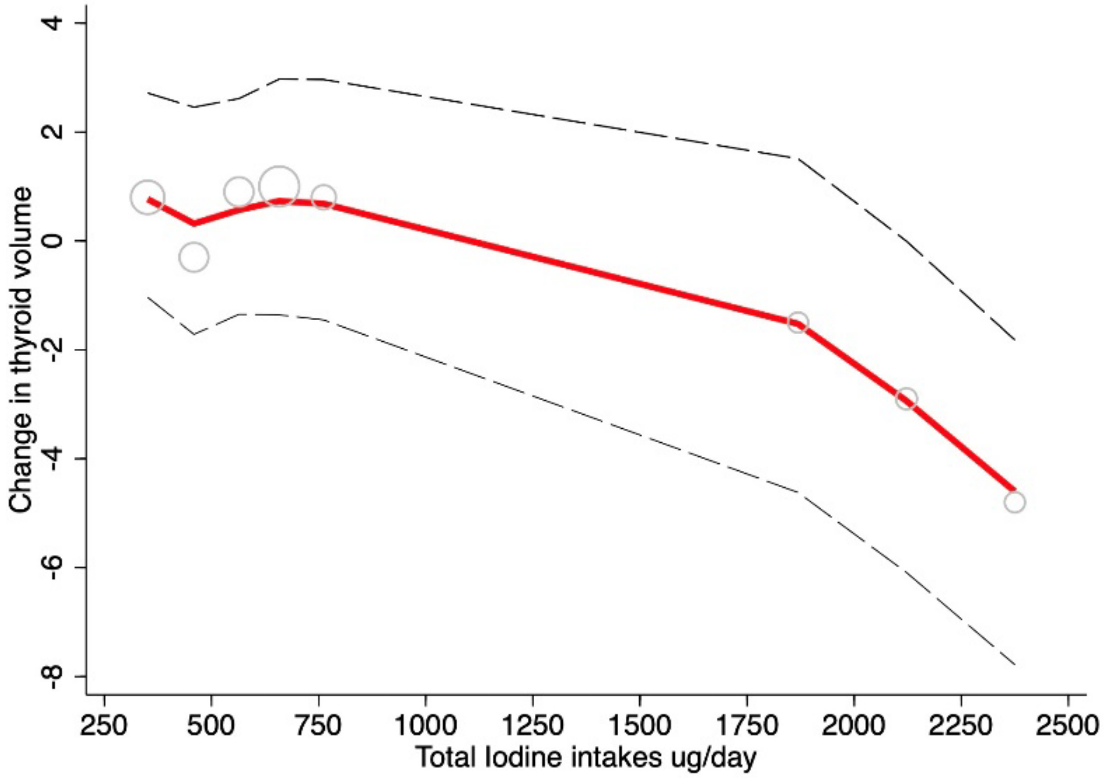

Figure 7. Change in thyroid volume with 95% confidence intervals and total Iodine intakes over four weeks in 179 euthyroid adults randomized to one of eight Iodine supplementation levels (0-2000ug

Appendix C - Systematic reviews

Characteristics of systematic reviews

Table 20. Characteristics of Systematic Reviews (Source: KSR Evidence, with minor adaptations/edits to summarise content where required)

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Aarsland et al 2025	To examine the association between mild-to-moderate iodine deficiency and thyroid hormone function in infants, children, adolescents, adults, pregnant and lactating women.	February 2024	P: The general population, including infants, children, adolescents, adults, pregnant and lactating women. Individuals with pre-existing chronic disease were excluded. I/E/C: Mild-to-moderate iodine deficiency, measured using UIC or UIC:Cr or dietary iodine intake (µg/d) converted to UIC. Compared with adequate status. O: Thyroid function parameters (TSH, FT3, FT4), thyroid dysfunction (hypothyroidism, hyperthyroidism, hypothyroxinaemia, and hyperthyroxinemia). TS: Observational studies. Cross-sectional studies, prospective and retrospective cohort studies, case-control studies.	72 studies (N=293,502 participants)	*D1: HIGH* *D2: UNCLEAR* *D3: LOW* *D4: LOW* *OVERALL: HIGH*
Beckford et al 2020	To estimate the average 24-h urine volume measured in healthy children and adolescents and assess its impact on the assessment of iodine status using urinary biomarkers.	October 2018	P: Healthy children and adolescents >1 and ≤19 years of age. I/E/C: 24-hour urine volume of children and adolescents. O: Average daily urinary output of children and adolescents and its impact on the assessment of iodine status using urinary biomarkers. TS: No restrictions on the types of study design eligible. Observational studies.	44 studies (N=7,712 participants; 9538 urine samples)	*D1: HIGH* *D2: HIGH* *D3: UNCLEAR* *D4: HIGH* *OVERALL: HIGH*

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Bolfi et al. 2025	To assess whether individual diagnosis of low urinary iodine concentration (UIC) in pregnant women is associated with adverse maternal and neonatal outcomes.	October 30 2023	P: Pregnant women without ethnicity restrictions and without the history of thyroid diseases or other chronic diseases. I/E/C: Mildly deficient pregnant women (UIC <150 µg/L). O: Birth outcomes, maternal thyroid parameters, neonatal thyroid parameters, child neurocognitive development TS: Cohort and analytical cross-sectional studies.	63 studies (N=65,636 participants)	*D1: LOW* *D2: UNCLEAR* *D3: LOW* *D4: LOW* ***OVERALL: LOW***
Businge et al 2021	To assess the iodine nutrition status of pregnant women with and without pre-eclampsia and the risk of pre-eclampsia due to iodine deficiency.	30 June 2020	P: Pregnant women I/E/C: Insufficient iodine status (UIC <150 µg/L) vs sufficient iodine nutrition status (UIC ≥150 µg/L) during pregnancy. O: Prevalence and incidence rates of pre-eclampsia. TS: Cohort and case-control studies.	5 studies (N=4,404 participants)	*D1: LOW* *D2: UNCLEAR* *D3: UNCLEAR* *D4: HIGH* ***OVERALL: HIGH***
Candido et al 2023	To assess the effects of iodine supplementation on maternal thyroid hormone concentrations and iodine status during and/or before pregnancy.	July 2023	P: Pregnant women I/E/C: Oral iodine supplementation. O: Iodine status of pregnant women. Urinary Iodine Concentration (UIC), maternal thyroid function, such as Thyroid Stimulating Hormone (TSH); Thyroxine (T4); Thyroglobulin (Tg) concentration; Free Triiodothyronine (FT3); Free Thyroxine (FT4); thyroid volume; and any other relevant thyroid effects. TS: Observational, nonrandomized and/or non-controlled studies, and randomized clinical trials.	11 studies (N=3,071 participants)	*D1: HIGH* *D2: UNCLEAR* *D3: UNCLEAR* *D4: HIGH* ***OVERALL: HIGH***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Cao et al 2017	To assess the possible relationship between iodine intake and thyroid cancer (TC) risk.	April 2016	P: Not mentioned, but given case-control studies were included these were patients with or without thyroid cancer. I/E/C: Iodine intake. Level of fish and shellfish intake. O: Thyroid cancer. TS: Case-control studies	8 studies (N=4,974 participants)	*D1: HIGH* *D2: HIGH* *D3: HIGH* *D4: LOW* ***OVERALL: HIGH***
Dineva et al 2020	To evaluate effects of iodine supplementation in mildly-to-moderately deficient pregnant women on maternal and infant thyroid function and child cognition.	January 2020	P: Pregnant women in areas of mild-to-moderate iodine deficiency, defined as a median urinary iodine concentration (UIC) in the range of 50-149 µg/L. Exclusion: Pregnant women in areas of iodine sufficiency, excess, or severe deficiency. I/E: Iodine supplementation during pregnancy in the form of iodised salt, potassium iodide, or other iodine-containing supplements. C: Non-iodine-supplemented group; non-users of iodised salt. O: Differences in maternal and infant thyroid function [e.g., differences in thyroid size and volume, concentrations of thyroid stimulating hormone (TSH), thyroid hormones (T4 and T3), thyroglobulin, or thyroid antibodies (TPO-Ab or Tg-Ab)]. Child neurodevelopment and behaviour (e.g., differences in IQ scores, reading ability, language development, motor skills etc.). TS: Observational studies, non-randomised or uncontrolled intervention studies and randomised controlled trials (RCTs).	37 studies (N=8,133 maternal studies; 2,452 children for thyroid function; >150,000 for child neurodevelopment)	*D1: HIGH* *D2: LOW* *D3: UNCLEAR* *D4: LOW* ***OVERALL: HIGH***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Dineva et al 2023	To evaluate the association between iodine exposure during development and hearing outcomes in children.	1 March 2021	P: Pregnant women and their offspring (children under 18 years), non-pregnant adults up to 65 years (if iodine exposure was measured during childhood). Excluded: Studies measuring iodine exposure in adults (aged 18 years and over), except if data from children and adults are combined, Pendred syndrome patients or individuals with Pendred syndrome symptoms or genetic mutations related to hearing defects, individuals with known thyroid disease or thyroid cancer. I/E/C: Varying dose of iodine supplementation (any type, dose, and regimen), use of iodised salt. O: Measures of hearing ability/function, including hearing thresholds, hearing impairment, auditory brainstem response, event-related potentials, auditory processing tests. TS: All types of study design: Observational studies (including case reports), non-randomised studies of interventions, randomised controlled trials (RCTs).	13 studies (N=2,754 participants)	*D1: HIGH* *D2: LOW* *D3: LOW* *D4: LOW* ***OVERALL: HIGH***
Dror et al 2018	To examine how breast milk iodine concentration (BMIC) trends throughout lactation, identify maternal factors or interventions that affect BMIC, and assess the relationship between BMIC and infant iodine status.	15 November 2015	P: Lactating mothers and their infants. Mothers who gave birth prematurely or who had other complicating factors (i.e., malnutrition, disease, inflammation, or smoking) were included. I/E/C: Varying levels of breast milk iodine concentration (BMIC) at various time points throughout lactation, O: infant iodine status. TS: Observational and intervention studies.	14 studies (N=1,122 participants)	*D1: LOW* *D2: HIGH* *D3: HIGH* *D4: HIGH* ***OVERALL: HIGH***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Farebrother et al 2018	To assess the effects of iodised salt or iodine supplements compared with placebo or no intervention on child growth outcomes (prenatal, postnatal and during childhood)	February 2017	P: Pregnant women or women of reproductive age, and their infants. Lactating women, infants, and children up to 18 years of age. I/E/C: higher iodine intake (iodine intervention - any form, dose, regimen - including iodised salt, daily iodine supplements, oral or intravenous oil) vs lower iodine (placebo, non-iodised salt, no intervention) O: Prenatal/postnatal growth outcomes, birth outcomes, maternal pregnancy outcomes TS: Randomized controlled trials, non-randomized trials, controlled before-and-after studies, and interrupted time series, including those with repeated measures.	18 studies (N=5,729 participants)	*D1: LOW* *D2: LOW* *D3: LOW* *D4: LOW* ***OVERALL: LOW***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Greenwood et al 2023	To quantify the association between iodine status and birth outcomes, including potential threshold effects using nonlinear dose-response curves.	10 October 2022	P: Pregnant women and their babies. I/E/C: Varying levels of urinary iodine concentration (UIC), urinary iodine excretion or iodine to creatinine ratio (I:Cr), and iodide intake. O: Birth weight, birth weight centile, small for gestational age (SGA), preterm delivery, and other birth outcomes. Low birth weight and macrosomia: defined as birth weight <2.5 kg and >4 kg, respectively. Small for gestational age (SGA): defined as birth weight <10th centile and large for gestational age (LGA) >90th centile. Spontaneous abortion: defined as fetal loss ≤24 weeks gestation and stillbirth as fetal loss >24 weeks gestation. Preterm delivery: spontaneous preterm birth <37 weeks, or any preterm delivery <37 weeks if this information was not available. TS: Cohorts, case-control studies nested within cohorts, and case cohort studies.	24 studies (N=42,503 participants)	*D1: HIGH* *D2: LOW* *D3: LOW* *D4: LOW* ***OVERALL: HIGH***
Harding et al 2017	To determine the benefits and harms of supplementation with iodine, alone or in combination with other vitamins and minerals, for women in the preconception, pregnancy or postpartum period on their and their children's outcomes.	November 2016	P: Women who become pregnant, or pregnant or postpartum women of any chronological age and parity (number of births). I/E: Any supplement containing iodine, any oral iodine supplement, oral iodine-only supplement, oral iodine supplement with other vitamins and/or minerals, any injected iodine supplement, injected iodine-only supplement, injected iodine supplement with other vitamins and/or minerals. C: Same supplement without iodine or no intervention/placebo, only other vitamins and/or minerals (exact same formulation of other vitamins/minerals, but no iodine). O: Maternal thyroid function, thyroid volume, birth outcomes, child mental or motor development. TS: Randomised and quasi-randomised controlled trials (including cross-over trials).	14 studies (N=3,154 participants)	*D1: LOW* *D2: LOW* *D3: LOW* *D4: LOW* ***OVERALL:*** LOW

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Katagiri et al 2017	To investigate the association between iodine excess and thyroid hormone levels or thyroid diseases in free-living populations.	3 June 2016	P: Free-living adults including apparently healthy elderly in nursing homes, adolescents, children, and infants. Newborns were excluded. I/E/C: Varying iodine intake/status including at least one arm with excess intake/status measured using urinary iodine or Cre values. O: Thyroid diseases (hyperthyroidism, hypothyroidism, goitre, and nodule); Thyroid volume; Thyroid hormones (TSH, T3, T4, and Tg) Excluded: Anti-thyroid antibody and autoimmune thyroiditis TS: Intervention trials (randomized and non-randomized); Cohort studies; Case-control studies; Cross-sectional studies	50 studies (No. participants unclear)	*D1: LOW* *D2: HIGH* *D3: HIGH* *D4: LOW* ***OVERALL: HIGH***
Lee et al 2017	To assess the relationship between iodine exposure and papillary thyroid carcinoma (PTC) prevalence	31 December 2015	P: Patients with PTC and controls without PTC. I/E/C: Varying level of iodine exposure determined by one of the following: (1) concentration of urinary iodine (2) reported average urinary iodine level of the population based on geographic location (3) the implementation of salt iodization (4) results of dietary questionnaire O: Papillary thyroid carcinoma (PTC) prevalence. TS: Case-control studies	16 studies (N>100,000 participants)	*D1: HIGH* *D2: HIGH* *D3: UNCLEAR* *D4: LOW* ***OVERALL: HIGH***
Li et al 2022	To assess the effect of iodine excess on children's intellectual development in areas with high iodine levels in their drinking water.	31 January 2020	P: Participants aged 7 and 14 years I/E/C: Areas with high iodine in drinking water and endemic high iodine goiter areas, with high iodine content in drinking water defined as >150 µg/L and/or median urinary iodine of children >400µg/L. O: Child neurocognitive development (intelligence) TS: Cross-sectional or controlled studies.	17 studies (N=14,794)	*D1: LOW* *D2: HIGH* *D3: HIGH* *D4: LOW* ***OVERALL: HIGH***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Liu et al 2022	To investigate if breast milk iodine concentration (BMIC) can be used as a biomarker for iodine status in lactating women and children <2 years of age.	2021	P: Healthy lactating women and their children <2 years of age (including neonates, infants, and toddlers). I/E/C: Varying levels of breastmilk iodine concentration (BMIC) O: Iodine status in lactating women and children <2 years of age measured by urinary iodine concentration (UIC) or and/or I/Cr ratio. TS: Not Specified	51 studies (N=10,388 participants)	*D1: HIGH* *D2: HIGH* *D3: HIGH* *D4: HIGH* ***OVERALL: HIGH***
Machamba et al 2021	To assess the effect of iodine supplementation during gestation on the neurocognitive development of children in areas where iodine deficiency is common.	April 2020	P: Pregnant women. I/E/C: Supplementation with iodine vs no supplementation O: Neurocognitive development outcomes TS: Randomized or non-randomized controlled trials or cohorts.	8 studies (No. participants unclear)	*D1: HIGH* *D2: HIGH* *D3: LOW* *D4: HIGH* ***OVERALL: HIGH***
Monaghan et al 2021	To investigate the associations between iodine intakes and neurodevelopmental outcomes in the offspring of pregnant women.	March 2021	P: Pregnant women and their children. I/E/C: Varying iodine status during pregnancy measured by both maternal urinary iodine assessment (UIC and/or iodine creatine ratio (ICr)) and dietary iodine intakes. Included: natural dietary sources and "accidental" supplementation e.g., women taking supplement prior to/not as part of the study Excluded: intentional dietary supplementation of iodine O: Neurocognitive development in child offspring TS: All study types e.g., prospective cohort, observational studies, and cross-sectional studies.	12 studies (N=124,000 participants)	*D1: HIGH* *D2: HIGH* *D3: UNCLEAR* *D4: UNCLEAR* ***OVERALL: HIGH***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Nazarpour et al 2020	To investigate the association between gestational urinary iodine status and adverse pregnancy outcomes in euthyroid pregnant women.	October 2019	P: Pregnant women without thyroid dysfunction who had not received iodine supplementation during pregnancy. I/E/C: Varying iodine status (via measurement of urinary iodine concentration (UIC) in the first half of pregnancy). O: At least one pregnancy outcome, including pregnancy loss (abortion or stillbirth), gestational hypertension or preeclampsia, gestational diabetes, antenatal or postpartum hemorrhage, placenta abruption, placenta previa, preterm birth, premature rupture of membranes (PROM), intrauterine growth restriction (IUGR), low birth weight (LBW), small for gestational age (SGA), fetal or neonatal distress, low Apgar score, neonatal death, malformation, and neonatal or NICU admission. TS: Randomized controlled trials (RCTs), non-randomized studies (NRS), prospective or retrospective cohort studies, and case-control studies.	6 studies (N=7,698 participants)	*D1: HIGH* *D2: HIGH* *D3: LOW* *D4: LOW* ***OVERALL: HIGH***
Nazeri et al 2016	To explore the association of neonatal thyrotropin concentrations and iodine status of mothers during pregnancy and early postpartum periods.	March 2015	P: Healthy pregnant women, postpartum mothers (in the first few weeks after delivery), and their healthy full-term neonates. I/E/C: Varying levels of maternal urinary iodine concentrations (UICs). Studies with environmental or medical exposures were excluded. O: Correlation between maternal urinary iodine concentrations (UICs) and neonatal thyrotropin concentrations. TS: Not specified, observational studies.	29 studies (N>500,000 participants)	*D1: HIGH* *D2: HIGH* *D3: LOW* *D4: HIGH* ***OVERALL: HIGH***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Nazeri et al 2020a	To assess the association between maternal urinary iodine concentration (UIC) and thyroglobulin (Tg) levels during pregnancy, and to determine whether Tg concentration accurately reflects iodine status among populations of pregnant women, using the median UIC as an index of iodine status.	December 2018	P: Healthy pregnant women and their infants. I/E/C: Varying maternal iodine status during pregnancy O: Thyroglobulin concentration TS: Not specified	25 studies (N=18,965 participants)	*D1: HIGH* *D2: HIGH* *D3: HIGH* *D4: LOW* ***OVERALL: HIGH***
Nazeri et al 2020b	To investigate whether growth parameters at birth are associated with maternal urinary iodine concentration (UIC) or normal ranges of thyroid hormones during pregnancy.	November 2018	P: Healthy pregnant women (thyroid hormones within the normal range during pregnancy) and their healthy full-term neonates. Excluded: studies in which pregnant women had been exposed to environmental factors (ie, tobacco use, iodine supplements, and iodine overload,eg, iodine-containing contrast media, radioactive iodine, and povidone-iodine for disinfection), pregnant women with thyroid disorders and/or in preterm, LBW, or unhealthy newborns. I/E/C: Varying level of maternal iodine status O: Neonatal anthropometric measures at birth. Birth weight, length, and head, chest, and abdominal circumference, subscapular and triceps skinfolds, and small-for-gestational age (SGA) status. TS: Longitudinal observational studies.	19 studies (N=11,000 participants)	*D1: LOW* *D2: HIGH* *D3: HIGH* *D4: LOW* ***OVERALL: HIGH***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Nazeri et al 2021	To assess the effects of iodine supplementation in pregnancy and investigate its potential benefits on infant growth parameters and neurocognitive development.	December 2019	P: Healthy pregnant women and their infants I/E/C: iodine supplementation, lower doses of iodine, a placebo or no supplementation O: Iodine status, different thyroid parameters, growth status, neurocognitive development, pregnancy or neonatal complications. TS: Randomized or quasi-randomized controlled trials.	14 studies (N=3432 participants)	*D1: HIGH* *D2: HIGH* *D3: UNCLEAR* *D4: HIGH* ***OVERALL: HIGH***
Nazeri et al 2024	To assess whether postpartum maternal iodine status or supplementation is associated with thyroid function after delivery.	December 2021	P: Healthy postpartum women with or without breastfeeding. I/E/C: Maternal iodine status during postpartum (sufficiency vs deficiency) O: Thyroid function parameters (TSH, FT4, T4) TS: Observational and intervention studies.	18 studies (N=5,197)	*D1: LOW* *D2: UNCLEAR* *D3: UNCLEAR* *D4: LOW* ***OVERALL: UNCLEAR***
Wassie et al 2022	To investigate the associations between newborn thyroid-stimulating-hormone concentration (TSH) and childhood neurodevelopment and growth.	June 2020	P: Children up to 18 years of age. Children with congenital hypothyroidism (CH) were excluded. I/E/C: Varying newborn TSH level O: Neurodevelopmental outcomes: cognitive, language, motor, and behavioural outcomes. Growth outcomes: weight, length, head circumference, waist circumference, skinfolds. TS: Observational studies, intervention studies.	17 studies (N=4,147 participants in cohorts; 503,706 in record-linkage)	*D1: LOW* *D2: HIGH* *D3: HIGH* *D4: LOW* ***OVERALL: HIGH***

