

## Iodine Deficiency in Pregnant Women Pre- and Post-Mandatory Iodine Fortification in Australia - An Epidemiological Review

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### Abstract

Adequate iodine nutrition is necessary during pregnancy and breastfeeding for proper neurodevelopment in offspring. Iodine deficiency is common in developed nations and persists despite various public health interventions. This review examines the effect of mandatory iodine fortification of food on iodine status in pregnant women in Australia. Although iodine status has improved, additional supplementation is still required to achieve adequate iodine levels in pregnant and breastfeeding women.

**Keywords:** Iodine fortification; Nutrition supplementation; Thyroid hormone; Pregnant women

### Background

Iodine deficiency is common in Australia where dietary intake appears to have declined over the course of the decade before mandatory iodine fortification was introduced in 2009 [1-3]. Surprisingly, the aforementioned trend prior to 2009 had emerged despite various other programs to reduce the burden and resulted in Australia being classified as a mild-to-moderately iodine-deficient country by the World Health Organization (WHO) [4].

As a precursor to thyroid hormone, iodine has a central role in normal thyroid function. Thyroid hormones play a key role in regulating metabolism and influence fetal and childhood physical and cognitive development [5]. Therefore, adequate iodine nutrition is particularly important for pregnant women and young children. During pregnancy, the demand for iodine increases in proportion to the needs of the foetus and increased maternal iodide clearance by the kidneys [6]. As such, pregnant women are vulnerable to developing iodine deficiency, which can cause neurodevelopmental changes in offspring [7,8]. Indeed, reduced academic outcomes have been documented in children born to iodine-deficient mothers [9,10]. Studies have demonstrated that up to 20-40% of mothers tested in Melbourne were moderately to severely iodine-deficient [11].

The Australia and New Zealand Food Regulation Ministerial Council made the Food Standards Australia New Zealand (FSANZ) implement food fortification to reduce neural tube defects and address the re-emergence of iodine deficiency in Australia and New Zealand [12]. This culminated in the revision of the Australia New Zealand Food Standards Code in 2009, which marked the beginning of mandatory iodine and folate fortification of food. Standard 2.1.1 of the Code requires the addition of folic acid to wheat flour in Australia and the use of iodized salt in bread-making in both Australia and New Zealand. The Standard excludes bread marked as 'organic' from complying with these requirements in both countries [13].

Median urinary iodine concentration (MUIC) is an indirect measure of iodine status and is determined from spot urine samples. Except in breastfeeding women, urinary iodine excretion accurately reflects recent iodine intake, with about 90% of dietary iodine appearing in the urine [14]. Although not a sufficient measure for individual iodine status, MUIC can be used to validly assess the population status [15].

The World Health Organization (WHO) considers a population mildly iodine deficient if the MUIC is less than 100 µg/L, and moderately iodine deficient if the MUIC is less than 50 µg/L. The WHO recommends that no more than 20% of the population be moderately iodine deficient [16]. Since requirements in pregnancy are increased, the NHMRC recommends that all women who are pregnant, breastfeeding or considering pregnancy, take an iodine supplement of 150 µg/L each day [17].

Given the extent of deficiency and the fact that it may be largely asymptomatic to confer a negative impact on neonatal outcome, a community-centered approach is vital in reducing future neurodevelopmental issues. Moreover, if population-based strategies fail to adequately address the problem in all groups in the past, the identification of those at highest risk may alert primary care physicians and obstetricians to suspect iodine deficiency in these patients with early recourse to treatment.

### Aims and Objectives

This report is a review of the literature with regard to those groups of women that are at highest risk of iodine deficiency before and after mandatory iodine fortification in Australia.

The key question the report will seek to answer is: How effective have fortification of foods and prenatal iodine supplementation been in reducing iodine deficiency in pregnant women?

## Methods

A standard literature review was conducted of iodine status in women, particularly during pregnancy in view of the deleterious effects of deficiency on offspring. Articles were chosen by snowball sampling from reference lists of relevant articles and Australian government reports, and by searching key terms in PubMed. Key terms included: iodine, deficiency, female, pregnancy, fortification.

Inclusion criteria was studies performed on Australian cohorts and articles written in the English language. The outcomes assessed was iodine status, primarily the MUIC.

