Ministry for Primary Industries
Manatū Ahu Matua

Update report on the dietary iodine intake of New Zealand children following fortification of bread with iodine

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RJ Hills Laboratories – conducting the analysis of breads and bread products for iodine and sodium.

Dr Terry Ryan (Ryan Analysis Ltd) – for developing the bread survey methodology and undertaking statistical analysis of iodine concentrations of breads.

David Wolf – for completing bread sampling and data entry activities

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1 Executive Summary

Iodine is an essential component of the thyroid hormones which play a key role in the normal growth and development of the human body. Poor intakes of iodine can lead to detrimental health outcomes throughout all life stages and include impaired mental development, congenital abnormalities, hypothyroidism, cretinism and goitre (1, 2).

Studies indicating the prevalence of mild to moderate iodine deficiency in the New Zealand population led to the introduction of mandatory fortification of bread with iodine, through the replacement of salt with iodised salt, in New Zealand in September 2009 (3). Organic and unleavened breads are exempt from mandatory fortification requirements (4).

The median iodine concentration of breads (required to contain iodised salt) for sale during August and September 2012 were in the range of 30.1µg – 45.9µg/100g. Organic and unleavened breads, which are not subject to mandatory fortification requirements, had a median iodine concentration of 1.6 µg/100g.

Modelling of dietary intakes indicate that since the introduction of mandatory fortification, the prevalence of children with inadequate iodine intakes has reduced considerably. The percentage of children with intakes less than the estimated average requirement (EAR) reduced from 95% to 21% when iodine intakes from food only were estimated; and from 7% to <1% when 1g of iodised discretionary salt was included. Less than 1% of children in all age and gender groups were at risk of consuming iodine intakes above the upper level (UL) when 1g of iodised salt was included for each child. It is important to note that the iodine UL for children has been extrapolated from the adult recommendation (5), and a review of the Australia and New Zealand Nutrient Reference Values, including the UL for iodine, is currently underway.

For children 5-14 years of age, the median iodine intake is estimated to be between 93-145µg/day. Of the key food groups (which exclude iodised discretionary salt) bread (45%) is the most significant contributor to iodine intakes of children, followed by milk and dairy products (21%).

The New Zealand Ministry of Health recommendation that *"if using salt, use iodised salt"* remains an important key message if children are to achieve adequate iodine intakes at current bread fortification levels (6).

Future monitoring surveys should take into account the extent of voluntary iodine fortification to ensure a more accurate estimate of the iodine intake from all foods. In addition to this, methods to quantify discretionary salt use should be explored to ensure the contribution of iodine from discretionary salt is adequately captured in intake estimates.

2 Background

Iodine is an essential component of the thyroid hormones. Poor intakes of iodine can lead to detrimental health outcomes throughout all life stages and include impaired mental development, congenital abnormalities, hypothyroidism, cretinism and goitre (1, 2).

Over the past two decades, there have been numerous studies indicating the prevalence of mild to moderate iodine deficiency in the New Zealand population (7-13). In 2005, the Australia New Zealand Food Regulation Ministerial Council noted that mandatory fortification with iodine was an effective public health strategy and requested that FSANZ, as a matter of priority, progress consideration of fortification of the Australia and New Zealand food supply with iodine (3). Following several years of draft standard development and consultation, mandatory fortification of bread with iodine was introduced into New Zealand and Australia in September and October 2009, respectively. At this time, bread manufacturers were required to replace salt used in breadmaking with iodised salt. Breads excluded from this requirement are organic and unleavened breads (4). Figure 1 below summarises the definition of bread and those products impacted by mandatory fortification.

Figure 1. Summary of breads and bread products impacted by mandatory iodine fortification

Bread *means the product made by baking a yeast-leavened dough prepared from one or more cereal flours or meals and water*[1]

Products subject to mandatory iodine fortification:

- all yeast leavened breads
- plain white, white high fibre, wholemeal and multigrain bread loaves, buns and rolls
- yeast-containing flat breads (e.g. pita bread)
- focaccia and pide (Turkish bread)
- bagels (white, wholemeal, sweet)
- topped breads, buns and rolls (e.g. cheese rolls)
- sweet buns (e.g. raspberry and boston buns)
- fruit breads and rolls
- yeast-containing baked English style muffins

Products that do not apply to mandatory iodine fortification:

- organic
- unleavened breads (do not contain yeast)
- unleavened tortillas and flat breads
- pizza bases
- bread crumbs
- pastries
- cakes (including brioche, panettone, stolen)
- biscuits
- crackers
- donuts
- pikelets

Source

Adapted from: The Ministry for Primary Industries. The addition of folic acid and iodised salt to bread. 2012. New Zealand User Guide on Implementing New Zealand Standards. Cited at: http://www.foodsafety.govt.nz/elibrary/industry/Addition_Folic-Manufacturers_Retailers.pdf.

Notes

[1]Food Standards Australia New Zealand (FSANZ). Australia New Zealand Food Standards Code. Standard 2.1.3 Cereals and cereal products 2002

The Ministry for Primary Industries (MPI) measures the performance of its regulatory food program on an on-going basis. Following the introduction of mandatory fortification of bread with iodine, MPI has undertaken to monitor iodine concentrations of the bread supply and, based on the 2002 New Zealand Children's Nutrition Survey (CNS02), estimate the impact on dietary iodine intakes of children 5-14 years of age.

