Urinary iodine deficiency in Gippsland pregnant women: the failure of bread fortification?

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ABSTRACT

Objective: To assess iodine status and the factors that influence iodine status among a cohort of pregnant women living in Gippsland.

Design, participants and setting: Cross-sectional study of 86 pregnant women (at ⩾ 28 weeks' gestation) conducted in hospital antenatal care services and private obstetrician clinics across the Gippsland region of Victoria, Australia, from 13 January 2009 to 17 February 2010.

Main outcome measures: Overall proportion of pregnant women with a urinary iodine concentration (UIC) > 150 μg/L; proportion of pregnant women with a UIC >150 μg/L after the mandatory iodine fortification of bread; use of supplements containing iodine; intake of foods known to be good sources of iodine; intake of bread.

Results: The percentage of pregnant women with UIC >150 μg/L (indicative of iodine sufficiency) was 28%. There was no statistically significant difference in UICs before and since iodine fortification of bread. The median UIC before fortification was 96 μg/L (interquartile range [IQR], 45–153 μg/L) and since fortification was 95.5 μg/L (IQR, 60–156 μg/L). The dietary intake of iodine-rich food (including bread) and the use of appropriate supplements was insufficient to meet the increased iodine requirements during pregnancy.

Conclusions: The UICs in this cohort of pregnant women are of concern, and seem unlikely to be improved by the national iodine fortification program. Pregnant women in Gippsland urgently need effective iodine education programs and encouragement to either consume iodine-rich foods or take appropriate supplements.

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Iodine is an essential micronutrient that plays a crucial role in ensuring the normal development of most organs, especially the brain.[1-3] The World Health Organization reports that even moderate iodine deficiency can cause a loss of 10–15 intelligence quotient (IQ) points, and iodine deficiency is the world's greatest single cause of preventable brain damage and developmental delay.[4] For this reason, maintaining an adequate iodine status is crucial for everyone, but it is especially important for pregnant and breastfeeding women. During pregnancy, iodine requirements are almost doubled, making the risk of iodine deficiency much more likely among pregnant women.[5] Lack of iodine in the diet, or iodine deficiency disorder is a major problem for both individuals and public health in many countries, including Australia.[6] The Gippsland region of Victoria has a long history of iodine deficiency. In 1960, Gippsland was described in a WHO monograph series on endemic goitre as the "home of goitre". Despite this history, the Gippsland population has not been screened for iodine deficiency since 1948.

Urinary iodine concentration (UIC) is considered to be the most practical biochemical marker for monitoring population iodine status.[4] The weighted median urinary iodine concentration from the Australian National Iodine Nutrition Study conducted among schoolchildren in 2003 and 2004 was found to be 96 μg/L, thus indicating that the Australian population was mildly iodine deficient.[7] In an attempt to correct this deficiency, Food Standards Australia and New Zealand (FSANZ) introduced mandatory iodine fortification of bread products in 2009.[8]

Before the bread fortification program was introduced, we had decided to undertake a cross-sectional urinary iodine study in a cohort of pregnant women across Gippsland. In addition, we also wanted to collect data on the women's diet during pregnancy. Only one Australian study of pregnant women has collected data on dietary sources of iodine and the use of supplements.[9] Our study overlapped the initiation of the national iodine fortification of bread program on 9 October 2009, enabling us to complete an early but rudimentary assessment of the efficacy of this program.

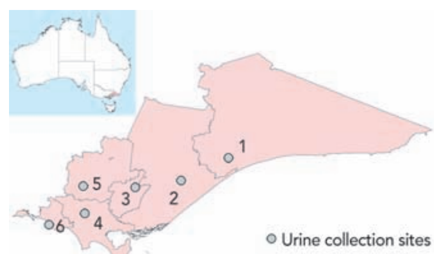
In this article, we report on the UICs, dietary iodine intake, use of supplements and estimated intake of bread (both before and after mandatory iodine fortification of bread) among a cohort of pregnant women living in Gippsland.