Non-literature primary sources of information were consulted for relevant datasets and include the Australian Bureau of Statistics (ABS) datasets from the relevant time periods, as well as published data from peer-review scholarly journals and government reports such as those of the Australian Institute of Health and Welfare (AIHW) [13].

## Discussion

Tasmania implemented a voluntary food fortification program in 2001, eight years prior to the implementation of the nationwide program in 2009 [18]. As such, Tasmanian studies did not have the same pre- and post-fortification timeframes as other reports. Nevertheless, they were included in the analysis as they were still considered a valid measure of the efficacy of food fortification as a public health intervention.

Historically, New Zealand and some parts of Australia, notably Tasmania, had low iodine intakes partly due to low soil iodine levels [13]. Over the last decade, several studies had shown a re-emergence of iodine deficiency in parts of Australia and New Zealand and further studies in both countries confirmed that both populations were mildly deficient [2,19]. As the use of iodized salt has also declined since that time, intakes of iodine have fallen in both Australia and New Zealand, [20-25].

The 2003-04 Australian National Iodine Nutrition Study (ANINS), measured the iodine status of Australian school children aged 8-10 years in five Australian states [2]. Although this study pertains to children, studies such as those from Tasmania indicate that the MUIC in children provides a reliable estimate of the MUIC in adults [18,26]. The results of the ANINS showed that in NSW and Victoria, respectively, 58.5% and 72.6% of children were iodine deficient (urinary iodine excretion <100 µg/L) [2]. Children in Western Australia and Queensland were found to be iodine replete by comparison. The results from NSW and Victoria were very similar to those previously reported [27-29].

Studies specific to pregnant women demonstrated a high overall prevalence of iodine deficiency prior to food fortification. 72% of a sample of pregnant women in Western Sydney were iodine deficient, with 32% suffering from moderate deficiency [30]. The MUIC of 81 µg/L was similar to the level found in a pregnant population in Sydney approximately 10 years prior indicating that the situation had not improved despite publicity in the medical and lay press about iodine deficiency [27]. Similar reports of iodine deficiency from Victoria and Tasmania indicate the degree of iodine deficiency in pregnant women (52 µg/L) was even worse than in NSW [11,18]. There was a significant increase in MUIC in women who were taking a pregnancy supplement. At 115 µg/L, however, it remained well below the recommended level of 150 µg/L [30].

Charlton et al. found a MUIC of 87.5 µg/L in a small sample of women attending an antenatal clinic in Wollongong. Their findings were similar in that the MUIC in the women taking a pregnancy supplement was significantly increased to 139 µg/L, but still below the recommended level [31].

A study by Travers et al. found the MUIC for pregnant women was 85 µg/L, indicating mild iodine deficiency. Almost 17% of pregnant women had a UIC <50 µg/L [32]. Gunton et al. found a similar prevalence of moderate iodine deficiency among pregnant women in a Sydney teaching hospital (19.8%) [20].

Hamrosi et al. investigated differences in iodine status in Vietnamese, Indian/Sri Lankan and Caucasian pregnant women residing in Melbourne. Like other studies in that region, iodine status was found to be much worse than in NSW. Non-Caucasian women had significantly better iodine status compared with Caucasian women, which the authors attributed to differences in dietary behaviours [11].

Mackerras et al. evaluated iodine status in Aboriginal Australians living in a remote area of the Northern Territory. The MUICs reported were below those reported in other parts of Australia. The authors admitted it could not be determined whether remoteness or ethnic factors were responsible for this discrepancy [33]. Given this is the only study prior to 2009 of iodine status in a defined Indigenous cohort, it could not be stated whether this group is at increased risk of iodine deficiency compared to non-Indigenous populations.

Data on iodine levels was collected in the 2011-12 National Health Measures Survey (NHMS) to provide national estimates and report on the effectiveness of mandatory iodine fortification [15]. The NHMS results showed that the Australian population median was a satisfactory 124.0 µg/L with 12.8% having a MUIC less than 50 µg/L. There was variation across the country with adults in Western Australia having the highest median iodine levels (157.4 µg/L) and Tasmanians the lowest (108.0 µg/L). Comparison with the pre-mandatory fortification ANINS suggests that MUIC has increased, although the baseline study contained data only for children [13].

