Iodine status of Tasmanians following voluntary fortification of bread with iodine

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ABSTRACT

Objective: To describe changes in the iodine status of Tasmanians following voluntary fortification of bread with iodine in October 2001.

Design and setting: Post-intervention, cross-sectional urinary iodine surveys of Tasmanian schoolchildren aged 8–11 years were used to assess population iodine status. Participants were selected using a one-stage cluster sampling method. The sampling frame comprised classes containing fourth-grade children from all Tasmanian government, Catholic and independent schools. Results were compared with pre-intervention survey results.

Main outcome measures: Median urinary iodine concentration (UIC) and percentage of UIC < 50 μg/L ascertained from spot urine samples.

Results: Median UIC was 75 μg/L in 1998, 72 μg/L in 2000, 105 μg/L in 2003, 109 μg/L in 2004 and 105 μg/L in 2005. Median UIC in post-intervention years (2003–2005) was significantly higher than in pre-intervention years. The percentage of UIC results < 50 μg/L was 16.9% in 1998, 18.7% in 2000, 10.1% in 2003, 10.0% in 2004 and 10.5% in 2005.

Conclusion: Despite methodological differences between the pre- and post-intervention surveys, switching to iodised salt in bread appears to have resulted in a significant improvement in iodine status in Tasmania. Given iodine deficiency has been identified in other parts of Australia and in New Zealand, mandatory iodine fortification of the food supply in both countries is worthy of consideration. As voluntary fortification relies on industry goodwill, mandating fortification could be expected to enhance population reach and give a greater guarantee of sustainability in Tasmania.

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Iodine deficiency leads to a range of conditions known as iodine deficiency disorders, with the most serious and overt consequences of iodine deficiency — cretinism and widespread goitre — occurring in the context of severe deficiency.[1] Mild to moderate iodine deficiency is associated with subclinical anomalies, including neuropsychological dysfunction and deficits in auditory acuity.[2,3]

Iodine deficiency was prevalent in Tasmania before the 1950s, and strategies to address iodine deficiency were adopted during the 1950s and 1960s.[4] Since the early 1970s, iodophors, used as sanitising agents in the dairy industry, are thought to have provided protection against iodine deficiency.

Urinary iodine surveys of Tasmanian schoolchildren in 1998 and 2000 revealed a recurrence of iodine deficiency.[5] Reasons postulated for this recurrence include reduced use of iodophors by the dairy industry and reduced household use of iodised salt (caused by a gradual increase in consumption of commercially processed foods containing non-iodised salt).

In October 2001, a voluntary iodine fortification program was implemented in Tasmania. The baking industry was asked to substitute iodised salt for regular salt in bread (details of the program are available from the authors). Mandatory fortification was considered but not pursued, as Tasmania was bound by a national food regulation agreement, which complicated introducing legislative measures at state level. In addition, the program was envisaged as an interim measure; a binational approach was anticipated because of evidence of emerging iodine deficiency elsewhere in Australia and in New Zealand.[6-12]

Here we present the results from post-intervention urinary iodine surveys of Tasmanian schoolchildren, and compare the results with pre-intervention survey results. Results from pre-intervention surveys and preliminary results from the 2003 post-intervention survey have been published previously.[5,13]

METHODS

Study design

Cross-sectional urinary iodine surveys of schoolchildren were conducted in 2003, 2004 and 2005. Urinary iodine concentration was determined from spot urine samples using recommended methods.[1]

Sample selection

A one-stage cluster sampling method was used to randomly select survey participants. A total of 451 school classes containing fourth-grade children were identified from 227 government, Catholic and independent schools throughout Tasmania. In 2003, 52 classes (from 47 schools) were randomly selected. In 2004 and 2005, to boost sample size and increase school participation, an additional eight classes were randomly selected.

Urine sample collection

Provision was made for school- or home-based urine sample collection. Urine samples were collected in labelled 70 mL plastic collection jars and delivered to a pathology service centre. Aliquot samples were transferred to 9 mL sterile vacuette test tubes, frozen, and transported to the laboratory at the Institute of Clinical Pathology and Medical Research at Westmead Hospital in New South Wales for analysis.

Urinary iodine determination

Urinary iodine concentration (UIC) was determined by a modified acid digestion method based on the Sandell–Kolthoff reaction.[14] The laboratory at which the analysis was done complies with ISO/IEC 17025 under the accreditation scheme of the National Association of Testing Authorities and the Royal College of Pathologists of Australasia.