Reference	Review objectives	Search date	Populations (P), Interventions/Exposures (I/E), Comparators (C), Outcomes (O) and Types of Studies (TS)	Included studies, participants	Risk of Bias
Weng et al 2017	To assess the prevalence of thyroid disease with different urinary iodine concentrations (UICs) in the general population of mainland China.	January 2016	P: Participants from a random community-based sample in mainland China. I/E/C: Median UIC of region (3 subgroups: low-iodine group median UIC <100 µg/L; medium-iodine group median UIC 100 to 299 µg/L; high iodine group with median UIC >300 µg/L). O: Thyroid disease (hyperthyroidism, hypothyroidism, thyroid cancer, thyroid nodules)	43 studies (N=178,995 participants)	*D1: LOW* *D2: UNCLEAR* *D3: HIGH* *D4: HIGH* ***OVERALL: HIGH***
Zhang et al 2022	To investigate the relationship between urinary iodine concentration (UIC) and papillary thyroid cancer (PTC).	September 2022	P: Papillary thyroid cancer (PTC) and non-PTC patients (including those with benign thyroid nodules, nodular goiter, and thyroid adenomas), PTC patients with or without lymph node metastases (LNM), PTC patients with or without the BRAF mutation. I/E/C: Differing urinary iodine levels O: Papillary thyroid cancer (PTC). TS: Case-control studies	10 studies (N=6,544 participants)	*D1: HIGH* *D2: UNCLEAR* *D3: LOW* *D4: LOW* ***OVERALL: HIGH***

Risk of bias of systematic reviews

Table 21. Summary of risk of bias assessments conducted by KSR Evidence and additional NHMRC commentary about the implications of risk of bias for NRV development

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Aarsland et al 2025	HIGH *Excluded Non-English language studies*	UNCLEAR *Methods additional to database searching not specified*	LOW *No concerns*	LOW *No concerns*	**HIGH**	Appears to be a reasonable quality SR. Concerns about RoB relate to exclusion of non-English studies and lack of information about how additional methods to database searches have been employed. These limitations are consistent with limitations of an NHMRC-commissioned review.
Beckford et al 2020	HIGH *Excluded conference proceedings and other grey literature*	HIGH *The search strategy did not appear adequate and limited to English language studies only.*	UNCLEAR *The number of reviewers involved in the data extraction process and risk of bias assessment was not reported.*	HIGH *The method of analysis was explained and appeared appropriate and methods used to pool data were appropriate. However, appropriate attempts to explore the observed heterogeneity were not made. Robustness of the findings was not demonstrated.*	**HIGH**	Concerns raised should be considered when using interpreting and applying findings. The review has several significant methodological limitations. However, the high risk of bias should not preclude the review findings from informing considerations about the typical urinary volume excreted by children of different ages.

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Bolfi et al 2024	LOW	UNCLEAR	LOW	LOW	**LOW**	Robust review, noting that the only limitation is that methods additional to database searching were not specified.
	No concerns	*Methods additional to database searching not specified*	*No concerns*	*No concerns*		
Businge et al 2021	LOW	UNCLEAR	UNCLEAR	HIGH	**HIGH**	Concerns raised should be considered when interpreting and applying findings. Given concerns about unaddressed heterogeneity, meta-analyses should be interpreted with caution.
	No concerns	*Embase not mentioned. Methods additional to database searching were not mentioned.*	*Data extraction by a single reviewer and checked by another. Some (but not all) study characteristics extracted and presented.*	*Heterogeneity was not addressed in the analyses. Subgroup or sensitivity analyses were not mentioned.*		
Candido et al 2023	HIGH	UNCLEAR	UNCLEAR	HIGH	**HIGH**	Substantial concerns raised about risk of bias. These should be considered when interpreting and applying findings, particularly concerns about the completeness of the body of evidence (missing search strategies) and robustness of data extraction and synthesis methods.
	Excluded Non-English language studies	*No search strategies were provided.*	*The number of reviewers involved in data extraction was not reported.*	*Heterogeneity was high and was not addressed in the analyses. Subgroup or sensitivity analyses were not mentioned.*		
Cao et al 2017	HIGH	HIGH	HIGH	LOW	**HIGH**	Findings to be interpreted with caution given uncertainties/ limitations raised.
	No specific inclusion criteria for participants were mentioned.	*Search strategies not provided, number of reviewers involved in screening and screening procedures not described*	*Characteristics extracted were insufficient for interpretation of results*	*No concerns*		

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Dineva et al 2020	HIGH - *Studies written in languages other than English, unpublished articles, or non-peer-reviewed articles (e.g., meeting abstracts or letters) were also exclude*	LOW *No concerns*	UNCLEAR - *The number of reviewers involved in the risk of bias assessment was not reported.*	LOW *No concerns*	**HIGH**	Concerns raised should be considered when using interpreting and applying findings, however fundamental methodology appears sound and most limitations are similar to those of NHMRC commissioned reviews (eg. exclusion of non-english studies and certain grey literature).
Dineva et al 2023	HIGH *Studies in languages other than English and unpublished or non-peer reviewed articles (e.g. meeting abstracts, letters) were excluded.*	LOW *No concerns*	LOW *No concerns*	LOW *No concerns*	**HIGH**	Despite being assessed as being at HIGH risk of bias, NHMRC considers this review to be well conducted. Concerns about RoB relate to exclusion of non-English studies and unpublished articles and abstracts - these limitations are consistent with the limitations of any NHMRC-commissioned review.
Dror et al 2018	LOW *No concerns*	HIGH - *The search terms were provided but full details of the search strategy were not reported.*	HIGH - *No. reviewers involved in data extraction not reported. Formal methodological quality assessment of included studies was not performed.*	HIGH - *Only narrative synthesis. Heterogeneity, publication bias and risk of bias not taken into consideration..*	**HIGH**	Concerns raised should be considered when interpreting and applying findings. The lack of assessment of methodological quality of included studies - and consideration of risk of bias during synthesis - is of particular concern.

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Farebrother et al 2018	LOW *No concerns*	LOW *No concerns*	LOW *No concerns*	LOW *No concerns*	**LOW**	Good quality SR, although consideration should be given to the currency of the review (Feb 2017 searches) when interpreting and applying findings
Greenwood et al 2023	HIGH *Non-English language studies and unpublished articles and abstracts excluded*	LOW *No concerns*	LOW *No concerns*	LOW *No concerns*	**HIGH**	Despite being assessed as being at HIGH risk of bias, NHMRC considers this review to be well conducted. Concerns about RoB relate to exclusion of non-English studies and unpublished articles and abstracts - these limitations are consistent with limitations of an NHMRC-commissioned review.
Harding et al 2017	LOW *No concerns*	LOW *No concerns*	LOW *No concerns*	LOW *No concerns*	**LOW**	Good quality SR, although consideration should be given to the currency of the review (2017) when interpreting and applying findings
Katagiri et al 2017	LOW *No concerns*	HIGH *Language restrictions were applied, limiting the search to articles in English or Japanese.*	HIGH *Data extraction and quality assessment of selected papers were conducted by one author.*	LOW *No concerns*	**HIGH**	Concerns raised should be considered when interpreting and applying findings. The fundamental methodology appears sound, although some concerns that data extraction and quality appraisal have not been performed in duplicate. Concerns about review currency should also be considered.

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Lee et al 2017	HIGH *Only case-control studies published in English were included.*	HIGH *Attempts to find additional citations to complement the database search were not made. The search terms were provided but full details of the search strategy were not reported.*	UNCLEAR *The number of reviewers involved in the methodological quality assessment were not reported.*	LOW *No concerns*	**HIGH**	Concerns raised should be considered when interpreting and applying findings, in particular noting concerns about the comprehensiveness of search strategy. Review currency is also a relevant consideration.
Li et al 2022	LOW *No concerns*	HIGH *Some keywords were provided, but no full search strategy. Study selection was by two independent reviewers. Methods additional to database searching were not mentioned.*	HIGH *The number of reviewers involved in data-extraction and risk of bias assessment was not mentioned. Some study characteristics were reported, but insufficient information about possible confounders.*	LOW *No concerns*	**HIGH**	Findings to be interpreted with caution given uncertainties/ limitations raised.
Liu et al 2022	HIGH *Non-English language studies were excluded.*	HIGH *The search terms were provided but full details of the search strategy were not reported. The number of reviewers involved in the study selection was not reported.*	HIGH *Inappropriate/ outdated tool used for appraisal (Jadad) and the number of reviewers involved in RoB assessment was not reported*	HIGH *Only narrative synthesis. Heterogeneity, publication bias and risk of bias assessment not taken into consideration.*	**HIGH**	Concerns raised should be considered when interpreting and applying findings.

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Machamba et al 2021	HIGH *Inclusion was limited to studies published in Portuguese, English and Spanish.*	HIGH *Embase was not mentioned. Searched strategies were presented and appeared sub-optimal. The number of reviewers involved in inclusion screening was not mentioned. Methods additional to database searching were not mentioned.*	LOW *No concerns*	HIGH *The paper did not mention any (quantitative) analysis methods. Narrative synthesis described, but no pre-defined analyses reported.*	**HIGH**	Concerns raised should be considered when interpreting and applying findings.
Monaghan et al 2021	HIGH *Restricted to English-language publications only.*	HIGH *Although no restrictions on publication form, language or date, the search strategy was not adequate. Three authors were involved in the full text screening, although initial screening was conducted by single reviewer.*	UNCLEAR *The number of reviewers involved in the data extraction process and risk of bias assessment was not reported.*	UNCLEAR *Only narrative synthesis was performed. Heterogeneity assessment and publication bias assessment were not taken into consideration. Biases in primary studies were taken into consideration.*	**HIGH**	Concerns raised should be considered when interpreting and applying findings, in particular noting concerns about the comprehensiveness of search methods and lack of clarity around other methods.

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Nazarpour et al 2020	HIGH *Restricted to English-language publications only. Studies were excluded if they were non-original (e.g., reviews, commentaries, case reports), lacked clear UIC classification, or had unclear or inaccurate data.*	HIGH *The search strategy did not appear to have used controlled terms such as MeSH.*	LOW *No concerns*	LOW *No concerns*	**HIGH**	Concerns raised should be considered when interpreting and applying findings. Although the fundamental methodology appears sound, concerns remain regarding the comprehensiveness of searches and criteria for classifying exposure. Review currency may also be a relevant consideration.
Nazeri et al 2016	HIGH *Non-English studies were excluded.*	HIGH - *The search terms were provided but full details of the search strategy were not reported.*	LOW *No concerns*	HIGH - *Heterogeneity was found to be high for all outcomes analysed and was not explored in detail.*	**HIGH**	Concerns raised should be considered when interpreting and applying findings. Although the fundamental methodology appears sound, concerns about comprehensiveness of search strategy and unexplained/ unexplored heterogeneity remain. Review currency is also a relevant consideration.
Nazeri et al 2020a	HIGH *Non-English studies were excluded. Inclusion criteria may not appropriately control for confounders (eg. included women exposed to environmental factors that influence thyroid function, thyroid disease)*	HIGH *Embase was not mentioned. Some keywords were mentioned but no full search strategy was presented*	HIGH *The number of reviewers involved in risk of bias assessment was not mentioned. Unsuitable risk of bias assessment tool used.*	LOW *No concerns*	**HIGH**	Concerns raised should be considered when interpreting and applying findings, particularly potential for confounding.

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Nazeri et al 2020b	HIGH - *Non-English studies were excluded.*	HIGH - *The search terms were provided but full details of the search strategy were not reported.*	UNCLEAR - *The number of reviewers in risk of bias assessment was not reported.*	LOW *No concerns*	**HIGH**	Concerns raised should be considered when interpreting and applying findings, in particular about the comprehensiveness of search methods and lack of clarity around other methods. Review currency should also be examined.
Nazeri et al 2021	HIGH *English language only*	HIGH *Databases included MEDLINE/PubMed, Web of Science, Cochrane Library, Scopus and Google and Google Scholar. Embase was not mentioned. The authors stated that search strategies were available in supplements, but these did not appear to be accessible.*	UNCLEAR *Two investigators extracted the trial data. Any disagreements were resolved through discussion or consultation with a third investigator. The number of reviewers involved in risk of bias assessment was not mentioned.*	HIGH *There was high heterogeneity which could not be investigated further due to low numbers of studies in the analyses.*	**HIGH**	Concerns raised should be considered when interpreting and applying findings, in particular methodological concerns as detail of the search strategy is unavailable and there is lack of clarity around risk of bias assessment and high heterogeneity.
Nazeri et al 2024	LOW *No concerns*	UNCLEAR *Full search strategies not provided*	UNCLEAR *The number of reviewers involved in risk of bias assessment was not mentioned.*	LOW *No concerns*	**UNCLEAR**	Review appears fairly comprehensive, although consideration should be given to highlighted limitations when interpreting and applying findings.

Reference	Domain 1 - Study Eligibility Criteria	Domain 2 - Identification and Selection of Studies	Domain 3 - Data Collection and Study Appraisal	Domain 4 - Synthesis and Findings	Overall Risk of Bias	NHMRC Comment
Wassie et al 2022	LOW *No concerns*	HIGH *The search strategy was adequate. However, it was limited to English language articles. Only one author was involved in screening the titles and abstracts.*	HIGH *One reviewer was involved in the data extraction process. The number of reviewers involved in risk of bias assessment was not reported.*	LOW *No concerns*	**HIGH**	Concerns raised should be considered when interpreting and applying findings. Although the fundamental methodology appears sound, accurate study selection and data extraction cannot be assured as duplicate screening and data extraction have not been performed.
Weng et al 2017	LOW *No concerns*	UNCLEAR *Some keywords were mentioned, but no full search strategies were presented. Methods additional to database searching were not mentioned.*	HIGH *Inappropriate risk of bias tool applied (QUADAS checklist, for diagnostic accuracy studies)*	HIGH *No analyses investigating heterogeneity were reported.*	**HIGH**	Concerns raised should be considered when interpreting and applying findings. In particular, risk of bias assessments and determinations about bias in the evidence base should not be relied upon given use of an inappropriate tool. Currency of findings (searches 2016) should also be considered.
Zhang et al 2022	HIGH *English language only*	UNCLEAR *The search terms were provided but full details of the search strategy were not reported.*	LOW *No concerns*	LOW *No concerns*	**HIGH**	Concerns raised should be considered when interpreting and applying findings. The fundamental methodology appears sound, although there is a lack of clarity regarding the comprehensiveness of the search strategy.

Appendix D - Outcomes from review of primary studies

Identified studies

Outcomes reported by studies are marked by an ‘x’ in the following tables.

Balance studies

Study design	Study ID	Overall risk of bias	Outcomes reported
Balance	Tan (2019)	Serious X	Iodine intake, excretion via 4 routes

Adults

Study characteristics			Outcomes reported						
Study design	Study ID	Overall risk of bias	TSH	FT4	Tg	Thyroid volume	Total goitre rate	Thyroid cancer	Thyroid autoimmunity
Randomised controlled trials (RCTs)	Clark 2003	High X	x	x					
	Gardner 1988	Some concerns -	x	x					
	Sang 2012	Low[6] +	x	x		x			
	Soriguer 2011	High X	x	x	x	x			
Non-randomised studies of interventions (NRSIs)	Paul 1988	Serious X	x	x					
Observational studies	Andersen 2001	Serious X	x	x					
	Gutierrez-Repiso 2015	Serious X	x	x					
	Teng 2006	Serious X	x	x	x		x	x	x

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[6] The evidence scoping contractor assessed Sang (2012) as being at low risk of bias. However, NHMRC suggests that there may be some concerns about risk of bias due to outcome measurement, owing to the 4 year time gap between the two study phases, which may have contributed to the observed differences between groups.

Pregnancy (published since 2016)

Maternal outcomes

Study characteristics			Outcomes reported						
Study type	Study ID	Overall risk of bias	TSH	FT4	Tg	Thyroid volume	Total goitre rate	Thyroid cancer	Thyroid autoimmunity
Randomised controlled trials (RCTs)	Censi 2019	Low +	x	x	x	x			
	Eriksen 2020	Low +	x		x				x
	Gowachirapant 2017	Some concerns -	x	x	x	x			x
	Manousou 2021	Low +	x	x	x				x
Observational studies	Corcino 2019/Silva De Morais 2020	Serious X	x	x	x				x
	Naess 2021	Some concerns -	x	x					
	Olesea 2020	Serious X					x		
	Ollero 2019	Serious X	x	x					x
	Threapleton 2021	Serious X	x	x	x		x		

Birth and child outcomes

Study characteristics			Outcomes reported				
Study type	Study ID	Overall risk of bias	Pregnancy and obstetric outcomes				Child development
			Miscarriage	Still-birth	Pre-term birth	Neonatal TSH	Neurocognitive development *(various measures)*
Randomised controlled trials (RCTs)	Censi 2019	Low +				x	
	Eriksen 2020	Low +				x	
	Gowachirapant 2017	Some concerns -				x	x
	Mohammed 2020	High X					x
	Manousou 2021	Low +				x	
Observational studies	Abel 2019/Abel 2020	Moderate -		x	x		x
	Corcino 2019/Silva De Morais 2020	Serious X	x	x	x		
	Markhus 2018	Serious X					x
	Murcia 2017	Serious X					x
	Olesea 2020	Serious X				x	
	Snart 2020/ Threapleton 2020	Serious X		x	x		x
	Torlinska 2018	Serious X		x	x		
	Zhou 2019	Serious X					x

Children and adolescents

Study type	Study ID	Overall risk of bias		Thyroid function			Thyroid volume	Total goitre rate	Thyroid cancer	Thyroid auto-immunity	Neurocognitive development
				TSH	FT4	Tg					
Randomised controlled trials (RCTs)	Eltom 1985	High	X	x				x			
	Gordon 2009	Some concerns	-			x					x
	van den Briel 2001	High	X	x	x	x					
	Zimmermann 2006	Some concerns	-	x		x					x
	van Stuijvenberg 1999	High	X					x			x
	Zahrou 2016	High	X								
Non-randomised studies of interventions (NRSIs)	Tajtáková 1998	Serious	X	x	x	x	x			x	
Observational studies	Nil identified										

Appendix E - Evidence-to-Decision Framework

Iodine - Requirements for avoiding deficiency

Background

Iodine - function and dietary sources

Iodine is a mineral that is found in soil and ocean waters and is an essential nutrient required for synthesis of thyroid hormones such as thyroxine (T4) and triiodothyronine (T3). Iodine deficiency is associated with thyroid dysfunction, thyroid disease, and adverse child neurocognitive development.