METHODS

Our cross-sectional study started on 13 January 2009 and finished on 17 February 2010. It included pregnant women from the major antenatal clinics across all six Gippsland local government areas (Box 1). Participants were asked to provide a morning urine sample and fill out a self-reported dietary questionnaire. However, to ensure that urine samples were obtained from as many pregnant women as possible, 30% of samples were collected on the spot on the day women agreed to participate. The sample size calculation for this study ($n = 86$) followed previously described methods.[10] The formula used for the sample size calculation was:

$$n = (Z \times CV\%/D)^2$$

1 Sample collection sites in Gippsland



1 East Gippsland (Bairnsdale)
2 Wellington (Sale)
3 Latrobe (Traralgon)
4 South Gippsland (Leongatha)
5 Baw Baw (Warragul)
6 Bass Coast (Wonthaggi)

where the confidence interval (Z) for 90% was 1.64; percentage coefficient of variance (CV%; square root of the variance divided by the mean, as a percentage) at the population level was 56.4; and the precision range (D) was ± 10%.

Eligible participants were residents living in Gippsland who were over the age of 18 years, who were pregnant at or over 28 weeks' gestation and who were not taking any thyroxine (thyroid hormone medication). Urine samples were collected at antenatal clinics from four hospitals (Latrobe Regional, Wonthaggi, Leongatha and Warragul) and from three private clinics (Leongatha Medical Centre, Macleod Street Medical Centre in Bairnsdale and the Gippsland Obstetrics and Gynaecology Centre in Sale).

All pregnant women attending the antenatal clinics were approached to participate in the study by one of us (A R), and those who gave their informed consent were provided with a sample collection kit and asked to bring the samples back at their next visit to the hospital or clinic. They were also asked to complete a short questionnaire on their diet in which they were asked about their consumption during their current pregnancy, of foods known to be good sources of iodine. Foods considered good sources of iodine included milk and milk products, bread (a slice of fortified bread [average weight, 30 g] will provide 10–25 μg of iodine[11]), table salt, cooking salt, eggs, tap water (documented as an important source of iodine by FSANZ[12]), seafood, seaweed and sushi. Consumption of these foods daily or 2–3 days per week was included in the iodine food frequency calculation.

On the day of collection, urine samples were transported in an ice box to the School of Applied Sciences and Engineering at Monash University Gippsland and stored at –20°C. Samples were later sent as a batch to the Institute of Clinical Pathology and Medical Research at Westmead Hospital, New South Wales, for analysis. The cold chain was maintained throughout transportation of the urine samples.

The UIC was determined by the modified acid digestion method based on the catalytic Sandell–Kolthoff reaction.[4] The laboratory at Westmead is the International Council for Control of Iodine Deficiency Disorders (ICCIDD) reference laboratory for the Asia–Pacific region for measuring UIC, and is accredited by the National Association of Testing Authorities in compliance with International Organization for Standardization/International Electrotechnical Commission standard 17025.

All the UIC cut-off values used in this report follow WHO/UNICEF/ICCIDD guidelines.[4] The *t* test, χ^2 test and Wilcoxon test (for non-parametric data) were used for tests of significance, and $P<0.05$ was considered significant. The study was approved by the Human Research Ethics Committees of Monash University, Latrobe Regional Hospital and the West Gippsland Healthcare Group.

SAS Enterprise Guide 4.1 (SAS Institute Inc, Cary, NC, USA) was used for statistical data analysis, and ArcGIS 9 (ESRI, Redlands, Calif, USA) was used as the mapping software.

RESULTS

The total number of participants was 86 (29% of the 296 antenatal clinic attendees approached); they had a mean age of 29.4 years (SD, 4.6 years; range, 19–40 years). Of the 62 participants who recorded their ethnicity, 58 (93.5%) were white; the remaining four participants were of Chinese, Filipino, Indian and Maori ethnic origins. All the participants were in their third trimester of pregnancy (⩾ 28 weeks' gestation). Twenty-four participants provided their urine samples and completed their questionnaires before the start of the national bread fortification program.