Statistical analysis

Data from pre-intervention urinary iodine surveys were extracted for children of the same age range (8–11 years) and used for comparison with the post-intervention surveys. Details of pre-intervention survey methods have been published elsewhere.[5]

Data were analysed using Stata version 9.2 (StataCorp, College Station, Tex, USA). Median UIC, interquartile range and the proportion of UIC < 50 μg/L were calculated. Differences in median UIC were determined using quantile regression. Logistic regression was used to determine differences in the proportion of UIC results < 50 μg/L. *P* values were corrected for multiple comparisons by the Holm method.

Ethics and consent

Ethics approval was obtained from the Southern Tasmanian Health and Medical Human Research Ethics Committee and the Department of Education's Office for Educational Review. Parent or carer consent was obtained for all participating children. To protect anonymity, no personal details other than school and sex were recorded with the urine samples.

RESULTS

Participants

We surveyed 347 children in 2003, 430 in 2004 and 401 in 2005. Because of composite class structures (eg, grades 3–4 or 4–5), participants' ages ranged from 8 to 11 years.

Participation rates in the post-intervention surveys ranged from 37% to 44%. Sample loss occurred through non-return of consent forms (31%–42%), declined consent (19%–20%), and lack of sample collection because the child was absent or unable to produce a sample (2%–6%) (Box 1).

Urinary iodine concentration

Box 2 shows the distribution of UIC results for the post-intervention surveys. Median UIC was significantly higher in each of the post-intervention years compared with pre-intervention ($P < 0.001$) (Box 3). There was a reduction in the proportion of UIC results < 50 μg/L in the post-intervention years compared with pre-intervention, but the differences were not significant.

DISCUSSION

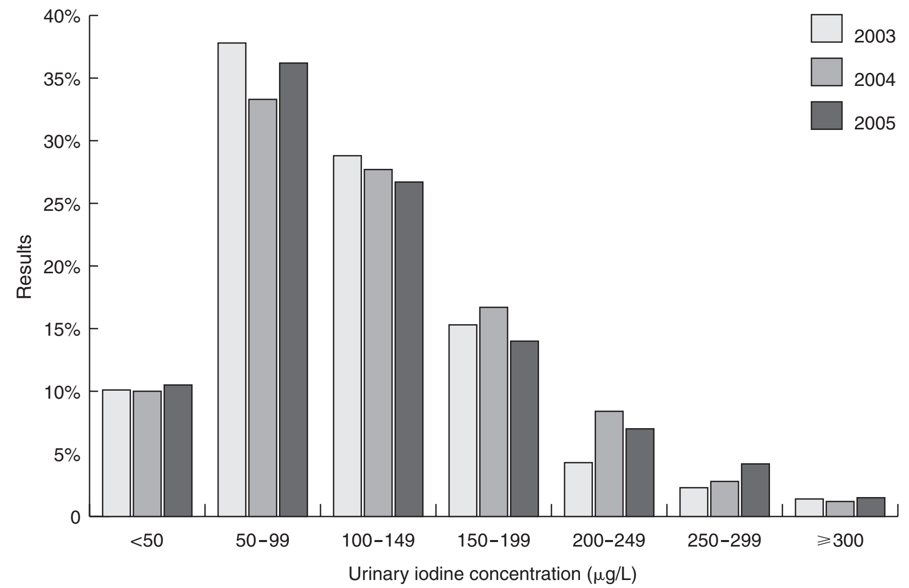
Population iodine status is considered optimal when the median UIC falls between 100 and 199 μg/L, with no more than 20% of samples < 50 μg/L.[1] Our post-intervention results are consistent with optimal iodine nutrition, and comparisons with the results from the 1998 pre-intervention survey suggest there has been a modest but significant improvement in median UIC. The observed increase in median UIC is in the order of 30–38 μg/L, which is consistent with increases predicted by dietary modelling before intervention (details can be obtained from the authors).