Iodine-rich foods include seafoods such as fish, shellfish, or seaweed, eggs, milk, and iodised salt. The level of iodine in cereal and grain foods varies depending on the iodine content of soil in which the food is grown. Low soil iodine levels are typical for New Zealand and in some parts of Australia such as Tasmania (AIHW, 2016). In 2009 Australia and New Zealand introduced mandatory fortification requirements for the addition of iodine (via iodised salt) to commercial bread, to address iodine deficiency in the population.

Absorption of iodine from food is estimated at 90 - 92% under normal conditions (Thomson et al 1996, Jahreis et al 2001, Aquaron et al 2002). Some compounds - known as goitrogens - impair iodine uptake and increase an individual's risk of deficiency. Identified goitrogens include tobacco and electronic cigarettes (Colzani et al 1998, Knudsen et al 2002, Shields et al 2008, Flieger et al. 2019), along with foods such as cassava, millet, maize and cruciferous vegetables (Gibson, 1991). However, the risk of deficiency from consumption of these foods may be negligible where iodine intake is adequate and a varied diet is consumed (Zimmermann et al. 2008). Absorption can also be affected by deficiencies in other micronutrients including selenium and iron (Yang et al 1997, Kohrle 1999, Thomson 2004, Zimmermann et al 2000).

The developing infant and neonates are particularly sensitive to the effects of maternal iodine deficiency during pregnancy or lactation, due to the critical role of iodine in early neurocognitive development. Individuals with low intake of iodine-containing foods - including vegans, vegetarians, and individuals with low dairy or commercial bread consumption - may be at greater risk of deficiency.

Criteria for measuring iodine intake and status

There are limitations in the accuracy of dietary iodine intake assessment methods, including concerns about reporting bias (including recall and social desirability bias), variability of iodine content in foods, difficulty in measuring contribution of iodine from use of iodised salt at the table and in cooking, and the inaccuracy of food composition data. It is also difficult to ascertain individual status based on dietary intakes which reflect intakes at a specific point in time. In people with iodine replete diets, iodine is incorporated into thyroglobulin and this can provide up to 3 months of thyroid hormone, ensuring that thyroid function is maintained during periods of low iodine intake (e.g. due to seasonal variation in iodine content of food).

Measures of urinary iodine concentration (UIC) are used as established biomarkers for intake and status, although these measures also have limitations. As more than 90% of dietary iodine is excreted in the urine, urinary iodine is used as an indicator of recent iodine intake. Urinary iodine can be measured over 24-hours or in a spot urine sample. Collection of 24-hour urine (known as urinary iodine excretion or UIE) is preferable to spot-sampling (UIC) due to diurnal variation in excretion of iodine in urine. However, this measure has a high respondent burden, and there is no internationally accepted method to determine if all urine voided during the 24-hours was collected (i.e. completeness).

The use of spot urine samples is simpler and consequently, more frequently used and reported in the literature. Furthermore, the epidemiologic criteria described below are based on median UIC (µg/L). In addition to the diurnal variation mentioned, variation in urinary volume is another concern with spot urine samples. High water intake and thus high urine volumes will result in lower UIC values which could be misinterpreted as poor iodine status whereas low urine volumes will result in higher UIC values, suggesting adequate iodine status where this may not be the case. To address this problem, corrected measures of UIC are often reported, for example, correcting for urinary creatinine level.

Both 24-hour UIE and UIC are associated with inter- and intra-individual variation, thus neither measure should be used to assess iodine status of an individual, but rather to assess the iodine status of a group or population (where sample sizes are sufficiently large). The World Health Organization (WHO) have developed epidemiologic criteria for assessing population iodine status in school-age children using median UIC, shown in Table 1. It also recommends that the proportion of the population with median UIC below 50 µg/L should not exceed 20% (WHO, 2007). The criteria for children were subsequently extended to adults (except during pregnancy).

Table 1. **WHO epidemiologic criteria for assessing iodine nutrition using median UIC (Source: WHO 2013)**

Population	Median UIC (µg/L)	Iodine intake/status	Iodine status
School-aged children (6 years and up) and non-pregnant adults	<20	Insufficient	Severe iodine deficiency
	20 - 49	Insufficient	Moderate iodine deficiency
	50 - 99	Insufficient	Mild iodine deficiency
	100 - 199	Adequate	Adequate iodine nutrition
	200 - 299	Above requirements	Slight risk of more than adequate iodine intake
	≥300	Excessive^	Risk of adverse health consequences
During pregnancy	<150	Insufficient	
	150 - 249	Adequate	
	250 - 499	Above requirements	
	≥500	Excessive^	
During lactation	<100	Insufficient	
	≥100	Adequate	

^ In this context, the term 'excessive' denotes an intake in excess of that required for prevention and control of iodine deficiency. It is not synonymous with an 'Upper Level' at which there is an elevated risk of toxicological effects.

Evidence to decision tables

Adults

Criterion	OPTION 1: Maintain current recommendations (EAR & RDI) Adapt current NRVs to new age groupings			OPTION 2: Revise recommendations to AIs to reflect uncertainty in evidence base	
Example recommendation		*EAR* *(µg/day)*	*RDI* *(µg/day)*		*AI* *(µg/day)*
	Males			*Males*	
	18 to under 30 years	*100*	*150*	*18 to under 30 years*	*150*
	30 to under 50 years	*100*	*150*	*30 to under 50 years*	*150*
	50 to under 65 years	*100*	*150*	*50 to under 65 years*	*150*
	65 to under 75 years	*100*	*150*	*65 to under 75 years*	*150*
	75 years and older	*100*	*150*	*75 years and older*	*150*
	Females			*Females*	
	18 to under 30 years	*100*	*150*	*18 to under 30 years*	*150*
	30 to under 50 years	*100*	*150*	*30 to under 50 years*	*150*
	50 to under 65 years	*100*	*150*	*50 to under 65 years*	*150*
	65 to under 75 years	*100*	*150*	*65 to under 75 years*	*150*
	75 years and older	*100*	*150*	*75 years and older*	*150*

Health evidence profile and supporting information	The current (2006) recommendations for adults are based on studies reporting average thyroid iodine accumulation and turnover between 91.2 and 96.5 µg/day in euthyroid adults (Fisher and Oddie, 1969a, Fisher and Oddie, 1969b). Values were rounded to 100 µg/day to reflect New Zealand data on urinary iodide to thyroid volume (Thomson et. al. 2001). The RDI was established by applying a 20% co-efficient of variation (CV), being half of the 40% CV reported by Fisher and Oddie (1969a). This adjustment was made on the basis that half of the observed variation was considered to be due to the complexity of the experimental design and calculations used to estimate turnover (US IOM, 2001). More recently, concerns have been raised about the accuracy of thyroid accumulation studies for determining iodine requirements. EFSA (2014) noted that thyroidal iodine capture is downregulated with increasing iodine intake. Fisher and Oddie's thyroid accumulation studies (Fisher and Oddie 1969a, 1969b) measured UIE at 410µg/day and 280 µg/day respectively, suggestive of higher habitual iodine intakes that may not reflect the Australian and New Zealand context. A 2014 balance study (Tan, 2019) found that neutral balance was achieved with an iodine intake of 111 µg/day, which equates to an RDI of 155 µg/day when a 20% CV is applied. The balance study had several limitations, including no run-in period, and it was conducted in a small sample (N=25) of iodine replete, euthyroid female students. Consequently, findings may not be broadly generalisable to the Australian and New Zealand context. Despite uncertainty in the evidence, the thyroid accumulation studies and recent balance studies collectively estimate requirements between 90 and 110 µg/day. The available	When developing NRV recommendations for nutritional adequacy, other international bodies (EFSA, 2014; Blomhoff et al. 2023) concluded that the available evidence is insufficient to support derivation of an EAR and RDI. This reflects concerns about the reliability of balance and thyroid accumulation studies for estimating requirements, including: methodological limitations of balance studies (eg. inadequate run-in periods, accuracy of methods for measuring intake and losses) that observed 'balance' may reflect requirements that only apply in a narrow range of contexts, or reflect transient adaptive changes rather than steady state requirements wide variation in the iodine intakes associated with 'null' balance reported across studies poor generalisability of estimates based on thyroid accumulation studies, noting that thyroidal iodine capture is downregulated with increasing iodine intake. Thyroid accumulation studies upon which current NRVs are based (Fisher and Oddie, 1969a, Fisher and Oddie, 1969b) measured UIE at 410 µg/day and 280 µg/day respectively, suggestive of higher habitual iodine intakes that may not reflect the Australian and New Zealand context. A 2014 balance study (Tan, 2019) found that neutral balance was achieved with an iodine intake of 111 µg/day, which equates to an RDI of 155 µg/day when a 20% CV is applied. However, the balance study had several limitations including no run-in period, and it was conducted in a small sample (N=25) of iodine replete, euthyroid female students. Consequently, findings may not be broadly generalisable to the Australian and New Zealand context. For most health outcomes or biomarkers related to deficiency or adequacy, the relationship with iodine intake is either not sufficiently characterised, or is insufficiently sensitive or reliable to inform establishment of an NRV. Establishing an Adequate Intake (AI) in place of the existing EAR and RDI recommendations reflects uncertainties in the underlying evidence base.

	evidence supports maintaining the current EAR of 100 µg/day. Furthermore, the RDI of 150 µg/day - derived by applying a CV of 20% to the EAR of 100 µg/day - is supported by observational data suggesting that 150 µg/day intake in adults corresponds with a low population prevalence of goitre (EFSA 2014).	Under the NHMRC's methodological framework for NRV development (NHMRC, 2025), an AI can be established based on experimental or observational data. Australian and New Zealand population data were deemed to be unsuitable for deriving AIs because: there is substantial variation between estimates (both between Australia and New Zealand, and across Australian jurisdictions). 2014/15 data suggest that mild deficiency remains an issue in some New Zealand populations, including females using Australian population data may overestimate requirements, because: there is no evidence that the general Australian population has any level of deficiency for most age groups (excluding pregnant and lactating populations, and women of child-bearing age) the CV of intake typically exceeds the CV of requirement due to mandatory fortification, intakes in some populations (e.g. children) are likely to substantially exceed requirements. The approach taken by EFSA (2014) and NNR (Blomhoff et. al. 2023) suggested an AI of 150 µg/day can be derived from observational data suggesting that UIC of 100 µg/day in children is associated with low prevalence of goitre (Delange et al 1997), which corresponds to an estimated 150 µg/day intake in adults (EFSA 2014). This value is supported by: data from thyroid accumulation studies upon which the existing RDI of 150 µg/day is based balance study data suggesting that 155 µg/day is sufficient to meet the requirements of almost all individuals (Tan 2019).

Iodine exposure in Australia and New Zealand

Recent (2022-24) urinary iodine data from Australia suggests that the adult population in Australia is iodine sufficient - based on WHO criteria - with almost all age groups having median UIC >100 µg/L (WHO 2013; ABS 2025a). However, data suggests mild population deficiency in females of reproductive age (aged 25 to 44 years). This raises concerns about iodine intakes and status in this population, given the critical role of iodine in fetal and neonatal development.

National dietary intake data from the 2023 National Nutrition and Physical Activity Survey (NNPAS; ABS 2025c) and 2011-13 Australian Health Survey (AHS; ABS 2015) are presented in Table 2. Intakes in females were lower than those of males across all age groups in both 2011-13 and 2023 surveys. Based 2011-13 data, females were more than 4 times as likely to have inadequate intakes as males with inadequate intake prevalent in 2% of males and 10% of females aged 19 years and over. However, it is unclear whether this data continues to reflect the situation in Australia, with the 2023 NNPAS reporting an increase in iodine intake between 2011 and 2023 (ABS 2025c).

TABLE 2 - AUSTRALIAN NATIONAL DIETARY IODINE INTAKE DATA IN ADULTS, 2023 NNPAS (ABS 2025C) AND 2011-13 AHS (ABS 2015)

Age groups in years (2023/2011-13)	2023 NNPAS (ABS, 2025c)		2011-13 AHS (ABS, 2015)			
	Males	Females	Males		Females	
	Mean intake (µg/day)	Mean intake (µg/day)	Mean (95% CI) Intake (µg/day)	% less than EAR	Mean (95% CI) Intake (µg/day)	% less than EAR
18 to <30y/19 to <31y	194.2	144.6	202 (120 - 299)	1.5%	146 (86 - 218)	11.7%
30 to <50y/31 to <51y	197.3	160.0	200 (119 - 297)	1.6%	152 (91 - 226)	9.0%
50 to <65y/51 to <71y	199.6	158.2	182 (106 - 274)	3.5%	149 (89 - 221)	10.5%
65 to <75y/71y and over	190.9	167.1	178 (103 - 270)	4.2%	151 (91 - 224)	9.2%
75y and over/71 y and over	193.1	164.6				

In New Zealand, the most recent national data found that median UIC for all adults was 103 µg/L, however one in five (20.3%) of those surveyed had UIC below 50 µg/L - slightly above the WHO threshold for population sufficiency (NZ MoH, 2020; WHO, 2013). Furthermore, whilst the median UIC for men was >100µg/L across all ages and ethnic groups, the median UIC for women remained below the WHO threshold for sufficiency at 93 µg/L, with only those women aged 15-24 years or of Māori, Pacific and Asian ethnicities reporting concentrations >100 µg/L (NZ MoH 2020)

There are no clear indicators of population-level health effects associated with iodine deficiency in Australia and New Zealand, following the introduction of mandatory fortification in 2009. However, the persistence of mild deficiency in women of reproductive age is of concern and requires careful consideration. Individuals with diets low in iodine-containing foods - such as vegan/vegetarian or dairy-free diets, low commercial bread intake, or low iodised salt intake - may be at increased risk of deficiency. This is a particular consideration with reduced consumption of commercial bread and bread products (ABS 2025b; ABS 2025c) and growing interest in plant-forward diets with lower animal product consumption in Australia and New Zealand (Roy Morgan 2016; Kantar 2022; Riverola et al. 2023).

Benchmarking against comparable international jurisdictions

Irrespective of whether an EAR and RDI is retained - or an AI set - the recommended iodine intake for adults aligns with values from comparable international jurisdictions, noting that the type of NRV (EAR & RDI vs AI) varies across jurisdictions. Table 3 shows NRV recommendations for comparable international jurisdictions. Where a jurisdiction specifies an EAR and RDI, the RDI has been extracted for comparison purposes.

TABLE 3 - ADULT NUTRITIONAL ADEQUACY RECOMMENDATIONS ACROSS COMPARABLE JURISDICTIONS

Age (years)	Proposed ANZ AI (µg/day)	Current/ Proposed ANZ RDI (2006) (µg/day)	EFSA AI (2014) (µg/day)	NNR AI (2023) (µg/day)	WHO RDI (2007) (µg/day)	D-A-C-H RDI (2013) (µg/day)
Adults 18 +years:	150	150	150	150	150	200

Balance of effects (benefits and harms)	The current recommendations are expected to be protective of public health. There is no physiological or epidemiologic evidence of deficiency at intakes aligned with current recommendations. Presenting NRV recommendations for iodine as an EAR and RDI may imply a degree of certainty in an NRV for which the underpinning evidence base is more limited. However, the relative consistency between estimates from thyroid accumulation studies, balance studies and observational studies provides some comfort in the robustness of estimates, with several studies suggestive of an EAR in the range of 95 - 110 µg/day. There is also no new evidence to suggest that the current recommendations are not suitable. Furthermore, comparison of food system modelling and estimated dietary intakes against the EAR provides a critical measure for monitoring and evaluating public health interventions, such as mandatory fortification. This is an important consideration, given the current iodine fortification program in Australia and New Zealand.	The proposed AI recommendation will be protective of public health and align with the current recommended RDIs. There is no physiological or epidemiologic evidence of deficiency at intakes aligned with current recommendations. Revising the recommendations from an EAR and RDI to an AI communicates uncertainties in the evidence base more clearly. However, the AI cannot be used to determine the prevalence of inadequate nutrient intakes within a population. Although a low prevalence of inadequacy may be presumed in populations with mean intakes around or above the AI, for those with intakes below the AI, adequacy cannot be determined (US IoM 2000). Consequently, removing the EAR in favour of an AI impedes analysis of population inadequacy for iodine using dietary intake data compared with EAR. This analysis is often performed by researchers and policymakers - including in the Australian Health Survey. Although dietary intake is not a reliable measure of iodine intake in Australia and New Zealand, given wide variability of iodine in the food supply, limitations in food composition data and the need to factor in use of iodised salt at the table and in cooking. In contrast, median UIC is an established biomarker for evaluating population iodine status (WHO 2007) and is routinely measured both in research and in the Australian National Health Measures Survey. The 2008/09 New Zealand National Nutrition Survey measured urinary iodine concentration to assess iodine status over dietary intake data, owing to concerns about the accuracy of food composition data for estimating intake (University of Otago and NZMoH 2011). Consequently, removal of the EAR may not impede population monitoring of iodine status.

		However, comparison of food system modelling and estimated dietary intakes against the EAR provides a critical measure for monitoring and evaluating public health interventions, such as mandatory fortification. This analysis would be precluded, if the EAR were replaced with an AI, for the reasons stated above.
Certainty of the evidence	The evidence for iodine requirements comes from experimental studies such as thyroid accumulation and balance studies, which are imprecise and may not accurately account for iodine requirements. Findings from observational studies on goitre prevalence vary substantially across geographic regions are subject to confounding due to a range of factors including past iodine status. Overall, the evidence for the intake of iodine required to prevent deficiency is very uncertain. However, the level of consistency across estimates derived using different approaches provides some assurance that the proposed recommendations - whether an EAR and RDI or an AI - will be protective of public health.	

Values, preferences and feasibility (consumers, communities)

The current RDI - or proposed AI recommendation - for adults are feasible to achieve, based on estimated iodine intakes across all foundation diets, and for each individual foundation diet (omnivore, rice-based, pasta-based and lacto-ovo-vegetarian). Relevant food modelling data are shown at Table 4.

TABLE 4 - FOOD MODELLING DATA (NHMRC, 2011) IN ADULTS

	Core food groups^	Foundation diets - overall		Rice-based		Pasta-based		Lacto-ovo-vego	
Age group (years)	Intake in persons (µg/day	Intake in males (µg/day)	Intake in females (µg/day)	Intake in males (µg/day)	Intake in females (µg/day)	Intake in males (µg/day)	Intake in females (µg/day)	Intake in males (µg/day)	Intake in females (µg/day)
19-30 yr	148	197	210	213	204	181	187	177	173
31-50 yr		210	211	224	210	192	197	190	178
51-70 yr		219	275	229	290	198	229	198	233
70+ yr		256	260	275	289	249	223	215	218

Resource impacts	Retaining the current values for adults has no material implications. Although adult age groupings are being adjusted to align with new NRVs age groupings (see Methodological Framework; NHMRC 2025), the adult NRVs are the same for all age groups so there is no material impact of this change. Consequently, this minor change to age groupings should have no implications for regulators, including FSANZ (food and food products) and TGA (supplements).	Replacing the current EAR and RDI with an AI to reflects uncertainty in the evidence base, and adjusts recommendations to align with new age groupings. While small, these changes may have significant implications for regulators, including FSANZ (food and food products) and the TGA (supplements). In particular, removal of the EAR may preclude analysis comparing dietary intake modelling data against the EAR. Preliminary discussions with FSANZ have indicated that removal of the EAR would be problematic for ongoing monitoring of the mandatory fortification program. The FSANZ adult regulatory RDI for iodine is 150 µg/day, although this regulatory value only applies in the context of food labelling. Views will be sought during targeted/stakeholder consultation and considered when developing final NRVs.
Other factors (health equity impacts, sustainability)	Groups at risk of deficiency include vegans, vegetarians, individuals with low consumption of dairy or commercial bread, individuals with low intakes of iodised salt, and smokers of both tobacco and electronic cigarettes. Reduced consumption of commercial bread and bread products in Australia (ABS 2025b) and increasing interest in predominantly plant-based diets (Roy Morgan 2016; Kantar 2022; Riverola et al. 2023) has the potential to reduce population iodine intake and should be closely monitored. Data from Australia and New Zealand also suggests that women of reproductive age may be mildly deficient. Sufficient iodine status during pregnancy is required to support child neurocognitive development. It is critical that public health communication addresses the need for iodine supplementation pre-conception and throughout pregnancy and lactation, to provide for optimal fetal development. With any change to the NRVs care must be taken to avoid suggesting that there is uncertainty about the need for increased iodine during pregnancy, or to undermine messaging about routine iodine supplementation in this cohort.	