Urinary iodine concentration

The median UIC among the pregnant women was 96.0 μg/L (interquartile range [IQR], 56–156 μg/L; Box 2). Twenty-four of the 86 participants (28%) had a UIC of 150 μg/L or higher, which is indicative of adequate iodine status (during pregnancy). The remaining 62 women (72%) had a UIC indicative of iodine deficiency. The 24 women who had urine samples collected before the bread fortification program had a median UIC of 96.0 μg/L, while the 62 whose samples were collected after the commencement of bread fortification had a median UIC of 95.5 μg/L. There was no statistically significant difference between these UIC values ($P=0.51$). The median UIC of the 44 participants taking vitamin and mineral supplements containing iodine was 121.5 μg/L (IQR, 81.5–179.5 μg/L), while that of the 42 taking supplements not containing iodine was 64.5 μg/L (IQR, 50.0–115.0 μg/L). This difference was statistically significant ($P<0.001$).

Dietary sources of iodine

Milk, milk products and bread were the most common food sources of iodine, with 81 participants consuming these foods. There was no significant difference in the consumption of these foods in the periods before and since iodine fortification of bread. Use of iodised salt was found to be lower among participants who were surveyed after the commencement of the bread fortification program (20 of 62 participants; 32%) compared with those surveyed before fortification (12 of 24 participants; 50%). Eggs — a moderate but important source of iodine — were eaten by about 50% of the women (41 of 80). Seafood, seaweed and sushi are foods known to have high iodine content. However, only seven women (9%) reported eating seafood both before and since iodine fortification, and seaweed and sushi made the smallest contribution as dietary sources of iodine. Sixty respondents (70%) reported drinking tap water, while 12 (14%) drank tank water and 10 (12%) drank bottled water.

The median reported intake of bread was two slices per day (Box 3) although we did not ask participants to specify the type of bread (fortified v organic or other non-fortified breads) consumed. The maximum number of slices consumed was eight per day (representing 1% of those surveyed). There was no significant difference in bread consumption between women sampled before and since iodine fortification of bread. The women reported that they maintained the same food habits during previous pregnancies.

Iodine-containing supplements and dietary iodine knowledge

Forty-four pregnant women (51%) were taking self-administered mineral and vitamin supplements containing 25–300 μg of iodine. Among these, the frequency of consumption was higher in the 13 women

2 Median urinary iodine concentrations of the participants in the periods before and since iodine fortification of bread, and in the total study period

Urine sample collection period	No. of participants	Median UIC (IQR)	Samples with UIC < 50 μg/L	Samples with UIC ⩾ 150 μg/L
Before iodine fortification of bread	24	96.0 μg/L (45–153 μg/L)	7 (29%)	6 (25%)
Since iodine fortification of bread	62	95.5 μg/L (60–156 μg/L)	8 (13%)	18 (29%)
Total period	86	96.0 μg/L (56–156 μg/L)	15 (17%)	24 (28%)

IQR = interquartile range. UIC = urinary iodine concentration. ◆

3 Daily bread consumption reported by 81 study participants

Bread consumption	All participants* (*n* = 81)	Participants sampled: Before iodine fortification of bread* (*n* = 23)	Participants sampled: Since iodine fortification of bread* (*n* = 58)
Slices/day			
1	7 (9%)	2 (9%)	5 (9%)
2	39 (48%)	11 (48%)	28 (48%)
3	15 (19%)	4 (17%)	11 (19%)
4	18 (22%)	6 (26%)	12 (21%)
> 4	2 (2%)	0	2 (3%)

* Median bread consumption was 2 slices/day for each category of participants. ◆

sampled before iodine fortification of bread (54%) than in the 31 sampled since fortification (50%). Twenty-eight respondents mentioned starting to take supplements before pregnancy. Only 23 of the 44 women taking supplements (51%) reported taking supplements containing 250 µg or more of iodine (250 µg is the daily iodine requirement during pregnancy[4]). The advice to take iodine-containing supplements mostly came from doctors (31 of 65 women; 48%) or was self-initiated (20 of 65 women; 31%). All 86 respondents reported hearing about the importance of folic acid during pregnancy, but only 28 (33%) reported hearing about the importance of iodine.