1 Participation rates in post-intervention surveys of urinary iodine concentration

	2003		2004		2005	
	n	(%)	*n*	(%)	*n*	(%)
Number of classes invited to participate	52		60		47	
Classes agreeing to participate	31	(60%)	43	(72%)	42	(89%)
Total number of children in participating classes	781		968		1075	
Consent forms returned	535	(69%)	663	(68%)	619	(58%)
Positive consent*	391	(50%)	466	(48%)	415	(39%)
Samples collected*	347	(44%)	430	(44%)	401	(37%)

*Percentages are of total number of children in participating classes. ◆

2 Distribution of urinary iodine concentration in schoolchildren, by year



3 Urinary iodine concentration in schoolchildren, by year

	Median (μg/L) (95% CI)	Interquartile range	*P**	% < 50 μg/L (95% CI)†	Odds ratio‡	*P**
1998 (*n* = 124)	75 (72–80)	60–96		16.9% (10.3%–23.6%)	1.00	
2000 (*n* = 91)	72 (67–84)	54–103	0.43	18.7% (10.6%–26.7%)	1.16	0.74
Intervention commenced October 2001						
2003 (*n* = 347)	105 (98–111)	72–147	< 0.001	10.1% (6.9%–13.3%)	0.49	0.14
2004 (*n* = 430)	109 (103–115)	74–159	< 0.001	10.0% (7.2%–12.8%)	0.51	0.14
2005 (*n* = 401)	105 (98–118)	72–155	< 0.001	10.5% (7.5%–13.5%)	0.53	0.11

* Difference in position of median estimated by quantile regression. *P* values corrected for multiple comparisons by the Holm method. † Confidence intervals estimated by the Wald binomial method. ‡ Odds ratio for percentage < 50 μg/L estimated by logistic regression. ◆

No attempt was made to measure health outcomes, as the effects of mild iodine deficiency, such as impaired intellectual and physical development, are generally subclinical and likely to be confounded by many factors. Thyroid volume measured by ultrasound is also considered a useful population level indicator of iodine status. However, UIC is considered more sensitive to recent changes in iodine nutrition, as thyroid volume takes time to respond to iodine supplementation.[1] Hence, thyroid volume was not measured in our post-intervention surveys.

Comparisons between pre- and post-intervention surveys are limited by methodological differences in sampling procedure, response rate and timing of urine collection.

A two-stage stratified sampling procedure was used in the pre-intervention surveys, compared with one-stage cluster sampling in the post-intervention surveys. Participation rates were lower post-intervention (37%–44%) than in the pre-intervention surveys (> 70%), possibly because ethics approval for the post-intervention surveys did not allow for direct follow-up with parents and carers to encourage participation. This had been standard practice in the pre-intervention surveys. Differences in sampling procedure and response rates are unlikely to have resulted in significant bias associated with factors such as socioeconomic status or geographic location, as prior investigations in Tasmania have not demonstrated an association between UIC and these factors.[5]

In the post-intervention surveys, casual spot urine samples were collected, compared with first-void samples in the pre-intervention surveys. Both sample types provide an adequate assessment of population iodine status, provided the sample size is large enough.[1] However, as UIC follows a circadian rhythm, being lowest first thing in the morning and peaking 4–5 hours after a meal, some researchers recommend that studies restricting sampling time to the morning (first void) should not be directly compared with studies in which urine is sampled throughout the day.[15] Although we cannot rule out some influence of the timing of urine sample collection, we believe our results show a real increase in iodine status, as the observed increase in UIC is consistent with predicted levels.

Although no conclusions can be drawn from these data about population subgroups, we remain concerned about groups whose needs may not have been met by this intervention. Such groups include those who consume little or no bread because of special dietary requirements, choice or cultural preferences; those who consume bread predominantly from an outlet not participating in the program; and those with increased iodine requirements. Pregnant and lactating women are of special concern, as their iodine requirements are increased and critical for the growth and development of the fetus and infant.[16]

CONCLUSION

Urinary iodine surveys of schoolchildren in Tasmania suggest that a modest but significant improvement in iodine status can be achieved by replacing regular salt with iodised salt in bread. The magnitude of increase in UIC is in the order of 30–38 μg/L. Whether the level of supplementation achieved is sufficient to meet the needs of all population subgroups warrants further investigation, especially for pregnant and lactating women.

As voluntary fortification relies on the goodwill and consistent practices of industry (baking and salt), the reach of the voluntary fortification program may be compromised and there is no guarantee of program sustainability. As iodine deficiency has been confirmed in other parts of Australia,[17] and in New Zealand,[11] we believe mandatory iodine fortification in both countries would provide a more effective and efficient approach for Tasmania, while addressing iodine deficiency elsewhere.

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COMPETING INTERESTS

None identified.

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