Levels of iodine and rates of moderate iodine deficiency appear to have improved at a MUIC of 116 µg/L. 18.3% of all women had a MUIC <50 µg/L. Nearly two thirds (62.2%) of women had an iodine level less than 150 µg/L, which is the recommended level for all women who are pregnant, breastfeeding or considering pregnancy [17,34]. Pregnant women were not sampled in this study, however the results for women of childbearing years indicate that mandatory fortification may not be sufficient to meet the additional requirements in this group.

The National Aboriginal and Torres Strait Islander Health Measures Survey 2012-13 (NATSIHMS) was another nationwide survey, specifically targeting Aboriginal and Torres Strait Islanders [35]. The NATSIHMS showed that the Aboriginal and Torres Strait Islander adult population was iodine sufficient, with a population MUIC of 135.0 µg/L. Only 10.8% had an iodine level of less than 50 µg/L. Interestingly, Aboriginal and Torres Strait Islander adults had higher iodine levels than non-Indigenous adults (a median of 135.0 µg/L compared with 124.0 µg/L) [34,36].

Although fortification has had favourable results in adults and children, several studies have demonstrated ongoing iodine deficiency in pregnant and breastfeeding women despite improvements in iodine status in the post-mandatory fortification period [37-39]. Indeed, the

FSANZ predicted that most pregnant women would remain iodine deficient [12]. WHY?

At least one study has documented a failure to elicit any improvement in MUIC in pregnant women post-fortification [40]. The authors have suggested that pregnant women were unlikely to reach recommended iodine levels even after fortification without a dietary supplement.

Burgess et al. reported a non-significant increase in MUIC in pregnant women post-fortification in Tasmania, noting that iodine deficiency has persisted in this group despite being corrected in children [26].

A study in regional NSW found that only those women who were taking prenatal supplements containing iodine had MUICs indicating sufficiency (150 µg/L) post fortification [41]. The same result was found by a study looking at a sample of pregnant women in South Australia [42]. This is most likely explained by the increased iodine needs and renal iodide clearance induced by pregnancy, as previously stated.

Among pregnant women in 2011-2012, 60%-66% were taking supplements containing iodine [43]. This means that up to 40% of women were still not taking recommended iodine supplements, which the authors suggested might be due to women not being informed about the need for supplementation by their antenatal care providers, despite there being written advice on supplements provided in public health facilities across NSW. More recent studies have confirmed these poor rates of supplementation, as well as finding that only 18.5% of pregnant women believed they needed a supplement [44] and only 26% of family doctors reported discussing iodine supplementation with their pregnant patients [45]. For this reason, we strongly recommend further education of antenatal clinicians regarding the importance of iodine supplementation.

## Conclusions

The literature review revealed that pregnant women were at significant risk of mild iodine deficiency pre-fortification. Those who took an iodine supplement had significantly better iodine status, but remained below the recommended level for pregnant women. Caucasian women appeared to be at greatest risk of iodine deficiency.

The results also indicated that MUICs had not changed substantially for pregnant women over the decade preceding mandatory fortification in 2009 despite attempts to improve iodine nutrition in the population.

Despite iodine status improving in children and adults, pregnant women appear to have had insufficient improvement in iodine levels post mandatory iodine fortification. Dietary supplementation with iodine was needed to prevent iodine deficiency during pregnancy.

Continuing national public health education and supplementation programs are necessary to ensure that adequate iodine requirements are met for all pregnant women.

## Recommendations

Ongoing surveillance of the iodine status of Australian communities to establish trends over time is recommended. Given the small sample sizes of most of the studies included in this report and paucity of data in pregnant women, there is a need for more robust research on the

impact of fortification of foods and supplementation on iodine status of pregnant women in particular.

Of note, there were no studies of MUIC of pregnant or breast-feeding women in Western Australia or Queensland that were conducted to determine if there are differences across states.

In light of the results presented in the current report, public health strategies, including nutritional education and supplementation, are urgently required to improve the iodine status of pregnant women.

Additionally, education of antenatal clinicians regarding the importance of iodine supplementation is strongly recommended.

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