Decision	Option 1 (retain existing EAR and RDI, adjusted to with additional age groupings) was selected in view of the potential harms to public health monitoring associated with removal of the EAR - in particular the existing iodine fortification program. Further, although the evidence underpinning the EAR is not robust, several different sources of evidence from thyroid accumulation and balance studies support establishing an EAR in the range of 90 - 110 µg/day. Finally, there is no evidence that the current recommendations are associated with adverse public health outcomes.

During pregnancy

Criterion	OPTION 1: Maintain current recommendations (EAR & RDI) Adapt current NRVs to new age groupings	OPTION 2: Revise recommendations to AIs to reflect uncertainty in evidence base
Example recommendation	*EAR* *RDI* *Pregnancy* *160 µg/day* *220 µg/day*	*AI* *Pregnancy* *220 µg/day*
Health evidence profile and supporting information	The current (2006) values for pregnancy were based on adult requirements, adjusted to account for additional requirements during pregnancy. Daily fetal thyroid iodine uptake was estimated at 75 µg/day based on 100% daily turnover of iodine in the newborn thyroid, and an estimated thyroid content of 50-100 µg in newborns (Delange and Burgi, 1989; Delange and Ermans, 1991). Assuming an EAR of 95 µg/day for non-pregnant women (based on the EAR identified by the US IOM), a preliminary EAR of 170 µg/day during pregnancy was calculated. This estimate was reduced to 160 µg/day in view of the following supportive evidence: a balance study which reported neutral balance among pregnant women with iodine intakes of around 160 µg/day (Dworkin et al., 1966); and studies on the effect of iodine supplementation on maternal thyroid volume, with daily intakes of 250 to 280 µg/day found	A 2023 balance study found that neutral balance was reached with iodine intake of 202 µg/day in a subset of 40 pregnant Chinese women (Chen et al 2023). This corresponds with an RDI of 280 µg/day when applying a 20% CV and is greater than the 160 µg/day reported by Dworkin et al (1966). Chen et al (2023) noted that estimated iodine balance was higher with increasing habitual intake and also varied by trimester. On this basis, the evidence from balance studies is uncertain about iodine requirements during pregnancy. In recent years there has been a proliferation of studies examining the relationship between iodine intake in pregnancy and child neurocognitive development. Although the relationship between severe iodine deficiency during pregnancy and global impairments in child neurocognitive development is well-established, the evidence for mild iodine deficiency is less certain. Robust supportive evidence of consistent adverse neurocognitive effects associated with mild-to-moderate iodine deficiency are lacking, with the evidence base limited by

	to prevent goitre during pregnancy (Pedersen et al., 1993), whereas intakes of 150 µg/day were insufficient to prevent increased thyroid volume (Glinoer, 1998). The RDI during pregnancy was estimated at 220 µg/day, based on an EAR of 160 µg/day and applying a 20% CV. More recently, a 2023 balance study found that neutral balance was reached with iodine intake of 202 µg/day in a subset of 40 pregnant Chinese women (Chen et al 2023). However, Chen et al (2023) noted that estimated iodine balance was higher with increasing habitual intake and also varied by trimester. The authors also noted that missing data may have impacted findings, with 35% of participants lost to follow up by day 7. These findings correspond with an EAR of 200 µg/day and RDI of 280 µg/day - compared with the EAR of 160 µg/day and RDI of 220 µg/day suggested by Dworkin et al (1966). Additional requirements during pregnancy have been estimated at 50 µg/day, in iodine-sufficient individuals with adequate iodine stores (EFSA, 2014). However, data suggests that Australian and New Zealand women of childbearing age may be mildly deficient, and adequate iodine stores cannot be assumed. The total requirements for daily fetal thyroid iodine uptake is estimated at 75 µg/day based on 100% daily turnover of iodine in the newborn thyroid, and an estimated thyroid content of 50-100 µg in newborns (Delange, 1989; Delange and Ermans, 1991). Although there is substantial uncertainty in the evidence, the additional data suggests that the current EAR of 160 µg/day and RDI 220 µg/day remain suitable for the Australian and New Zealand population.	inconsistent findings and significant heterogeneity (Monaghan 2021). Similarly, reviews on the effects of supplementation during pregnancy have found no significant improvement in neurocognitive outcomes with supplementation. However, it has been suggested that these findings may be due to supplementation commencing after a critical developmental period (Nazeri 2021). Reviews have concluded that there is a lack of high-quality evidence on the effect of iodine supplementation during pregnancy on child neurocognitive development (Dineva 2020; Harding 2017). Two Australian epidemiological studies suggest that child neurocognitive outcomes may be optimised with maternal UIC ≥150 µg/L (Hynes 2017) or with maternal intakes between 185 and 365 µg/day (Sullivan et al 2024). However, the evidence remains uncertain due to imprecision and inconsistency in the evidence, and the potential for residual confounding. In the absence of robust evidence, the AI for pregnancy can be calculated based on the AI for adults, factoring in additional life-stage requirements. EFSA (2014) estimated additional requirements during pregnancy at 50 µg/day, in iodine-sufficient individuals with adequate iodine stores. However, data suggests that Australian and New Zealand women of childbearing age may be mildly deficient, and adequate iodine stores cannot be assumed. Therefore, the AI during pregnancy should aim to meet the total requirements for daily fetal thyroid iodine uptake, which is estimated at 75 µg/day based on 100% daily turnover of iodine in the newborn thyroid, and an estimated thyroid content of 50-100 µg in newborns (Delange, 1989; Delange and Ermans, 1991). The AI of 220 µg/day was estimated by adding the additional 75 µg/day requirement to the adult AI of 150 µg/day and rounding down by 5 µg/day.

Iodine exposure in Australia and New Zealand	In Australia, the 2011-12 NHMS reported median UIC for pregnant and breastfeeding women aged 16 to 44 years of 116 µg/L and 103 µg/L respectively (ABS, 2013). These values were lower than the median UIC for all Australian women of that age reported in the 2011-12 NHMS (121 µg/L) and are indicative of insufficient intakes during pregnancy under WHO criteria (WHO, 2013). Contemporary data in pregnant cohorts are lacking, although recent national data releases in reproductive-age females are also informative for this population. The 2023 NNPAS survey (ABS 2025c) reported mean intakes among females of child-bearing age of 145 µg/day for 18 to 29 year-olds and 160 µg/day for 30 to 49 year-olds respectively (2023 NNPAS data for pregnant cohorts are not available). The 2022-24 NHMS reported median UIC in females of child-bearing age (aged 16 to 44 years) of 101 µg/L indicating marginal population sufficiency for non-pregnant adults based on WHO epidemiologic criteria (ABS, 2025a; WHO, 2013). However, data suggests mild population deficiency among reproductive age females (aged 25 to 34 years and 35 to 44 years), with median UIC of 87 µg/L and 97 µg/L respectively, and more than 20% of individuals with UIC <50 in both age groups. These findings are echoed in data from the 2014/15 NZHS which - while based on a small cohort of pregnant women (N=110) - reported median UIC of 114 µg/L (95% CI: 87, 141 µg/L), below the WHO-recommended median UIC of 150 µg/L (NZ MoH, 2020; WHO, 2013) Studies have also suggested deficiencies in the knowledge of - and adherence to - recommendations for iodine supplementation during pregnancy amongst Australians and New Zealanders (El-mani et al 2014, Lucas et al 2014, Martin et al 2014, Malek et al 2016, Guess et al 2017, Hine et al 2018, Reynolds and Skeaff 2017, Jin et al 2021). Furthermore, although iodine supplementation has been associated with adequate iodine status in pregnant Australian women (Hurley et al 2019), some studies suggest that supplementation may not address the neurocognitive effects of maternal deficiency in pregnancy, unless commenced during pre-conception and continued throughout pregnancy (Hynes et al 2019).

Benchmarking against comparable international jurisdictions

Table 5 shows NRV recommendations for comparable international jurisdictions. Where a jurisdiction specifies an EAR and RDI, the RDI has been extracted for comparison purposes.

TABLE 5 - PREGNANCY IODINE REQUIREMENT RECOMMENDATIONS ACROSS COMPARABLE JURISDICTIONS

Age (years)	Proposed ANZ AI (µg/day)	Current ANZ (2006)* RDI (µg/day)	EFSA (2014)* AI (µg/day)	NNR (2023)* AI (µg/day)	WHO (2007)*RDI (µg/day)	D-A-C-H (2015)* RDI (µg/day)
Pregnancy (all):	220	220	200	200	230	230

Irrespective of whether an EAR and RDI is retained, or an AI set, the recommended iodine intake during pregnancy aligns with values from comparable international jurisdictions, noting that the type of NRV (EAR & RDI vs AI) varies across jurisdictions. Similarly, there is some variation in the recommended intake to meet requirements during pregnancy, reflecting the differing public health nutrition contexts of each country. For example, in Germany where insufficiency remains a concern, recommendations for requirement are higher than elsewhere in Europe, reflecting the need for intakes to replenish depleted stores along with maintaining adequacy into the future. Similarly, in countries with longstanding sufficiency, recommendations during pregnancy and lactation are lower, reflecting the ability of maternal iodine stores to meet increased requirements. This may not be the case in Australia and New Zealand, where mild deficiency continues to be a concern within some populations - in particular women of reproductive age.

Balance of effects (benefits and harms)	The current recommendations are expected to be protective of public health. There is no physiological or epidemiologic evidence to suggest that the current recommendations do not reflect requirements for preventing deficiency. Presenting NRV recommendations for iodine as an EAR and RDI may imply a degree of certainty in an NRV for which the underpinning evidence base is more limited. However, comparison of food system modelling and estimated dietary intakes against the EAR provides a critical measure for monitoring and evaluating public health interventions, such as mandatory fortification. This is an important consideration, given the current iodine fortification program in Australia and New Zealand. This information is critical, given that data is suggestive of persisting mild deficiency among Australian and New Zealand women of child bearing age and during pregnancy.	The proposed AI recommendation will be protective of public health and align with the current recommended RDIs. There is no physiological or epidemiologic evidence to suggest that the current recommendations do not reflect requirements for preventing deficiency. Revising the recommendations from an EAR and RDI to an AI communicates uncertainties in the evidence base more clearly. However, the AI cannot be used to determine the prevalence of inadequate nutrient intakes within a population. Although a low prevalence of inadequacy may be presumed in populations with mean intakes around or above the AI, for those with intakes below the AI, adequacy cannot be determined (US IoM 2000). Consequently, removing the EAR in favour of an AI impedes analysis of population inadequacy for iodine using dietary intake data compared with EAR. This analysis is often performed by researchers and policymakers - including in the Australian Health Survey. Dietary intake is not a reliable measure of iodine intake in Australia and New Zealand, given wide variability of iodine in the food supply, limitations in food composition data and the need to factor in use of iodised salt at the table and in cooking. In contrast, median UIC is an established biomarker for evaluating population iodine status (WHO 2007) and is routinely measured in research and in the Australian National Health Measures Survey. The 2008/09 New Zealand National Nutrition Survey measured urinary iodine concentration to assess iodine status over dietary intake data, owing to concerns about the accuracy of food composition data for estimating intake (University of Otago and NZMoH 2011). Removal of the EAR is not expected to impede population monitoring of iodine status.

<table>
<tr><td></td><td></td><td>However, comparison of food system modelling and estimated dietary intakes against the EAR provides a critical measure for monitoring and evaluating public health interventions, such as mandatory fortification. This analysis would be precluded, if the EAR were replaced with an AI, for the reasons stated above.</td></tr>
<tr><td>Certainty of the evidence</td><td colspan="2">Requirements during pregnancy are estimated based on adult requirements and factoring in additional requirements for fetal development during pregnancy. These estimates are imprecise, and may not account individual variability in status and requirements.
There is a paucity of evidence examining the relationship between maternal iodine intake on maternal and child thyroid function and child neurodevelopment. Available studies are limited by the use of spot urinary iodine measures for quantifying intake, or extrapolation of an intake based on urinary iodine excretion, which may be imprecise or inaccurate during pregnancy.
Although there is a well-established association between severe maternal iodine deficiency during pregnancy and impaired cognitive development in the child, data on the iodine intake required to prevent cognitive impairment are inconsistent and imprecise.
The evidence for the iodine intake required to prevent maternal and child deficiency during pregnancy remains uncertain.</td></tr>
<tr><td>Values, preferences and feasibility (consumers, communities)</td><td colspan="2">The current RDI or proposed AI recommendation during pregnancy is feasible to achieve, with iodine intake estimated across all foundation diets at between 233 and 261 µg/day (NHMRC, 2011)</td></tr>
</table>

Resource impacts	Retaining the current recommendations for pregnancy is expected to have no implications for regulators, including FSANZ (food and food products) and TGA (supplements). Current recommendations during pregnancy are presented for each age group, although the NRV is the same for each age group. It is proposed that the revised recommendations will be presented as a single recommendation during pregnancy. This will alter how recommendations are presented, but has no impact on the actual recommendations themselves.	The proposed change is nominal, replacing the current EAR and RDI with an AI to reflect uncertainty in the evidence base, and adjusting recommendations to align with new age groupings. While small, these changes may have significant implications for regulators, including FSANZ (food and food products) and the TGA (supplements). In particular, removal of the EAR may preclude analysis comparing dietary intake modelling data against the EAR. Preliminary discussions with FSANZ have indicated that removal of the EAR would be problematic for ongoing monitoring of the mandatory fortification program. Views will be sought during targeted/stakeholder consultation and considered when developing final NRVs.
Other factors (health equity impacts, sustainability)	Groups at risk of deficiency include: vegans or vegetarians; individuals with low consumption of dairy, commercial bread, or iodised salt; and smokers of both tobacco and electronic cigarettes. Reduced consumption of commercial bread and bread products in Australia (ABS 2025b) and increasing interest in predominantly plant-based diets (Roy Morgan 2016; Kantar 2022; Riverola et al. 2023) has the potential to reduce population iodine intake and should be closely monitored. Data from Australia and New Zealand also suggests that women of reproductive age may be mildly deficient. Sufficient iodine status during pregnancy is critical for supporting child neurocognitive development. Studies suggest that knowledge about the importance of iodine supplementation during pregnancy and lactation - and adherence to supplementation recommendations - are lacking among Australians and New Zealanders (El-mani et al 2014, Lucas et al 2014, Martin et al 2014, Malek et al 2016, Guess et al 2017, Hine et al 2018, Jin et al 2021). It is critical that public health messaging communicates the importance of achieving and maintaining sufficient iodine status prior to conception and throughout pregnancy and lactation, for optimal fetal development. If the change from an EAR and RDI to an AI is adopted to reflect uncertainty in the evidence base, care must be taken to avoid suggesting that there is uncertainty about the need for increased iodine during pregnancy, or to undermine messaging about routine iodine supplementation in this cohort. It is recommended that pregnant and lactating women take an iodine-containing supplement to ensure adequacy. However, the affordability of iodine supplements has been identified as a barrier to use during pregnancy and lactation in Australia (Nolan et al 2022, Jorgensen et al 2016). This may have equity implications for individuals' abilities to meet nutritional recommendations during this life stage. This equity issue should be addressed by public health policy makers.	

Decision	Retain the current EAR and RDI during pregnancy. Rationale: potential harms associated with removal of the EAR - in particular impeding food modelling analysis to support public health decision making and the existing iodine fortification program - outweigh any benefits of acknowledging uncertainty in the evidence base through replacing the EAR and RDI with an AI. This is a particularly important consideration in pregnant populations, in view of the effects of maternal deficiency on the developing infant although the evidence underpinning the EAR is not robust, several different sources of evidence estimate physiological requirements in the range 160 - 185 µg/day during pregnancy. There is no evidence to indicate that the current recommendations are inaccurate or inadequate for meeting nutritional needs of the general, pregnant population.

During lactation

Criterion	OPTION 1: Maintain current recommendations (EAR & RDI) Adapt current NRVs to new age groupings	OPTION 2: Revise recommendations to AIs to reflect uncertainty in evidence base
Example recommendation	*EAR* *RDI* *Lactation* *190 µg/day* *270 µg/day*	*AI* *Lactation* *270 µg/day*
Health evidence profile and supporting information	The current (2006) EAR during lactation was set at 190 µg/day, based on the adult EAR (100 µg/day) plus replacement of iodine secreted in breast milk estimated at 90 µg/day. The replacement value of 90 µg/day was lower than the 114 µg/day estimated by the US IOM (based on Gushurst et al 1984) as the panel considered a broader range of studies on the topic (Delange e al 1984, Gushurst et al 1984, FAO:WHO 2001, Johnson et al 1990). The RDI was set at 270 µg/day assuming a CV of 20% for the EAR. A 2018 systematic review concluded that a breast milk iodine concentration (BMIC) of 150 µg/L would meet- and potentially exceed - infant requirements in the first 6 months of lactation (Dror & Allen 2018). This finding	There is no established reference range for breast milk iodine concentration (BMIC). A 2018 systematic review found significant variation in BMIC is noted both between populations, and over the course of lactation (Dror & Allen 2018). It concluded that a BMIC of 150 µg/L would meet- and potentially exceed - infant requirements in the first 6 months of lactation. This finding supports the conclusions of EFSA (2014) which suggested that positive balance was reached with BMIC between 100 and 200 µg/L. Assuming an average breast milk volume of 0.8 L/day, an additional 120 µg/day of iodine would be required to achieve BMIC of 150 µg/L. A 2014 study found that lactating women with a BMIC of 112 µg/L had median UIE of 87µg/L, putting them below the 100 µg/L threshold for sufficiency (Andersen et al 2014). Based on this

	supports the conclusions of EFSA (2014) which suggested that positive balance was reached with BMIC between 100 and 200 µg/L. Assuming an average breast milk volume of 0.8 L/day, an additional 120 µg/day of iodine would be required to achieve BMIC of 150 µg/L. A 2014 study found that lactating women with a BMIC of 112 µg/L had median UIE of 87µg/L, putting them below the 100 µg/L threshold for sufficiency (Andersen et al 2014). Based on this finding, and assuming an average breast milk volume of 0.8 L/day, EFSA (2014) estimated daily losses to be 90 µg/day. A 2016 crossover study examining iodine balance in 11 healthy, formula-fed infants aged 2 to 5 months found that null balance occurred with intakes of 70 µg/day (Dold et al 2016). However, it has been suggested that intakes should exceed that required for nutritional adequacy of infants during this life stage, to support accumulation of thyroidal iodine stores (Dror & Allen 2018). Furthermore, the small sample size of this study may not adequately account for individual variability in requirements. Collectively, these studies suggest an additional requirement of 90-120 µg/day to account for iodine losses through breast milk. In adequate populations, large stores of iodine exist and intake is not required to fully compensate for iodine losses in breast milk. However, in Australia and New Zealand mild population deficiency persists in females of reproductive age. Consequently, adequate status should not be presumed, and recommendations may need to approach full replacement of losses to avoid deficiency states. While there is uncertainty around the evidence, additional data supports maintaining an EAR of 190 µg/day and RDI of 270 µg/day.	finding, and assuming an average breast milk volume of 0.8 L/day, EFSA (2014) estimated daily losses to be 90 µg/day. A 2016 crossover study examining iodine balance in 11 healthy, formula-fed infants aged 2 to 5 months found that null balance occurred with intakes of 70 µg/day (Dold et al 2016). However, it has been suggested that intakes should exceed that required for nutritional adequacy of infants during this life stage, to support accumulation of thyroidal iodine stores (Dror & Allen 2018). Furthermore, the small sample size of this study may not adequately account for individual variability in requirements. Collectively, these studies suggest an additional requirement of 90-120 µg/day to account for iodine losses through breast milk. In adequate populations, large stores of iodine exist and intake is not required to fully compensate for iodine losses in breast milk. However, in Australia and New Zealand mild population deficiency persists in females of reproductive age. Consequently, adequate status should not be presumed, and recommendations may need to approach full replacement of losses to avoid deficiency states. On this basis, an AI of 270 µg/day can be estimated by adding an additional 120 µg/day to the adult AI of 150 µg/day.