DISCUSSION

The median UIC of these pregnant women living in Gippsland (96 µg/L) was indicative of mild iodine deficiency, which is in line with the findings of other Australian studies.[9,13-15] Our findings also suggest that pregnant women in Gippsland probably have a history of consuming insufficient iodine in their diets, and lack awareness of the importance of iodine intake, especially during pregnancy. Our study spanned the time before and after the commencement of a national bread iodine fortification program in mainland Australia, thereby allowing an early assessment of the efficacy of this program. However, although our total sample size was statistically significant, the numbers of women sampled before and since bread fortification were relatively small. Thus, although there was no statistically significant difference between the UIC results of the women sampled before and since bread fortification, a larger study would be required to accurately determine the efficacy of the fortification program using median UIC values. However, our results do indicate that iodine fortification of bread is unlikely to meet the increased iodine needs of pregnant women living in Gippsland. It is therefore likely that the program will fail to achieve the expected outcome of reducing iodine deficiency among women of childbearing age that was proposed by FSANZ.[16]

The proportion of our sample of pregnant women living in Gippsland who were iodine deficient (UIC, < 150 µg/L)[4] was 72%, which is the same as the proportion of iodine-deficient schoolchildren (UIC, < 100 µg/L)[4] found in Victoria in the National Iodine Nutrition Study.[15] The total proportion of our study sample with a UIC < 50 µg/L was 17%. A previous study investigating the iodine status of pregnant women in Victoria showed that the median UIC for white women from Melbourne was 52 µg/L.[13]

According to WHO criteria, in an iodine-replete population, no more than 20% of the population should have a UIC below 50 µg/L.[4] However, these cut-off values do not take into account the changes in UIC due to altered physiology during pregnancy (ie, UIC is increased during early pregnancy compared with the latter two trimesters). One report acknowledges these changes, and yet proposes that (until appropriate values can be determined) the proportion of pregnant women with UIC below 50 µg/L should be less than 10%.[17]

Our findings are consistent with those of other urinary iodine studies of pregnant women across Australia.[9,14,17] One of these studies examined pregnant women in all trimesters before and since bread iodine fortification in Tasmania and found a median UIC before bread fortification of 76 µg/L, and after the introduction of fortification, of 86 µg/L.[14] This small increase was not statistically (or clinically) significant, suggesting that iodine fortification of bread alone was unsuccessful in preventing iodine deficiency during pregnancy.[14] In a UIC study undertaken in the Central Coast area of NSW, the researchers found that a cohort of pregnant women in their third trimester was mildly iodine deficient.[18] A recent iodine study in pregnant women from the Illawarra region of NSW found the participants to be mildly iodine deficient (median UIC, 87.5 µg/L), with only 14.5% of the participants having an adequate UIC of > 150 µg/L.[9] That study also found that 15% of pregnant women had a UIC < 50 µg/L.

The Illawarra study is, to our knowledge, the only other Australian study to look at pregnant womens' knowledge and practices regarding iodine intake, and our findings are similar to those of that study. We found that, in the Gippsland region, the food intake pattern of pregnant women for foods known to be a good source of iodine was poor. Of the foods considered good sources of iodine, only milk, milk products and fortified bread were consumed regularly. In addition, our study participants were poorly informed about the importance of iodine in the diet, especially during pregnancy, with only a third having heard of the importance of iodine during pregnancy (yet all were aware of the importance of folic acid).

In our unpublished paper on environmental iodine levels in Gippsland, we found that the iodine concentration in reticulated tap water and rainwater in tanks was negligible, and was indicative of environmental iodine deficiency.[19] Most of our study participants reported drinking local tap water or tank water, neither of which would be a useful dietary source of iodine. Their iodine intake from local tap water would be close to zero, and not the 5%–9% reported in the Australian Total Diet Study.[12]

Clearly, the pregnant and breastfeeding women of Gippsland urgently require knowledge about the crucial importance of iodine in their diets. According to the United Nations Convention on the Rights of the Child, adopted in 1989, every mother has the right to adequate iodine nutrition to ensure her newborn baby's normal brain development.[20] Our study is in agreement with the earlier Tasmanian study in suggesting that iodine fortification of bread (at the current level) is insufficient to prevent iodine deficiency in pregnant women.[14]

Pregnant women in Gippsland should have access to effective iodine education programs and be encouraged to either consume iodine-rich foods or take appropriate supplements to improve their iodine status during pregnancy. We also recommend the use of iodised salt in all processed food — not just bread products.

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COMPETING INTERESTS

None identified.

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