<table>
<tr>
<td>Iodine exposure in Australia and New Zealand</td>
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In Australia, the 2011-12 NHMS reported median UIC for pregnant and breastfeeding women aged 16-44 years of 116 µg/L and 103 µg/L respectively (ABS, 2013). These values were lower than the median UIC for all Australian women of that age reported in the 2011-12 NHMS (121 µg/L) and are indicative of insufficient intakes during pregnancy under WHO criteria (WHO, 2013). However, the WHO criteria specify median UIC ≥100 µg/L as sufficient, and consequently the data suggest sufficiency within lactating women. However, the grouping of this population along with pregnant women makes it difficult to determine population status with accuracy.
Contemporary national data in lactating cohorts are lacking, although the 2023 NNPAS survey (ABS 2025c) reported mean intakes among non-pregnant females of child-bearing age of 145 µg/day for 18-29 year-olds and 160 µg/day for 30-49 year-olds respectively (2023 NNPAS data for pregnant cohorts are not available). Data from the 2022-24 NHMS suggests mild population deficiency in reproductive-age females aged 25 to 34 years and 35 to 44 years (ABS, 2025a).
Studies have also suggested deficiencies in the knowledge of - and adherence to - recommendations for iodine supplementation during pregnancy amongst Australians and New Zealanders (El-mani et al 2014, Lucas et al 2014, Martin et al 2014, Malek et al 2016, Guess et al 2017, Hine et al 2018, Reynolds and Skeaff 2017).
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<tr>
<td>Benchmarking against comparable international jurisdictions</td>
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Table 6 shows NRV recommendations for comparable international jurisdictions. Where a jurisdiction specifies an EAR and RDI, the RDI has been extracted for comparison purposes.
TABLE 6 - PREGNANCY IODINE REQUIREMENT RECOMMENDATIONS ACROSS COMPARABLE JURISDICTIONS
<table>
<tr><th>Age (years)</th><th>Proposed AI or RDI (µg/day)</th><th>Current ANZ RDI (2006) (µg/day)</th><th>EFSA AI (2014) (µg/day)</th><th>NNR AI (2023) (µg/day)</th><th>WHO RDI (2007) (µg/day)</th><th>D-A-C-H RDI (2013) (µg/day)</th></tr>
<tr><td>Adults 18 +years:</td><td>270</td><td>270</td><td>200</td><td>200</td><td>260</td><td>260</td></tr>
</table>
Irrespective of whether an EAR and RDI is retained, or an AI set, there is broad alignment across jurisdictions on recommendations for iodine intake during lactation, noting that the type of NRV (EAR & RDI vs AI) varies across jurisdictions. Although there is some variation in the recommendations, this reflects different public health nutrition contexts. For example, in countries such as Australia and New Zealand, or Germany (D-A-C-H) where insufficiency remains a concern, recommendations reflect the need for intakes to approximate full replacement rather than relying on existing stores to meet requirements. In contrast, in regions with longstanding sufficiency, recommendations are lower, reflecting the ability of maternal iodine stores to meet increased requirements during lactation.
</td>
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</table>

Balance of effects (benefits and harms)	The current recommendations are protective of public health and align with the current recommended RDIs. There is no physiological or epidemiologic evidence to suggest that the current recommendations do not reflect requirements for preventing deficiency. Presenting NRV recommendations for iodine as an EAR and RDI may imply a degree of certainty in an NRV for which the underpinning evidence base is more limited. However, comparison of food system modelling and estimated dietary intakes against the EAR provides a critica measure for monitoring and evaluating public health interventions, such as mandatory fortification. This is an important consideration, given the current iodine fortification program in Australia and New Zealand.	The proposed AI recommendation will be protective of public health and align with the current recommended RDIs. There is no physiological or epidemiologic evidence to suggest that the current recommendations do not reflect requirements for preventing deficiency. Revising the recommendations from an EAR and RDI to an AI communicates uncertainties in the evidence base more accurately and transparently. However, the AI cannot be used to determine the prevalence of inadequate nutrient intakes within a population. Although a low prevalence of inadequacy may be presumed in populations with mean intakes around or above the AI, for those with intakes below the AI, adequacy cannot be determined (US IoM 2000). Consequently, removing the EAR in favour of an AI impedes analysis of population inadequacy for iodine using dietary intake data compared with EAR. This analysis is often performed by researchers and policymakers - including in the Australian Health Survey. Dietary intake is not a reliable measure of iodine intake in Australia and New Zealand, given wide variability of iodine in the food supply, limitations in food composition data and the need to factor in use of iodised salt at the table and in cooking. In contrast, median UIC is an established biomarker for evaluating population iodine status (WHO 2007) and is routinely measured in research and in the Australian National Health Measures Survey. The 2008/09 New Zealand National Nutrition Survey measured urinary iodine concentration to assess iodine status over dietary intake data, owing to concerns about the accuracy of food composition data for estimating intake (University of Otago and NZMoH 2011). Consequently, removal of the EAR is not expected to impede population monitoring of iodine status.

		However, comparison of food system modelling and estimated dietary intakes against the EAR provides a critical measure for monitoring and evaluating public health interventions, such as mandatory fortification. This analysis would be precluded, if the EAR were replaced with an AI, for the reasons stated above.
Certainty of the evidence	Requirements during lactation are estimated based on adult requirements and factoring in additional losses in breast milk, measured using BMIC. The evidence for BMIC is inconsistent, with findings varying between populations, and over the course of lactation. The evidence for the iodine intake required to prevent maternal and child deficiency during lactation is uncertain.	
Values, preferences and feasibility (consumers, communities)	Foundation diet modelling (NHMRC, 2011) estimates dietary iodine intake in lactating women at between 251 and 253 µg/day. This falls short of the RDI of 270 µg/day, suggesting that the recommendations may not be fully achievable from diet alone. However, these concerns have been reflected in public health policy, with the recommendation that all Australian and New Zealand women who are lactating should be encouraged to take an iodine supplement (NHMRC, 2010).	
Resource impacts	Retaining the current values during lactation is expected to have no implications for regulators, including FSANZ (food and food products) and TGA (supplements). Current recommendations during lactation are presented fo each age group, although the NRV is the same for each age group. It is proposed that the revised recommendations will be presented as a single recommendation that applies across all ages and for the duration of lactation. This will alter how recommendations are presented, but has no impact on the actual recommendations themselves.	The proposed change is nominal, replacing the current EAR and RDI with an AI to reflect uncertainty in the evidence base, and adjusting recommendations to align with new age groupings. While small, these changes may have significant implications for regulators, including FSANZ (food and food products) and the TGA (supplements). In particular, removal of the EAR may preclude analysis comparing dietary intake modelling data against the EAR. Preliminary discussions with FSANZ have indicated that removal of the EAR would be problematic for ongoing monitoring of the mandatory fortification program. Views will be sought during targeted/stakeholder consultation and considered when developing final NRVs.

Other factors (health equity impacts, sustainability)	Groups at risk of deficiency include: vegans or vegetarians; individuals with low consumption of dairy, commercial bread, or iodised salt; and smokers of both tobacco and electronic cigarettes. Reduced consumption of commercial bread and bread products in Australia (ABS 2025b) and increasing interest in predominantly plant-based diets (Roy Morgan 2016; Kantar 2022; Riverola et al. 2023) has the potential to reduce population iodine intake and should be closely monitored. If the change from an EAR and RDI to an AI is adopted to reflect uncertainty in the evidence base, care must be taken to avoid suggesting that there is uncertainty about the need for increased iodine during pregnancy, or to undermine messaging about routine iodine supplementation in this cohort. Data from Australia and New Zealand also suggests that women of reproductive age may be mildly deficient. Sufficient iodine status during lactation is essential for child neurocognitive development. Studies suggest that knowledge about the importance of iodine supplementation during pregnancy and lactation - and adherence to supplementation recommendations - are lacking among Australians and New Zealanders (El-mani et al 2014, Lucas et al 2014, Martin et al 2014, Malek et al 2016, Guess et al 2017, Hine et al 2018, Jin et al 2021). It is critical that public health messaging communicates the importance of achieving and maintaining sufficient iodine status prior to conception and throughout pregnancy and lactation, for optimal fetal development. Dietary modelling suggests that the current and proposed recommendations may be unable to be met from diet alone. However, the affordability of iodine supplements has been identified as a barrier to use during pregnancy and lactation in Australia (Nolan et al 2022, Jorgensen et al 2016). This may have equity implications for the ability of individuals to meet nutritional recommendations during this life stage. This equity issue should be addressed by public health policy makers.
Decision	Retain existing EAR and RDI recommendations. Rationale: Maintaining the EAR and RDI (vs shifting to an AI) is important as it provides a critical mechanism for public health evaluation Although the evidence is uncertain, studies collectively suggest additional requirements between 90-120 µg/day to account for iodine losses through breast milk. There is no evidence to indicate that the current recommendations are inaccurate or inadequate for meeting nutritional needs of lactating women and their infants.

Children and adolescents

Criterion	OPTION 1: Maintain current recommendations (EAR & RDI) Present NRVs for current and revised age groupings to provide options for different stakeholders/users	OPTION 2: Revise recommendations to AIs to reflect uncertainty in evidence base Present NRVs for current and revised age groupings to provide greater options for different stakeholders/users

Example recommendation	NRVs age groupings:	*EAR* (*µg/day*)	*RDI* (*µg/day*)	NRVs age groupings:	*AI* (*µg/day*)
	All			*All*	
	1 to under 4 years	*65*	*90*	*1 to under 4 years*	*90*
	4 to under 9 years	*65*	*90*	*4 to under 9 years*	*90*
	Males			*Males*	
	9 to under 14 years	*75*	*120*	*9 to under 14 years*	*120*
	14 to under 18 years	*95*	*150*	*14 to under 18 years*	*150*
	Females			*Females*	
	9 to under 14 years	*75*	*120*	*9 to under 14 years*	*120*
	14 to under 18 years	*95*	*150*	*14 to under 18 years*	*150*
	Age groupings by school-age:	*EAR* (*µg/day*)	*RDI* (*µg/day*)	Age groupings by school-age:	*AI* (*µg/day*)
	All			*All*	
	12 to under 24 months	*65*	*90*	*12 to under 24 months*	*90*
	2 to under 5 years	*65*	*90*	*2 to under 5 years*	*90*
	Males			*Males*	
	5 to under 12 years	*70*	*110*	*5 to under 12 years*	*110*
	12 to under 18 years	*90*	*140*	*12 to under 18 years*	*140*
	Females			*Females*	
	5 to under 12 years	*70*	*110*	*5 to under 12 years*	*110*
	12 to under 18 years	*90*	*140*	*12 to under 18 years*	*140*

Health evidence profile and supporting information	The 2006 NRV recommendations for children and adolescents are based on balance studies conducted in small numbers of children of varying age. This includes: A 4-day balance study in seven previously malnourished children aged 1.5 to 2.5 who had been nutritionally rehabilitated (Ingenbleek and Malvaux 1974). The EAR of 65 µg/day was set based on there being a positive balance of 19 µg/day observed with intakes of 63.5 µg/day Extracting results of two 8-year-old participants from a 1969 balance study (Malvaux et al. 1969) with intakes of 20 or 40 µg/day, resulting in negative balance (-23 or -26 µg/day respectively), from which the EAR of 65 µg/day in children aged 4 - 8 was set. the EARs for children aged 9-13 years and 14 to 18 years were extrapolated from adult values The EARs for younger children have been derived from very small samples, or by extracting data for a small number of individuals within a broader sample. These methods lack precision and methodological rigour, and are unreliable for estimating individual requirements. Consequently, revised EAR and RDIs were calculated by extrapolation from adult values, based on metabolic body weight, using the formula: $\text{Estimated EAR}_{\text{child}} = \text{Estimated EAR}_{\text{adult}} \times$ $[\text{Weight}_{\text{child}} / \text{Weight}_{\text{adult}}]^{0.75} \times [1 + \text{growth factor}]$ Inputs were as follows: $\text{EAR}_{\text{adult}} = 100$ µg/day $\text{Weight}_{\text{adult}} = 62.9$ kg Growth factors (GF) and reference weights were as per the current NRVs Methodological Framework (NHMRC,	There is a lack of data on iodine requirements in childhood and adolescents, and current recommendations are based on data from select individuals within balance studies of short duration and small sample sizes. These studies may be unreliable for estimating individual requirements. Goitre prevalence in children aged 6 to 12 years is an established measure of long-term population iodine status, with prevalence >5% indicative of population-level deficiency (WHO 2007). However, it should be noted that thyroid volume can take months or even years to return to normal after deficiency is corrected. Consequently, goitre prevalence may be an unreliable measure, in populations where deficiency has been recently corrected, and thyroid volumes have not yet returned to normal. Thyroid assessment methods also vary considerably, and the method selected can have substantial implications for case finding. Consequently, consideration was limited to studies conducted in regions comparable to the Australian or New Zealand context, for which robust measurement methods were reported, and without recent history of deficiency. A study of 7,599 European school children aged 6-12 years found that a median UIC of 100 µg/L was associated with total goitre prevalence of 2-3%, once values were adjusted for age and body-surface area (Delange et al 1997). This study forms the basis for the proposed adult AI recommendation of 150 µg/day. In the Australian and New Zealand context, studies measuring median UIC and total goitre prevalence in children have reported mixed results. One study in 324 Australian children aged 5 to 13 years residing on the Central Coast of NSW reported a goitre prevalence of 0% with median UIC of 82µg/L (Guttikonda et al . 2003). During a similar time period, but in Melbourne, a study in 577 older school children aged 11 to 18 years reported a goitre prevalence of 19% with median UIC of 70 µg/L (McDonnell et al 2003).

2025), using contemporary 'ideal body weight' data from the Australian Bureau of Statistics.

Calculated values were rounded to ensure the requirements of all children within an age bracket would be met, to smooth out transitions between age groups. EAR calculations are shown in Table 7.

TABLE 7 - CALCULATIONS AND ROUNDING FOR EXTRAPOLATING ADULT EAR TO CHILDREN AND ADOLESCENTS

Age group	Weight child (kg)	GF	Calculated EAR (µg/day)	Rounded /Proposed EAR (µg/day)
NRVs age groupings:				
1 to <4y	13	0.25	38.3	65
4 to <9y	22.4	0.09	50.2	65
9 to <14y	40.7	0.13	81.5	75
14 to <18y	57.6	0.08	101.1	95
Age (grouped by school-age):				
12 to <24mo	10.6	0.44	37.9	65
2 to <5y	15.9	0.12	39.9	65
5 to <12y	28.6	0.12	62.0	70
12 to <18y	54.5	0.07	96.1	90

The RDI was then calculated applying a CV of 20%, and rounded as follows:

AIs for children and adolescents were extrapolated from the adult AI (150 µg/day) based on metabolic body weight, using the formula:

Estimated AI_{child} = Estimated AI_{adult} x

$[\text{Weight}_{\text{child}} / \text{Weight}_{\text{adult}}]^{0.75}$ x [1 + growth factor]

Inputs were as follows:

AI_{adult} = 150 µg/day

Weight $_{\text{adult}}$ = 62.9 kg

Growth factors (GF) and reference weights were as per the current NRVs Methodological Framework (NHMRC, 2025), using contemporary 'ideal body weight' data from the Australian Bureau of Statistics.

Calculated values were rounded up to ensure the requirements of older children within each age bracket were met, and to align proposed AIs with current intakes and existing RDI recommendations. AI calculations are shown in Table 8.

TABLE 8 - CALCULATIONS AND ROUNDING FOR EXTRAPOLATING ADULT AI TO CHILDREN AND ADOLESCENTS

Age group	Weight child (kg)	GF	Calculated AI µg/day	Round-ing	Rounded /Proposed AI µg/day
NRVs age groupings:					
1 to <4y	13	0.25	57.5	32.5	90
4 to <9y	22.4	0.09	75.4	14.6	90
9 to <14y	40.7	0.13	122.3	-2.3	120
14 to <18y	57.6	0.08	151.6	-1.6	150

Age group	EAR child μg/day	CV	RDI (calculated) μg/day	Proposed RDI (rounded) μg/day
NRVs age groupings:				
1 to <4y	65	20%	91	90
4 to <9y	65	20%	91	90
9 to <14y	75	20%	105	120
14 to <18y	95	20%	133	150
Age (grouped by school-age):				
12 to <24mo	65	20%	91	90
2 to <5y	65	20%	91	90
5 to <12y	70	20%	98	110
12 to <18y	90	20%	126	140

This represents a change to methods for calculating the EAR and RDI for children and adolescents. However, the EAR and RDI recommendations are not changed, except for the additional presentation of NRVs for school age groupings.

Age (grouped by school-age):					
12 to <24mo	10.6	0.44	56.8	33.2	90
2 to <5y	15.9	0.12	59.9	30.1	90
5 to <12y	28.6	0.12	93.0	17.0	110
12 to <18y	54.5	0.07	144.1	-4.1	140

Iodine exposure in Australia and New Zealand

The 2022-24 NHMS reported that children aged 5 to 17 were iodine-sufficient, with a median UIC of 171 µg/L and only 8% with UIC <50 µg/L (ABS, 2025a). Urinary iodine measures were highest in children aged 5 to 11 years (median UIC 185 µg/L for males; 188 µg/L for females).

National dietary intake data from the 2023 National Nutrition and Physical Activity Survey (NNPAS; ABS 2025c) and 2011-13 Australian Health Survey (AHS; ABS 2015) are presented in Table 9.

TABLE 9 – INTAKE IN CHILDREN AND ADOLESCENTS, NNPAS (ABS, 2025C) AND AHS 2011-13 (ABS, 2015)

	2023 NNPAS (ABS, 2025c)		2011-13 AHS (ABS, 2015)			
	Males	Females	Males		Females	
Age groups in years (2023 / 2011-13)	Mean intake (µg/day)	Mean intake (µg/day)	Mean (95% CI) Intake (µg/day)	% less than EAR	Mean (95% CI) Intake (µg/day)	% less than EAR
2-4 yr/2-3 yr	152	143	157 (100 – 222)	0.1%	141 (88 – 202)	0.5%
5-11 yr/4-8 yr	176	165	164 (106 – 231)	0.1%	148 (93 – 210)	0.3%
5-11 yr/9-13 yr			190 (111 – 285)	0.3%	169 (102 – 247)	0.5%
12 – 17 yr/14-18 yr	220	161	205 (123 – 303)	0.8%	153 (91 – 229)	6.4%

In New Zealand, population data do not capture intake or median UIC for children aged under 15 years. However, a 2011 study of 147 children aged 8-10 years post-fortification reported population sufficiency, with a median UIC of 113 µg/L, and 12% of children with UIC <50 µg/L (Skeaff & Lonsdale-Cooper, 2013). A 2015 study in 415 children aged 8 to 10 echoed these findings, reporting a median UIC of 116 µg/L and 5% with UIC <50 µg/L (Jones et al 2016). A smaller study in 84 children aged 9 – 11 estimated intake from UIE at 74 µg/day; below the recommended dietary intake of 120 µg/day for this age group (Peniamina et al 2019).

Benchmarking against comparable international jurisdictions

Table 10 shows NRV recommendations for comparable international jurisdictions. Values have been adjusted using a weighted average calculation, to align with the proposed age groupings (denoted by * in the table). Where a jurisdiction specifies an EAR and RDI, the RDI has been extracted for comparison purposes.

TABLE 10 – CHILD AND ADOLESCENT IODINE REQUIREMENT RECOMMENDATIONS ACROSS COMPARABLE JURISDICTIONS

Age (years)	Proposed AI or RDI (µg/day)	Current ANZ (2006)* RDI (µg/day)	EFSA (2014)* AI (µg/day)	NNR (2023)* AI (µg/day)	WHO (2007)*RDI (µg/day)	D-A-C-H (2013)* RDI (µg/day)
NRVs age groupings:						
1 to under 4 years	90	90	90	100	90	100 – 120
4 to under 9 years	90	90	90	100	108*	156*
9 to under 14 years	120	120	108*	115*	132*	176*
14 to under 18 years	150	150	128*	129*	150	200
Age (grouped by school-age):						
12 to under 24 months	90	90*	90	100	90	100
2 to under 5 years	90	90*	90	100	90	107*
5 to under 12 years	110	103*	94*	103*	120	146*
12 to under 18 years	140	140*	125*	128*	145*	197*

Irrespective of whether an EAR and RDI is retained, or an AI set, there is good alignment between the proposed values and recommended iodine intake for children and adolescents in comparable international jurisdictions. The type of NRV (EAR & RDI vs AI) varies across jurisdictions, and there is some variation in the recommended intakes for each age group, reflecting the differing public health nutrition contexts of each country. Values in 5 to under 12 year-olds are on the higher end of comparable recommendations, however this reflects the scaling up of this recommendation to ensure that the needs of older children in the age band continue to be met.

Balance of effects (benefits and harms)	The current recommendations are protective of public health. There is no physiological or epidemiologic evidence to suggest that the current recommendations do not reflect requirements for preventing deficiency. Presenting NRV recommendations for iodine as an EAR and RDI may imply a degree of certainty in an NRV for which the underpinning evidence base is more limited. However, comparison of food system modelling and estimated dietary intakes against the EAR provides a critical measure for monitoring and evaluating public health interventions, such as mandatory fortification. This is an important consideration, given the current iodine fortification program in Australia and New Zealand.	The proposed AI recommendations will be protective of public health and align with the current recommended RDIs. There is no physiological or epidemiologic evidence to suggest that the current recommendations do not reflect requirements for preventing deficiency. Revising the recommendations from an EAR and RDI to an AI communicates uncertainties in the evidence base more clearly. However, the AI cannot be used to determine the prevalence of inadequate nutrient intakes within a population. Although a low prevalence of inadequacy may be presumed in populations with mean intakes around or above the AI, for those with intakes below the AI, adequacy cannot be determined (US IoM 2000). Consequently, removing the EAR in favour of an AI impedes analysis of population inadequacy for iodine using dietary intake data compared with EAR. This analysis is often performed by researchers and policymakers – including in the Australian Health Survey. Dietary intake is not a reliable measure of iodine intake in Australia and New Zealand, given wide variability of iodine in the food supply, limitations in food composition data and the need to factor in use of iodised salt at the table and in cooking. In contrast, median UIC is an established biomarker for evaluating population iodine status (WHO 2007) and is routinely measured in research and in the Australian National Health Measures Survey. The 2008/09 New Zealand National Nutrition Survey used urinary iodine measures of status over dietary intake data, owing to concerns about the accuracy of food composition data for estimating intake (University of Otago and NZMoH 2011). Consequently, removal of the EAR is not expected to impede population monitoring of iodine status.

		However, comparison of food system modelling and estimated dietary intakes against the EAR provides a critical measure for monitoring and evaluating public health interventions, such as mandatory fortification. This analysis would be precluded, if the EAR were replaced with an AI, for the reasons stated above.
Certainty of the evidence	Requirements for children and adolescents are estimated based on scaling adult requirements, due to a lack of available evidence in children and adolescents. The evidence for the iodine intake required to for normal growth and development is uncertain.	
Values, preferences and feasibility (consumers, communities)	Data from the food modelling system (NHMRC, 2011) suggest that current RDIs – or proposed AI recommendations -are feasible to achieve across all age groupings. Relevant data are shown at Table 11.	

TABLE 11 – CHILDREN AND ADOLESCENT FOOD MODELLING DATA (NHMRC, 2011)

Age group (years)	Core food groups^	AGHE 98		Foundation diets – overall		Rice-based		Pasta-based		Lacto-ovo-vego	
		Persons									
	Persons	Upper	Lower	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
13-23 mo				95	96						
2 – 3 yr				117	119					124	102
4 – 8 yr	112^	188	227	143	133					132	109
9 – 11 yr	132	214	273	173	189	200	195	163	158	170	169
12 – 13 yr	163^	247	365	235	221	245	234	215	211	224	215
14 – 18 yr				209	212	230	223	203	200	236	244

^ Age groupings for core food group and AGHE 98 modelling: 4-7yrs; 8-11yrs; 12-18yrs

Resource impacts	If current values for children and adolescents are retained - including additional values aligned with school-age groupings- it is expected to have minimal implications for regulators, including FSANZ (food and food products) and TGA (supplements). .	The proposed change Is nominal, re”laci’g the current EAR and RDI with an AI to reflect uncertainty in the evidence base, and adjusting recommendations to align with new age groupings. While small, these changes may have significant implications for regulators, including FSANZ (food and food products) and the TGA (supplements). In particular, removal of the EAR may preclude analysis comparing dietary intake modelling data against the EAR. Preliminary discussions with FSANZ have indicated that removal of the EAR would be problematic for ongoing monitoring of the mandatory fortification program. The FSANZ regulatory RDI for iodine for ages 1-3 is 70µg/day (current RDI and proposed AI 90 µg/day). Views will be sought during targeted/stakeholder consultation and considered when developing final NRVs.
Other factors (health equity impacts, sustainability)	Groups at risk of deficiency include: vegans or vegetarians; individuals with low consumption of dairy, commercial bread, or iodised salt; and smokers of both tobacco and electronic cigarettes. Reduced consumption of commercial bread and bread products in Australia (ABS 2025b) and increasing interest in predominantly plant-based diets (Roy Morgan 2016; Kantar 2022; Riverola et al. 2023) has the potential to reduce population iodine intake and should be closely monitored. Increasing use of e-cigarettes among youth (AIHW 2024) may also impact on iodine uptake from diet.	
Decision	Retain EAR and RDI, derived by scaling / extrapolation by new age groupings. Rationale: The benefits of having an EAR for public health evaluation outweigh the benefits of acknowledging uncertainty in the underlying evidence base Available evidence in children and adolescents is very limited, and evidence used to derive current EAR from small balance studies or select individuals within a broader study sample is not sufficiently robust. Scaling / extrapolation of adult values to child / adolescent populations is considered a more appropriate approach. There is no evidence that the current recommendations are inaccurate or unsuitable for children and adolescents.	

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Iodine – Upper Levels

Background

Iodine – function and dietary sources

Iodine is a mineral that is found in soil and ocean waters and is an essential nutrient required for synthesis of thyroid hormones such as thyroxine (T4) and triiodothyronine (T3). Iodine deficiency is associated with thyroid dysfunction, thyroid disease, and adverse child neurocognitive development.

Iodine-rich foods include seafoods such as fish, shellfish, or seaweed, eggs, milk, and iodised salt. The level of iodine in cereal and grain foods varies depending on the iodine content of soil in which the food is grown. In 2009 Australia and New Zealand introduced mandatory fortification requirements for the addition of iodine (via iodised salt) to commercial bread, to address iodine deficiency in the population. High habitual intakes can arise from diets high in seaweed, high levels of iodine in drinking water or excessive salt iodisation.

Although typical Western diets are unlikely to result in iodine intakes exceeding 1mg/day, diets high in iodine-rich foods such as seaweed may lead to high habitual iodine intake.

Absorption of iodine from food is estimated at 90 – 92% under normal conditions (Thomson et al 1996, Jahreis et al 2001, Aquaron et al 2002), however it has been suggested that this absorption rate may not hold where intakes are very high (UK SACN, 2014).

Health effects of excess

Excess iodine can result in thyroid abnormalities including hypo- and hyper-thyroidism. The primary health concern associated with iodine excess is iodine-induced hyperthyroidism. Evidence suggests that there is significant variation in tolerance to high iodine intakes, with some individuals ingesting high doses with no apparent adverse effects, and some individuals experiencing thyroid disease even where intakes are within the normal range (WHO, 2007).

Sensitive groups include:

- older adults, who are more sensitive to the effects of high intakes
- individuals with a recent history of deficiency
- individuals with underlying thyroid abnormalities
- infants during pregnancy, as the developing fetus lacks the escape mechanism from the Wolff-Chaikoff effect which begins to develop around 36 weeks gestation, fully maturing during the early neonatal period.

Identifying sufficiently sensitive biomarkers of iodine excess remains a challenge. Subclinical hypothyroidism – indicated by higher TSH (> 10 mU/L) and positive antithyroid antibodies – is a risk factor for progression to overt hypothyroidism and for cardiovascular disease (Razvi et al 2010, Delitala et al 2017, Inoue et al 2020). Elevated TSH in adults has previously been used as a marker for establishing Upper Level recommendations for iodine, in the absence of more robust biomarkers for iodine excess. Although these measures have limitations as endpoints of toxicity, they remain the most reliable biomarkers upon which to base an UL.

Criteria for measuring iodine intake and status

There are limitations in the accuracy of dietary iodine intake assessment methods, including concerns about reporting bias (including social desirability bias), variability of iodine content in foods, difficulty in measuring contribution of iodine from use of iodised salt at the table and in cooking, and the inaccuracy of food composition data. It is also difficult to ascertain individual status based on dietary intakes which reflect intakes at a specific point in time. In people with iodine replete diets, iodine is incorporated into thyroglobulin and this can provide up to 3 months of thyroid hormone, even during periods of low iodine intake.

Measures of urinary iodine concentration are used as established biomarkers for intake and status, although these measures also have limitations. As more than 90% of dietary iodine is excreted in the urine, urinary iodine is used as an indicator of recent iodine intake. Urinary iodine can be measured over 24-hours or in a spot urine sample. Given the diurnal variation in excretion of iodine in urine, the collection of 24-hour urine samples can overcome this issue. However, this measure has a high respondent burden, and there is no internationally accepted method to determine if all urine voided during the 24-hours was collected (i.e. completeness). The use of spot urine samples is simpler and consequently, more frequently reported in the literature. Furthermore, the epidemiologic criteria described below is based on UIC (ug/L). In addition to the diurnal variation mentioned, urine volume is another concern in spot urine samples; high urine volumes will lower UIC which could be misinterpreted as poor iodine status whereas low urine volumes will raise UIC, suggesting good iodine status. To address this problem, corrected measures of UIC are often reported, for example, correcting for urinary creatinine. Both 24-hour UIE and UIC are associated with inter- and intra-individual variation, thus neither should be used to assess iodine status of an individual, but rather to assess the iodine status of a group or population.

Evidence to decision table

Adults

Criterion	OPTION 1: Maintain current UL recommendations Adapt current UL to additional age groupings		OPTION 2: Reduce UL to reflect recent evidence suggestive of an increased risk of subclinical hypothyroidism at intakes below the current UL	
Example recommendation		*UL*		*UL*
	Males		*Males*	
	18 to under 30 years	*1,100 µg/day*	*18 to under 30 years*	*600 µg/day*
	30 to under 50 years	*1,100 µg/day*	*30 to under 50 years*	*600 µg/day*
	50 to under 65 years	*1,100 µg/day*	*50 to under 65 years*	*600 µg/day*
	65 to under 75 years	*1,100 µg/day*	*65 to under 75 years*	*600 µg/day*
	75 years and older	*1,100 µg/day*	*75 years and older*	*600 µg/day*
	Females		*Females*	
	18 to under 30 years	*1,100 µg/day*	*18 to under 30 years*	*600 µg/day*
	30 to under 50 years	*1,100 µg/day*	*30 to under 50 years*	*600 µg/day*
	50 to under 65 years	*1,100 µg/day*	*50 to under 65 years*	*600 µg/day*
	65 to under 75 years	*1,100 µg/day*	*65 to under 75 years*	*600 µg/day*
	75 years and older	*1,100 µg/day*	*75 years and older*	*600 µg/day*
	Note: Individuals with thyroid disorders or a long history of iodine deficiency may still respond adversely at levels of intake below the UL.		*Some individuals are particularly sensitive to the effects of iodine excess and they may respond adversely at levels of intake below the UL. Sensitive groups include people with a long history of iodine deficiency, and those with pre-existing thyroid dysfunction or disorders. Frequent consumption of seaweed – or seaweed containing products – may increase a person's risk of exceeding the UL, due to the high iodine content in some seaweed varieties.*	

Health evidence profile and supporting information	The current recommendations for adults are derived from a LOAEL (lowest observed adverse effect level) of 1700 µg/day, based on two 1988 studies of supplemental iodine that found increased thyroid stimulating hormone (TSH) from baseline with intakes between 1,700 and 1,800 µg/day (Paul et. Al, 1988; Gardner et. Al, 1988; (NHMRC, 2006). One study included only men, and sample sizes for both studies were small (N=32 and N=30 participants total, spread across 3 arms in each study). The intervention period was also short for both studies (14 days). Critically, although both studies reported increases in TSH compared with baseline, levels remained within the normal reference range at the end of intervention period. The UL was calculated by applying an uncertainty factor of 1.5 to arrive at a rounded adult UL of 1,100 µg/day (NHMRC, 2006). The relatively low uncertainty factor reflected the soft nature of elevated TSH as an end point for toxicity, noting that it is mild and reversible in nature.	There is a lack of sensitive end points for establishing upper levels for iodine, with the relationship between iodine intake and adverse health outcomes either not well characterised, or insufficiently sensitive or reliable to inform establishment of an NRV. In the absence of more robust biomarkers, elevated TSH has previously been used to derive Upper Level recommendations. Five interventional studies were identified that explored the effect of high iodine intake on status and thyroid function measures (including elevated TSH) in healthy, euthyroid adults. However, significant heterogeneity precluded meta-analysis. One study was selected for further analysis, as it was at low risk of bias and evaluated the effect of varying levels of supplementation (0 – 2000 µg/day) on thyroid function (Sang 2012). The trial was performed in two phases, with the initial phase conducted in 2004 (iodine supplement >500 µg/day) and the second phase (iodine supplement 0-400 µg/day) in 2008. Participants were 256 young, euthyroid Chinese adults aged 19 to 25 years who were randomised to one of twelve iodine supplementation interventions, ranging from 0-2000 µg/day for a four-week period. Overall, the results from Sang et. Al. (2012) demonstrate significant capacity for the thyroid to adapt to high intakes of iodine – including intakes substantially exceeding current UL recommendations. However, elevated TSH and increasing rates of subclinical hypothyroidism were observed with iodine intakes of 869µg/day or greater. The UL should aim to protect almos” all’Individuals within a population. Accordingly, 869µg/day was selected as the LOAEL, as the inflexion point at which cases of subclinical hypothyroidism became significantly increased, and the upper bound of the 95% CI for TSH was elevated beyond 5.0mU/L

(Sang et. Al. 2012 reported a reference range of 0.3 – 5.0 mU/L for the TSH assay used).

An Uncertainty Factor of 1.5 was applied, with consideration given to:

Substantial inter-individual variability in tolerance for high iodine intakes, noting that selection of the LOAEL can be expected to account for some level of individual variability

The use of a LOAEL rather than a NOAEL as a reference point

the mild and reversible nature of the end-point

This resulted in an estimated UL of 579.3µg/day, which was rounded up to 600µg/day.

Iodine exposure in Australia and New Zealand

Recent (2022-24) data from Australia suggests that the adult population in Australia is iodine sufficient – based on WHO criteria – with almost all age groups having median UIC >100µg/L (WHO, 2013; ABS, 2025a). However, data suggests mild population deficiency in females of reproductive age (aged 25 to 44 years).

Current dietary intake data from the 2023 National Nutrition and Physical Activity Survey (NNPAS) are presented at Table 1. Current ABS data do not report the 95% CI nor the percentage of the population exceeding the UL. Consequently, data from the 2011-13 Australian Health Survey (ABS, 2015) are also presented inclusive of this data. These data show that iodine intakes are well below the proposed UL of 600 µg/day for at least 95% of adults across all age groups.

TABLE 6 – AUSTRALIAN NATIONAL DIETARY IODINE INTAKE DATA IN ADULTS, 2023 NNPAS (ABS, 2025B) AND 2011-13 AHS (ABS, 2015)

Age groups (years) (2023 / 2011-13)	Sex	2023 NNPAS (ABS, 2025b)	2011-13 AHS (ABS, 2015)		
		Mean intake (µg/day)	Intake (µg/day) Mean (95% CI)	% less than EAR	% exceeding UL
18 to <30y / 19 to <31y	Males	194	202 (120 – 299)	1.5%	0%
	Females	145	146 (86 – 218)	11.7%	0%
20 to <50y / 31 to <51y	Males	197	200 (119 – 297)	1.6%	0%
	Females	160	152 (91 – 226)	9.0%	0%

50 to <65y / 51-<71y	Males	200	182 (106 – 274)	3.5%	0%
	Females	158	149 (89 – 221)	10.5%	0%
65 to <75y / 71y +	Males	191	178 (103 – 270)	4.2%	0%
	Females	167	151 (91 – 224)	9.2%	0%
75 y + / 71 y +	Males	193	178 (103 – 270)	4.2%	0%
	Females	165	151 (91 – 224)	9.2%	0%

Populations with history of deficiency can be more sensitive to effects of excess. It has been suggested that this sensitivity should abate within 7- 8 years following fortification (Braverman and Pearce, 2025). Mandatory fortification was introduced more than 15 years ago in Australia and New Zealand and subsequent national surveys reported sufficiency in most populations. However, those subpopulations for whom mild deficiency remains a concern (such as females aged 25-44) may be more sensitive to effects of excess.

Benchmarking against comparable international jurisdictions

Upper Level recommendations vary substantially internationally. The 2006 NRVs currently recommend a UL of 1100 µg/day, in line with recommendations for the US and Canada (NHMRC, 2006; US IOM, 2001). However, these recommendations are based on evidence from 2001 and have not been recently reviewed.

EFSA established an UL of 600µg/day (EFSA, 2003), derived from the same evidence-base as the current 2006 NRVs (Paul et. Al. 1988, Gardner et. Al. 1988), but applying an Uncertainty Factor of 3, compared with the 1.5 factor applied by the US / Canada and Australia (US IOM 2001; NHMRC 2006).

More recently, the Nordic Nutrition Recommendations 2023 (Blomhoff et al. 2023) and Chinese Dietary Reference Intake reviews recommended that the UL for adults be set at 600 µg/day, with the latter deriving its recommendations from the 2012 Sang study (Guo et al 2025).

In other jurisdictions, recommendations vary from 500 µg/day in Germany and Austria (D-A-CH, 2015) to as high as 2400-3000 µg/day in Korea and Japan respectively (Guo et al 2025), although chronic high intakes in these countries mean that recommendations are not comparable to the Australian and New Zealand context.

Upper Level recommendations from comparable international jurisdictions are presented in Table 2 below.

TABLE 7 – ADULT UPPER LEVEL RECOMMENDATIONS ACROSS COMPARABLE JURISDICTIONS

Age (years)	Proposed ANZ UL (µg/day)	NHMRC (2006) Current UL (µg/day)	EFSA (2002) UL (µg/day)	NNR (2023) UL (µg/day)	WHO (2004) UL^ (µg/day)	D-A-C-H (2015) UL (µg/day)
Adults 18 +years	600	1,100	600	600	1,875	500

^WHO Upper Limits are specified in units of µg/kg/day; the UL presented here has been derived from the UL of 30 µg/kg/day, and the adult UL calculated using the adult reference weight for comparison purposes (62.5kg NHMS 2025, ABS 2025a).

Balance of effects (benefits and harms)

Evidence suggests that the current Upper Level of 1,100 µg/day may not be protective of nearly all individuals in the population. Iodine excess can disrupt normal thyroid function, particularly where there is underlying thyroid disease. This includes autoimmune thyroid disease – a common form of thyroid disease primarily affecting adult women – or nodular thyroid disease, most common in the elderly or in people with a previous history of iodine deficiency.

Despite introduction of mandatory fortification in 2009, data suggests that mild population deficiency may persist in some sub-populations, including women of reproductive age (ABS, 2025a). Growing interest in plant-forward diets (Roy Morgan 2016; Kantar 2022; Riverola et al. 2023) may further reduce individuals' iodine intake and exacerbate existing deficiency in the population. This deficiency increases individual sensitivity to the effects of excess iodine.

Although data from Sang et. Al. (2012) suggest that most individuals can readily adapt to high intakes of iodine, it also demonstrates increased frequency of elevated TSH and subclinical hypothyroidism with intakes above 600 µg/day. This is below the current UL of 1,100 µg/day. However, elevated TSH and subclinical hypothyroidism represent mild

The proposed recommendations are expected to be protective of public health, including most individuals who are sensitive to the effects of excess iodine intakes. Although it is not feasible to set a UL that protects all individuals within the population – because some individuals may be sensitive at intakes within the normal range – the UL should aim to be protective of most individuals within the population. The recommendations should include a note to identify that some individuals may still respond adversely at levels of intake below the UL.

Intakes from the 2011-13 Australian Health Survey (ABS, 2015) suggest that for the majority (95% or more) of the adult population, intakes remain within the range of 86 to 299 µg/day. These data are supported by more recent median UIC population data, suggesting that iodine deficiency – rather than excess – is a more prevalent concern within the Australian and New Zealand adult population. It is therefore unlikely that lowering the UL will result in a material increase in the number of individuals classified as 'exceeding the UL'. Similarly, this provides a comfortable buffer between the proposed RDI of 150 µg/day, the upper range of intakes (299 µg/day) and the proposed UL of 600 µg/day.

	and reversible states. The relatively short duration of the Sang et. Al. (2012) study makes it difficult to determine whether these observed effects represent a transient adaptive effect, or the onset of chronic subclinical hypothyroidism. Further evidence on the long-term effects of increased iodine on TSH and subclinical hypothyroidism are required to inform decision making. The overwhelming public health concern In Australia and New Zealand continues to be iodine deficiency, particularly in reproductive age females.	Growing interest in seaweed consumption – and the potential for intakes to exceed the UL due to the high iodine content in some seaweed varieties – has been highlighted as a concern in other jurisdictions (EFSA, 2023). Consequently, it is proposed that any UL recommendation is accompanied by a statement to highlight that frequent – or high – consumption of seaweed or seaweed-containing products may lead to high habitual iodine intakes, increasing an individual's risk of exceeding the UL. The overwhelming public health concern In Australia and New Zealand continues to be iodine deficiency, particularly in reproductive age females. Any changes to the UL should be carefully communicated to avoid the suggestion that individuals should minimise their iodine intake, when there is no evidence to suggest thyroid disease due to iodine excess within the general population
Certainty of the evidence	The evidence underpinning current recommendations is limited by concerns about: risk of bias: Gardner 1988 was assessed as having some concerns using ROB-2, and Paul 1988 as having serious concerns using ROBINS-I, and the intervention period was short for both studies imprecision: small sample sizes (N=30 or 32 participants across 3 intervention arms), generalisability: one study included only men.	Although the association between high iodine intake and elevated TSH is well-established, the evidence for the dose-response relationship is lacking. Risk of bias was assessed as being high or some concerns across the 5 interventional studies that examined the relationship between iodine dose and elevated TSH. Whilst the study by Sang et al (2012) was generally well-designed, the 12 intervention arms were not wholly concurrent, with the study split into two phases, four years apart (supplementation ≥500 µg/day in 2004; and <500 µg/day in 2008). The study was also limited by small sample size, with approximately 19 participants for each arm. The outcomes upon Ih the UL Is to be established (subclinical hypothyroidism and elevated TSH) are also relatively soft end points, adding to uncertainty in the evidence. Overall, the evidence is very uncertain about the level of iodine intake at which adverse effects may occur.

Values, preferences and feasibility (consumers, communities)

Modelling suggests that iodine intakes will remain substantially below an UL of 600 or 1,100 µg/day for individuals with consumption aligned with the foundation diets (NHMRC, 2011). Relevant food modelling data are shown at Table 3.

TABLE 8 – FOOD MODELLING DATA (NHMRC, 2011) IN ADULTS

	Core food groups^	Foundation diets – overall		Rice-based		Pasta-based		Lacto-ovo-vego	
Age group (years)	Intake in persons (µg/day)	Intake in males (µg/day)	Intake in females (µg/day)	Intake in males (µg/day)	Intake in females (µg/day)	Intake in males (µg/day)	Intake in females (µg/day)	Intake in males (µg/day)	Intake in females (µg/day)
19-30 yr	148	197	210	213	204	181	187	177	173
31-50 yr		210	211	224	210	192	197	190	178
51-70 yr		219	275	229	290	198	229	198	233
70+ yr		256	260	275	289	249	223	215	218

National intake data (ABS, 2013) and population exposure data (ABS 2025a, NZMoH 2020) suggest that both the current UL of 1,100 and the proposed UL of 600 µg/day are feasible, with insufficient iodine intake more prevalent within the Australian and New Zealand population than excess intakes.

Resource impacts

Retaining the current values for adults has no material implications. Although adult age groupings are being adjusted t align with new age groups, the adult NRVs are the same for all age groups so there is no material impact of this change. Consequently, this minor change to age groupings should have no implications for regulators, including FSANZ (food and food products) and TGA (supplements).

The proposed change to the UL is significant, and may have implications for regulators, including FSANZ (food and food products) and TGA (supplements). Views will be sought during targeted/stakeholder consultation and considered when developing final NRVs.

The Australia New Zealand Food Standards Code requires the addition of iodised salt in bread. Iodised salt contains no less than 25 mg/kg (or µg/g) of iodine and no more than 65 mg/kg of iodine.

There are a small number of foods permitted to add iodine up to a maximum of:

15 µg/200mL- legumes, cereals, nuts, seed based beverages

		15 µg/150g – legume-based analogues of yoghurt and dairy desserts 10 µg/25g – legume-based analogues of cheese 38 µg/600mL – formulated beverages These products are unlikely to be impacted by changes to the Upper Level Special Purpose Foods must include iodine up to a maximum of: 75 µg/serve – formulated meal replacements 75 µg/serve – formulated supplementary foods 75 µg/one-day quantity – formulated supplementary sports food 84 µg/MJ – food for special medical purposes represented as a sole source of nutrition Very low energy diets require a minimum 140 µg iodine per daily intake. At normal levels of consumption these products are unlikely to be impacted by changes to the Upper Level In April 2025 TGA recalled multiple vitamin and perinatal products due to lack of or excessive potassium iodine. TGA requires warning statements on preparations for internal therapeutic use with 300µg or more of iodine. *CAUTION – Total iodine intake may exceed recommended level when taking this preparation* *WARNING – Contains iodine - do not take when pregnant except on physician's advice.*
Other factors (health equity impacts, sustainability)	The UL should aim to be protective of almost all individuals within the population. Maintaining the UL of 1,100 µg/day may expose some individuals to the health effects of iodine excess – notably subclinical hypothyroidism, overt hypo- or hyper-thyroidism, and associated chronic diseases. Some groups may	The UL should aim to be protective of almost all Individuals within the population. Reducing the UL to 600 µg/day ensures that a greater proportion of the population are protected, including individuals with underlying thyroid disorders, older adults and those with a previous history of iodine deficiency.

	be at increased risk of experiencing adverse effects at lower levels of iodine intake, including migrants (who may have an increased risk of iodine deficiency) and women or older adults (increased risk of underlying thyroid abnormalities). These groups may bear an inequitable health burden associated with maintaining the UL at current levels.	Previous iodine deficiency and underlying thyroid disease may increase a person's sensitivity to iodine excess. These risk factors may be inequitably distributed among the population, affecting vulnerable groups including migrants – who may be at increased risk of iodine deficiency (Magri et. Al. 2019) – and women or older adults in whom underlying thyroid abnormalities are more prevalent (Mammen and Cappola 2023, Miller et al 2016). It is important to ensure that the UL is established at a value that is protective of these population groups.
Decision	Option 2 was selected as it provides protection for almost all individuals within the population, whilst allowing for a diverse range of intakes above the RDI within the Australian and New Zealand population. Despite almost halving the existing UL (1,100 µg/day), the proposed UL (600 µg/day) remains significantly higher than the RDI of 150µg/day. Population data suggests that adult intakes in Australia and New Zealand do not approach the revised UL for most (95%+) of the population, reducing the risk that non-sensitive individuals with higher intakes may be classified as 'exceeding the UL' where there may be no significant risk of harm.	

Pregnancy

Criterion	OPTION 1: Maintain current UL recommendations Adapt current UL to new age groupings	OPTION 2: Reduce UL to reflect recent evidence suggestive of an increased risk of subclinical hypothyroidism at intakes below the current UL
Example recommendation	*UL* *Pregnancy* *1,100 µg/day*	*UL* *Pregnancy* *600 µg/day*
Health evidence profile and supporting information	Current recommendations for pregnancy are based on the recommended UL in adults, based on the assumption that there was no evidence of increased sensitivity in these populations.	The WHO defines UIC > 500ug/L during pregnancy as an "excess intake" (WHO, 2007). However, in this context the term excess refers to intakes that are "in excess of the amount required to prevent and control iodine deficiency".

<table>
<tr><th></th><th></th><th></th></tr>
<tr><td></td><td>More recently, concerns have been raised about the effect of high maternal iodine intake on fetal development during pregnancy. The developing fetus is particularly vulnerable to excess iodine, as the Wolff-Chaikoff escape mechanism does not begin to develop until around 36 weeks gestation, fully maturing during the early neonatal period.
Relevant data and considerations are summarised under ‘Option 2’.</td><td>Consequently, the 500 µg/L threshold should not be interpreted as describing a UL.
There remains a dearth of good quality data on the effects of high intakes of iodine on maternal and child outcomes during pregnancy. Nevertheless, concerns have been raised about the effect of high iodine intakes during pregnancy and adverse effects on the foetus, due to the inability to escape from the Wolff-Chaikoff effect, which begins to develop around 36 weeks gestation, fully maturing during the early neonatal period.
Data from cross-sectional studies suggest that intakes >500 µg/day during pregnancy may be associated with maternal thyroid dysfunction (Wu et al 2023; Shi et al 2015; Guo et al 2025). However, the evidence is not compelling, with a 2018 systematic review reporting inconsistent findings across studies (Katagiri 2018). Concerns about imprecise estimation of intake based on urinary iodine during pregnancy and limited generalisability to the Australian and New Zealand nutritional context further limit certainty in the evidence.
In the absence of robust evidence for the effects of excess iodine intake during pregnancy, it is proposed that the adult UL of 600 µg/day be adopted.
The overwhelming public health concern in Australia and New Zealand continues to be iodine deficiency during pregnancy. Any changes to the UL during pregnancy should be carefully communicated to ensure that the need for supplementation during pregnancy continues to be a core message.</td></tr>
<tr><td>Iodine exposure in Australia and New Zealand</td><td colspan="2">In Australia, the 2011-12 NHMS (ABS, 2013) reported median UIC for pregnant and breastfeeding women aged 16-44 years of 116 µg/L and 103 µg/L respectively. These values were lower than the median UIC for all Australian women of that age reported in the 2011-12 NHMS (121 µg/L) and are indicative of insufficient intakes during pregnancy under WHO criteria (WHO, 2013).
Although 2022-24 NHMS data is not available for pregnant cohorts, median UIC in non-pregnant, reproductive-age females (16 to 44 years) was 101µg/L indicating borderline sufficiency (ABS, 2025a). However, females aged 25 to 34 years and 35 to 44</td></tr>
</table>

years are mildly deficient, with median UIC of 87µg/L and 97µg/L respectively, and more than 20% of individuals with UIC <50 in both age groups.

These findings are echoed in data from the 2014/15 NZHS which - while based on a small cohort of pregnant women (N=110) - reported median UIC of 114µg/L (95% CI: 87, 141µg/L), below the WHO-recommended median UIC of 150µg/L (NZ MoH, 2020; WHO, 2013).

Although intake data are unavailable for pregnant women, the 2011-13 Australian Health Survey (ABS, 2015) found that 95% of females aged 19-50 yrs have intakes well below the proposed UL of 600 µg/day, as shown in Table 4. Recently released dietary intake data from the 2023 NNPAS (ABS, 2025b) suggests similar intakes in reproductive age females, although 95% confidence intervals and the percentage exceeding the UL were not reported.

TABLE 9 - INTAKE IN REPRODUCTIVE-AGE FEMALES (19-50 YEARS), 2023 NNPAS (ABS, 2025B) AND AHS 2011-13 (ABS, 2015)

Age groups (years) 2023 / 2011-13	2023 NNPAS (ABS, 2025b)	2011-13 AHS (ABS, 2015)		
	Mean intake (µg/day)	Intake (µg/day) Mean (95% CI)	% less than EAR	% exceeding UL
18 to <30y / 19 to <31 y	145	146 (86 - 218)	11.7%	0%
30 to <50y / 31 to <51 y	160	152 (91 - 226)	9.0%	0%

Benchmarking against comparable international jurisdictions

In most jurisdictions, the recommendations for adults have been adopted - unaltered - for pregnant women. However, in Japan - where the UL is 3,000 µg/day - the UL during pregnancy is established at 2,000 µg/day to account for increased sensitivity. More recent recommendations from China (2023) established the UL at 500 µg/day - slightly below the value of 600µg/day adopted for adults, and based on the abovementioned cross-sectional studies conducted in China.

A 2022 UK report on the effects of excess iodine intake on maternal and child health found there was insufficient evidence to inform a risk assessment, noting that current intakes were of limited concern except in individuals with diets high in seaweed (UK FSA COT, 2022).

Relevant recommendations from comparable international jurisdictions are shown in Table 5.

TABLE 10 - PREGNANCY UPPER LEVEL RECOMMENDATIONS ACROSS COMPARABLE JURISDICTIONS

Age (years)	Proposed ANZ UL (µg/day)	Current ANZ UL (2006) (µg/day)	US / Canada UL (2001) (µg/day)	EFSA UL (2002) (µg/day)	UK SCF UL (2000) (µg/day)	NNR UL (2023) (µg/day)
Pregnancy (all)	600	1,100	1,100	600	600	600

Balance of effects (benefits and harms)

Evidence suggests that the current Upper Level of 1,100 µg/day may not be protective of maternal and child health during pregnancy.

Current national data suggest that Australian and New Zealand females of reproductive age are mildly deficient. Growing interest in plant-forward diets (Roy Morgan 2016; Kantar 2022; Riverola et al. 2023) may further reduce individuals' iodine intake and exacerbate existing deficiency in the population. This deficiency increases individual sensitivity to the effects of excess iodine.

Although there is insufficient, high quality exposure data to support a risk assessment of excess iodine during pregnancy, evidence suggests that adverse effects on maternal thyroid function may occur below the current UL.

However, there is no evidence that adverse maternal or child health outcomes from excess iodine are prevalent within the Australian and New Zealand population. The overwhelming public health concern remains the effect of mild population deficiency during pregnancy on birth outcomes and child neurodevelopment.

Although very limited data suggests that adverse effects can occur with intakes >500µg/day, the evidence is not compelling, and may not be generalisable to the Australian context. If the UL for pregnant women were reduced to 500µg/day, this would create a discrepancy between the values for adults and during pregnancy, and may result in a misperception that high iodine intake during pregnancy is an issue of public health concern in Australia and New Zealand.

However, the overwhelming public health concern in this context remains iodine deficiency during pregnancy. In contrast, reducing both the adult and pregnancy UL to 600 µg/day will be protective of the general population - including both mother and the developing infant during pregnancy - without undermining existing public health efforts to address persistent mild population deficiency within females of reproductive age.

Certainty of the evidence

The evidence on the levels of iodine intake at which adverse effects may occur during pregnancy is very uncertain.

Values, preferences and feasibility (consumers, communities)	Food modelling data suggests that both the current UL of 1,100 µg/day and the proposed UL of 600 µg/day are feasible to achieve, with intake from foundation diets estimated at between 233 and 261 µg/day (NHMRC, 2011). It is also suggested that pregnant women take supplemental iodine of 150 µg/day (NHMRC 2010). As a result, intakes during pregnancy in those following the foundation diets may increase to around 380 - 410 µg/day. Although intake data are unavailable for pregnant women, data from the 2011-13 Australian Health Survey (ABS, 2015) indicate that 95% of females aged 19-50 yrs have intakes between ~86 and 226 µg/day, which is also well below the lower proposed UL of 600 µg/day. Most recent population median UIC data in pregnant women is indicative of mild population deficiency in both Australia and New Zealand. The proposed UL is also substantially higher than the proposed RDI of 220 µg/day, providing for sufficient variability in individual intakes within the range of normal. This provides another rationale for not adopting a lower UL of 500 µg/day in this population, which may excessively narrow the window of acceptable intakes between the RDI (220 µg/day) and UL.	
Resource impacts	Retaining the current values for pregnancy is expected to have no regulatory implications or resource impacts.	The proposed change to the UL is significant, and may have implications for regulators, including FSANZ (food and food products) and TGA (supplements). Views will be sought during targeted / stakeholder consultation and considered when developing final NRVs.
Other factors (health equity impacts, sustainability)	The UL should aim to be protective of almost all individual within the population. Maintaining the UL of 1,100 µg/day may expose some individuals to the health effects of iodin excess - notably subclinical hypothyroidism, overt hypo- o hyper- thyroidism, and associated chronic diseases. Some groups may be at increased risk of experiencing adverse effects at lower levels of iodine intake, including migrants (who may have an increased risk of iodine deficiency) and women or older adults (increased risk of underlying thyroi abnormalities). These groups may bear an inequitable health burden associated with maintaining the UL at current levels.	The UL should aim to be protective of almost all individuals within the population. Reducing the UL to 600 µg/day ensures that a greater proportion of the population are protected, including individuals with underlying thyroid disorders, older adults and those with a previous history of iodine deficiency. Previous iodine deficiency and underlying thyroid disease may increase a person's sensitivity to iodine excess. These risk factors may be inequitably distributed among the population, affecting vulnerable groups including migrants - who may be at increased risk of iodine deficiency (Magri et. al. 2019) - and women in whom underlying thyroid abnormalities are more prevalent (Mammen and Cappola 2023, Miller et al 2016). It is important to ensure that the UL is established at a value that is protective of these population groups.

Decision	Option 2 was selected as it provides protection for almost all individuals within the population including the developing fetus, whilst allowing for a diverse range of intakes above the RDI within the Australian and New Zealand population. Despite almost halving the existing UL (1,100 µg/day), the proposed UL (600 µg/day) remains significantly higher than the RDI of 220 µg/day. Population data suggests that adult intakes in Australia and New Zealand do not approach the revised UL for most (95%+) of the population, reducing the risk that non-sensitive individuals with higher intakes may be classified as ‘exceeding the UL’ where there may be no significant risk of harm. Mild iodine deficiency remains the overwhelming public health concern in lactating populations in Australia and New Zealand. Care must be taken to ensure that communication about the UL emphasises concerns about deficiency and reinforces public health messaging about the need for supplementation during pregnancy and throughout pregnancy.

Lactation

Criterion	OPTION 1: Maintain current UL recommendations Adapt current UL to new age groupings	OPTION 2: Reduce UL to reflect recent evidence suggestive of an increased risk of subclinical hypothyroidism at intakes below the current UL
Example recommendation	*UL* *Lactation* *1,100 µg/day*	*UL* *Lactation* *600 µg/day*
Health evidence profile and supporting information	Current recommendations for during lactation are based on the recommended UL in adults. This reflects the assumption that there was no evidence of increased sensitivity in these populations. More recently, concerns have been raised about the effect of high maternal iodine intake on fetal development for pre-term neonates. The developing fetus is particularly vulnerable to excess iodine, as the Wolff-Chaikoff escape mechanism which begins to develop around 36 weeks gestation, fully maturing during the early neonatal period. However, data in this cohort are lacking. In the absence of data, the UL for lactating women should be set based upon the recommendation for during pregnancy.	Concerns have been raised about the effect of high maternal iodine intake on fetal development for pre-term neonates. The developing fetus is particularly vulnerable to excess iodine, as the Wolff-Chaikoff escape mechanism which begins to develop around 36 weeks gestation, fully maturing during the early neonatal period. However, data in this cohort are lacking. In the absence of data, the UL for lactating women should be set based upon the recommendation for during pregnancy. The overwhelming public health concern in Australia and New Zealand continues to be iodine deficiency during pregnancy (and lactation). Any changes to the UL during lactation should be carefully communicated to ensure that the need for supplementation during pregnancy and throughout lactation continues to be a core message.
Iodine exposure in Australia and New Zealand	Exposure data in lactating females from Australia and New Zealand are limited. However, relevant data from comparable groups are highlighted below for completeness. In Australia, the 2011-12 NHMS reported median UIC for pregnant and breastfeeding women aged 16-44 years of 116 µg/L and 103 µg/L respectively (ABS, 2013). These values were lower than the median UIC for all Australian women of that age reported in the 2011-12 NHMS (121 µg/L) and are indicative of insufficient intakes during pregnancy under WHO criteria (WHO, 2013). Although more recent data from the 2022-24 NHMS is not available for breastfeeding women, median UIC in non-pregnant females of reproductive age (16 to 44 years) indicates borderline sufficiency (101 µg/L; ABS, 2025a). However, data	

suggests mild population deficiency in females aged 25 to 34 years and 35 to 44 years, with median UIC of 87 µg/L and 97 µg/L respectively, and more than 20% of individuals with UIC <50 µg/L in both age groups.

These findings are echoed in data from the 2014/15 NZHS which - while based on a small cohort of pregnant women (N=110) - reported median UIC of 114 µg/L (95% CI: 87, 141 µg/L), below the WHO-recommended median UIC of 150 µg/L (NZ MoH, 2020; WHO, 2013).

Although intake data are unavailable for pregnant women, the 2011-13 Australian Health Survey (ABS, 2015) found that 95% of females aged 19-50 yrs have intakes well below the proposed UL of 600 µg/day, as shown in Table 6. Recently released dietary intake data from the 2023 NNPAS (ABS, 2025b) suggests similar intakes in reproductive age females, although 95% confidence intervals and the percentage exceeding the UL were not reported.

TABLE 11 - INTAKE IN REPRODUCTIVE-AGE FEMALES (19-50 YEARS), 2023 NNPAS (ABS, 2025B) AND AHS 2011-13 (ABS, 2015)

Age groups (years) 2023 / 2011-13	2023 NNPAS (ABS, 2025b)	2011-13 AHS (ABS, 2015)		
	Mean intake (µg/day)	Intake (µg/day) Mean (95% CI)	% less than EAR	% exceeding UL
18 to <30y / 19 to <31 y	145	146 (86 - 218)	11.7%	0%
30 to <50y / 31 to <51 y	160	152 (91 - 226)	9.0%	0%

Benchmarking against comparable international jurisdictions

In most jurisdictions, the recommendations for adults and pregnancy have been adopted - unaltered - for lactating females. However, in Japan - where the UL is 3,000 µg/day - the UL during lactation is established at 2,000 µg/day to account for increased sensitivity in this population. More recent recommendations from China (2023) established the UL at 500 µg/day in line with recommendations during pregnancy.

A 2022 UK report on the effects of excess iodine intake on maternal and child health found there was insufficient evidence to inform a risk assessment, noting that current intakes were of limited concern except in individuals with diets high in seaweed (UK FSA COT, 2022).

Relevant recommendations from comparable international jurisdictions are shown in Table 7.

TABLE 12 - UPPER LEVEL RECOMMENDATIONS ACROSS COMPARABLE JURISDICTIONS

Age (years)	Proposed ANZ UL (µg/day)	Current ANZ UL (2006) (µg/day)	US/Canada UL (2001) (µg/day)	EFSA UL (2002) (µg/day)	NNR UL (2023) (µg/day)
Pregnancy (all)	600	1,100	1,100	600	600

Balance of effects (benefits and harms)	There is insufficient evidence from lactating cohorts to support a risk assessment. However, evidence suggests that the current UL of 1,100 µg/day may not be protective of maternal and child health during pregnancy. It is reasonable to expect that the UL in lactating cohorts will be comparable to that during pregnancy. A UL of 600 µg/day is expected to be more protective for most individuals within the population. Current national data suggest that Australian and New Zealand females of reproductive age are mildly deficient. Growing interest in plant-forward diets (Roy Morgan 2016; Kantar 2022; Riverola et al. 2023) may further reduce individuals' iodine intake and exacerbate existing deficiency in the population. This deficiency increases individual sensitivity to the effects of excess iodine. However, there is no evidence that adverse maternal or child health outcomes from excess iodine are prevalent within the Australian and New Zealand population. The overwhelming public health concern remains the effect of mild population deficiency during pregnancy and lactation on birth outcomes and child neurodevelopment.
Certainty of the evidence	The evidence on the levels of iodine intake at which adverse effects may occur during lactation is very uncertain.
Values, preferences and feasibility (consumers, communities)	Foundation diet modelling (NHMRC, 2011) estimates dietary iodine intake in lactating women at between 251 and 253 µg/day - below the proposed RDII of 270µg/day, suggesting that the recommendations may not be fully achievable from diet alone. However, it is currently recommended that all Australian and New Zealand women who are lactating take a daily iodine supplement containing 150µg of iodine (NHMRC, 2010). Consequently, intakes could increase to around 400 µg/day in those following the foundation diet who also follow the recommendations for supplementation. Although intake data are unavailable for pregnant women, data from the 2011-13 Australian Health Survey (ABS, 2015) indicate that 95% of females aged 19-50 yrs have intakes between ~86 and 226 µg/day, which is also well below the lower proposed UL of 600 µg/day, even factoring in additional iodine from supplements. Most recent population median UIC data in pregnant women is indicative of mild population deficiency in both Australia and New Zealand.

	The proposed UL is also substantially higher than the proposed RDI, providing for sufficient variability in individual intakes within the range between the RDI (270 µg/day), estimated intakes from dietary modelling and supplementation (400 µg/day) and the proposed UL (600 µg/day).	
Resource impacts	Retaining the current values for lactation is expected to have no regulatory implications or resource impacts.	The proposed change to the UL is significant, and may have implications for regulators, including FSANZ (food and food products) and TGA (supplements). Views will be sought during targeted / stakeholder consultation and considered when developing final NRVs.
Other factors (health equity impacts, sustainability)	The UL should aim to be protective of almost all individuals within the population. Maintaining the UL of 1,100 µg/day may expose some individuals to the health effects of iodine excess - notably subclinical hypothyroidism, overt hypo- o hyper- thyroidism, and associated chronic diseases. Some groups may be at increased risk of experiencing adverse effects at lower levels of iodine intake, including migrants (who may have an increased risk of iodine deficiency) and women or older adults (increased risk of underlying thyroid abnormalities). These groups may bear an inequitable health burden associated with maintaining the UL at current levels.	The UL should aim to be protective of almost all individuals within the population. Reducing the UL to 600 µg/day ensures that a greater proportion of the population are protected, including individuals with underlying thyroid disorders, older adults and those with a previous history of iodine deficiency. Previous iodine deficiency and underlying thyroid disease may increase a person's sensitivity to iodine excess. These risk factors may be inequitably distributed among the population, affecting vulnerable groups including migrants - who may be at increased risk of iodine deficiency (Magri et. al. 2019) - and women in whom underlying thyroid abnormalities are more prevalent (Mammen and Cappola 2023, Miller et al 2016). It is important to ensure that the UL is established at a value that is protective of these population groups.
Decision	**Option 2 was selected as it provides protection for almost all individuals within the population - including the developing fetus - whilst allowing for a diverse range of intakes above the RDI within the Australian and New Zealand population.** **Despite almost halving the existing UL (1,100 µg/day), the proposed UL (600 µg/day) remains significantly higher than the RDI of 270µg/day. Population data suggests that adult intakes in Australia and New Zealand do not approach the revised UL for most (95%+) of the population, reducing the risk that non-sensitive individuals with higher intakes may be classified as 'exceeding the UL' where there may be no significant risk of harm.**	

	Mild iodine deficiency remains the overwhelming public health concern in lactating populations in Australia and New Zealand. Care must be taken to ensure that communication about the UL emphasises concerns about deficiency and reinforces public health messaging about the need for supplementation during throughout lactation.

Children and adolescents

Criterion	OPTION 1: Maintain current UL recommendations Adapt current UL to additional new age groupings	OPTION 2: Reduce UL to reflect recent evidence suggestive of an increased risk of subclinical hypothyroidism at intakes below the current UL
Example recommendation	NRV age groupings: UL (µg/day) All (males & females) 1 to under 4 years 200 4 to under 9 years 300 9 to under 14 years 600 14 to under 18 years 900 Age groupings by school-age: All (males & females) UL (µg/day) 12 to under 24 months 200 2 to under 5 years 250 5 to under 12 years 450 12 to under 18 years 800	NRV age groupings: UL (µg/day) All (males & females) 1 to under 4 years 200 4 to under 9 years 300 9 to under 14 years 450 14 to under 18 years 550 Age groupings by school-age: All (males & females) UL (µg/day) 12 to under 24 months 200 2 to under 5 years 250 5 to under 12 years 350 12 to under 18 years 500
Health evidence profile and supporting information	In the absence of evidence in children and adolescents, current recommendations have been extrapolated from the adult UL, based on metabolic body weight. There remains insufficient evidence to inform derivation of ULs for children and adolescents.	In the absence of evidence in children and adolescents, recommendations can be extrapolated from the adult UL, based on metabolic body weight using the following formula: $UL_{child} = UL_{adult}$ x $(Weight_{child}/Weight_{adult})^{0.75}$ Reference weights used were based on 2022 ideal weight data from the Australian Bureau of Statistics, as per the current NRVs Methodological Framework (NHMRC, 2025). Calculated values were rounded up to the nearest 50 (children aged <12 years) or rounded to the nearest 100 (children aged >12 years) to arrive at final values.

Inputs for extrapolation and the raw calculated UL value are shown at Table 8, and rounding of calculated UL to proposed UL is shown at Table 9.

TABLE 13 - INPUTS FOR EXTRAPOLATION OF ADULT UL TO CHILDREN

Age group	UL_{adult} (µg/day)	$Weight_{child}$ (kg)	$Weight_{adult}$ (kg)	UL_{child} (µg/day)
NRVs age groupings:				
1 to <4y	600	13	62.9	183.9
4 to <9y		22.4		276.6
9 to <14y		40.7		432.9
14 to <18y		57.6		561.7
Age (grouped by school-age):				
12 to <24 mo	600	10.6	62.9	157.8
2 to <5 yr		15.9		213.9
5 to <12 yr		28.6		332.2
12 to <18 yr		54.5		538.8

TABLE 14 - ROUNDING FOR EXTRAPOLATED CHILD AND ADOLESCENT ULS

Age group	Calculated UL_{child} (µg/day)	Rounding (µg/day)	Proposed UL_{child} (µg/day)
NRVs age groupings:			

1 to <4 yr	183.9	16.1	200
4 to <9 yr	276.6	23.4	300
9 to <14 yr	432.9	17.1	450
14 to <18 yr	561.7	-11.7	550
Age (grouped by school-age):			
12 to <24 mo	157.8	42.2	200
2 to <5 yr	213.9	36.1	250
5 to <12 yr	332.2	17.8	350
12 to <18 yr	538.8	-38.8	500

Iodine exposure in Australia and New Zealand	The 2022-24 NHMS reported that children aged 5 to under 18 were iodine-sufficient, with a median UIC of 171 µg/L and only 8% with UIC <50 µg/L (ABS, 2025a). Urinary iodine measures were highest in children aged 5 to under 12 years (median UIC 185µg/L for males; 188µg/L for females). Current dietary intake data from the 2023 National Nutrition and Physical Activity Survey (NNPAS) are presented at Table 10. Current ABS data do not report the 95% confidence interval nor the percentage of the population exceeding the UL. Consequently, data from the 2011-13 Australian Health Survey (ABS, 2015) are also presented inclusive of this data. These data show that iodine intakes are well below the proposed ULs for at least 95% of the population across all age groups, except for young children. Data from the 2011-13 Australian Health Survey (ABS, 2015) suggested that 12.9% of males and 5.6% of females aged 2-3 years had intakes exceeding the UL. However, these intakes are unlikely to have adverse health effects, in view of the safety margins used to derive an UL and given the reversible nature of the clinical end point on which ULs are based (sub-clinical hypothyroidism). Furthermore, the period of excessive intake is expected to be transient, with less than 1% of children expected to exceed the UL at the age of 4 years (FSANZ 2016).

TABLE 15 - INTAKE IN CHILDREN AND ADOLESCENTS (2 - 18 YEARS), AUSTRALIAN HEALTH SURVEY 2011-13 (ABS, 2015)

Age groups (years) 2023 / 2011-13)	2023 NNPAS (ABS, 2025b)		2011-13 AHS (ABS, 2015)			
	Intake Males. (µg/day)	Intake Females (µg/day)	Intake in Males (µg/day) Mean (95% CI)	% exceeding UL	Intake in Females (µg/day) Mean (95% CI)	% exceeding UL
2 to <5 y / 2 to <4 y	152	143	157 (100 - 222)	12.9%	141 (88 - 202)	5.6%
5 to <12 y / 4 to <9 yr	176	165	164 (106 - 231)	0.1%	148 (93 - 210)	0%
12 to <18 y / 9 to <14 yr	220	161	190 (111 - 285)	0%	169 (102 - 247)	0%
12 to <18 y / 14 to <19 yr	220	161	205 (123 - 303)	0%	153 (91 - 229)	0%

In New Zealand, available population data have not captured intake or median UIC for children aged under 15 years. However, studies suggest that children aged 8-10 years are iodine sufficient (Skeaff & Lonsdale-Cooper, 2013; Jones et al 2016), although a more recent, smaller study in children aged 9-11 years estimated intake to be 74µg/day; below the RDI (120µg/day) in this age group (Peniamina et al 2019).

Benchmarking against comparable international jurisdictions

Table 11 shows NRV recommendations for comparable international jurisdictions. Values have been adjusted using a weighted average calculation, to align with the proposed age groupings (denoted by * in the table).

TABLE 16 - CHILD AND ADOLESCENT UPPER LEVEL RECOMMENDATIONS ACROSS COMPARABLE JURISDICTIONS

Age (years)	Proposed UL (µg/day)	Current ANZ UL (2006)* (µg/day)	USA/Canada UL (2001)* (µg/day)	EFSA UL (2014)* (µg/day)	NNR UL (2023)* (µg/day)
NRVs age groupings:					
1 to under 4 years	200	200	200	200	-
4 to under 9 years	300	300	300	280*	-
9 to under 14 years	450	600	600	390*	-
14 to under 18 years	550	900	900	488*	600^

Age (grouped by school-age):					
12 to under 24 months:	200	200	200	200	-
2 to under 5 years:	250	233*	233*	217*	-
5 to under 12 years:	350	429*	429*	307*	-
12 to under 18 years:	500	800*	800*	475*	600^

^NNR (2023) specifies a UL for 14 - 18 year olds during lactation or pregnancy only

Balance of effects (benefits and harms)	There is insufficient evidence from children and adolescents to support a risk assessment and derive a UL. However, evidence suggests that the current UL of 1,100 µg/day may not be protective of all adults within the population. It is reasonable to assume that extrapolation of revised adult values - based on metabolic body weight - will ensure that the UL for children and adolescents will be protective for most individuals in the general population.
Certainty of the evidence	The evidence on the levels of iodine intake at which adverse effects may occur in children and adolescents is very uncertain.
Values, preferences and feasibility (consumers, communities)	Data from the food modelling system (NHMRC, 2011) suggests that child or adolescent intakes from each of the foundation diets exceed the proposed RDI, but do not approach the ULs for each age group. Intake data from the 2011-13 Australian Health Survey (ABS, 2015) also suggest that the proposed UL is feasible, with intakes for at least 95% of males and females across all age groups less than the proposed ULs. Finally, the proposed UL is substantially higher than the proposed RDI across all age groups, allowing for sufficient variability in individual intakes within the range between the RDII and the proposed UL. Food modelling data from the overall foundation diets are shown at Table 12 alongside the proposed AI, UL and 2011-13 AHS intake data for comparison purposes.

TABLE 17 - COMPARISON OF PROPOSED NRVS WITH FOOD MODELLING DATA (NHMRC, 2011) AND INTAKE DATA (ABS, 2015)

Age group (years)	Proposed RDI - NRVs ages (µg/day)	Proposed RDI - School age groupings (µg/day)	Proposed UL - NRVs age groups (µg/day)	Proposed UL - School-age groupings (µg/day)	Foundation diets - overall		2011-13 AHS Intake data	
					Male intake (µg/day)	Female intake (µg/day)	Males Mean (95% CI) intake (µg/day)	Female Mean (95% CI intake (µg/day
12 to <24mo	90	90	200	200	95	96		
2 to <4yr	90	90	250	200	117	119	157 (100-222)	141 (88-2
4 to <9yr	110[#]	120	350[#]	300	143	133	164 (106-231)	148 (93-2
9 to <11yr	110	120	350	450	173	189	190 (111-285)	169 (102-2
12 to <13yr	140	150	500	450	235	221		
14 to <18yr	140	150	500	600	209	212	205 (123-303)	153 (91-2

[#] Age groupings for UL do not fully align with food modelling ages. For 4 year olds the proposed RDI is 90 µg/day and UL is 250 µg/day.

Resource impacts	Retaining the current values for children and adolescents is expected to have no regulatory implications or resource impacts.	The proposed change to the UL is significant, and may have implications for regulators, including FSANZ (food and food products) and TGA (supplements). Views will be sought during targeted/stakeholder consultation and considered when developing final NRVs. Formulated supplementary foods for young children must contain iodine up to a maximum of 70µg/serve.
Other factors (health equity impacts, sustainability)	No specific factors in addition to those outlined fo adults and pregnancy/lactation above.	No specific factors in addition to those outlined for adults and pregnancy/lactation above.

Decision	Option 2 was selected as it provides protection for almost all individuals within the population, whilst allowing for a diverse range of intakes above the RDI within the Australian and New Zealand population. UL values for young children (<8 years for NRVs age groupings; <5 years for school age groupings) are unchanged from current recommendations. For remaining age groups, the proposed UL does narrow the window between the RDI and UL slightly, although based on available population data the majority (95%+) of the population are unlikely to have intakes approaching the revised UL. This reduces the risk that non-sensitive individuals with higher intakes may be classified as 'exceeding the UL' where there may be no significant risk of harm.

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