In 2010, MPI (the then Ministry for Agriculture and Forestry) conducted an analytical survey to measure the iodine and sodium[1] concentration of bread following the mandatory fortification of bread with iodine. These results together with the estimated iodine intakes of children 5-14 years of age were published in a 2012 report entitled: *'Dietary iodine intake of New Zealand children following fortification of bread with iodine'* (14). The analytical data collected in this survey was mostly limited to generic leavened breads (e.g. white, wholegrain), organic breads and crumpets, and did not include breads manufactured by private label brands (such as a supermarket's own bread range) or a range of bread products (e.g. hamburger buns and pita breads). This was identified as a limitation of the dietary intake estimated in the previous survey, and a recommendation made to address this in future surveys. It was therefore proposed that a second monitoring survey include a range of these products to ensure that accurate iodine intake estimates be obtained.

This report therefore presents the analytical results of a second iodine fortification monitoring survey as well as updated iodine intake estimates of New Zealand children 5-14 years of age.

The results of the monitoring surveys conducted to-date will be used to inform Ministers and government agencies of any potential risks or benefits to the New Zealand population with current iodine fortification levels and provide appropriate recommendations for managing risks. It is important to note that this work has been undertaken for dietary intake monitoring purposes only, and will not be used for compliance and enforcement purposes.

[1]The sodium concentrations of bread were collected primarily to determine the relationship between the amount of iodised salt added and the iodine concentration of bread. The sodium concentrations of bread types have not been specifically reported in 2010 and in this update report.

3 Aim

The aim of this study was to estimate the impact mandatory fortification of bread with iodine has had on the dietary iodine intakes of New Zealand children 5-14 years of age.

3.1 OBJECTIVES

To measure the mean and median iodine and sodium concentration of a sample of breads and bread products available for sale in New Zealand during 2012[2].

To use the median iodine concentrations of breads and bread products to estimate the proportion of New Zealand children aged 5-14 years with inadequate iodine intakes pre- and post-fortification.

To use the median iodine concentrations of breads and bread products to estimate the proportion of New Zealand children aged 5-14 years with excessive iodine intakes pre- and post-fortification.

To identify the key food contributors to iodine intakes of New Zealand children aged 5-14 years pre- and post-fortification.

To compare and identify changes in bread survey results and dietary iodine intake estimates with that found in 2010.

[2] Only the median iodine concentration has been provided in the results section of this report as these were the values used to estimate iodine intakes.

4 Methodology

4.1 SAMPLING OVERVIEW

It was planned that the iodine and sodium concentration of a representative sample of breads available for sale in New Zealand during 2012 be measured. The representative sample would reflect the current market share of different brands; a range of bread types (such as white, wholemeal and mixed grain breads); and take account of potential batch and regional differences in the manufacture of bread. In addition to this, a non-representative sample of bread products available for sale in 2012 (such as pizza bases, tortillas and hamburger buns) were planned to be analysed for iodine and sodium. Market share data was not available for these bread products, however it was aimed that multiple batches of prominent brands from different regions be sampled. Details on the sampling plan are provided in more detail below.

4.2 SAMPLING FRAME

Three sampling frames were devised, one for breads (based on 2011 brand market share data), one for private label breads one for bread products.

For breads, a random stratified approach with strata based on 2011 brand market share data from Synovate Aztec was used. Breads were sorted by bread type, annual production and categorised as ‘high’, ‘medium’, or ‘low’ market share. A sampling plan was devised with the aim of obtaining a higher proportion of high market share breads (except for fibre white breads where there were more low market share breads) (refer to Table 1).

This data source did not include ‘private label’ brands such as a supermarket’s own bread range or other bread products such as pizza bases and tortillas. Two further sampling frames were developed to include private label breads and bread products (refer to Tables 2 and 3). For the private label breads, there were a higher number expected to be sampled in Christchurch compared to Wellington as there was one brand of bread predominantly available for sale in the South Island.

All breads and bread products were to be purchased over six sampling weeks (during August and September 2012) in two New Zealand regions: Wellington and Christchurch. Samples were to be collected in Wellington in the 1st, 3rd and 5th weeks, and in Christchurch in the 2nd, 4th, and 6th weeks. One bread sampler was contracted to complete all six sampling rounds. Sampling commenced the week of 20 August 2012 with the final week commencing 24 September 2012. In total, 438 breads and bread products were expected to be collected; 213 from Wellington and 225 from Christchurch. Table 4 below outlines the full sampling schedule.

The bread sampler was provided with a detailed sampling protocol of the breads and bread products to be collected. The breads that were ranked in to high, medium and low (from Table 1) were randomised three different times and provided in three unique lists. Each of the three lists were used for each of the different region visits (i.e. one list was used for weeks one and two in Wellington and Christchurch respectively). The bread sampler was required to work through the list of high, medium and low market share breads until the required number of breads was obtained; these could be purchased at any of the retail outlets. Where a bread on the list could not be located, the sampler was asked to purchase the most similar product using guidance provided in the sampling protocol. The bread sampler was required to package and send breads to the contracted laboratory for analysis on the day of collection.

Table 1: Sampling frame for breads[1]

Bread category	No. of breads by market share						Total number of bread samples
	High		Medium		Low		
	Wellington	Christchurch	Wellington	Christchurch	Wellington	Christchurch	
Fibre white	3	3	1	1	2	2	36
Fruited	3	3	2	2	1	1	36
Mixed grain	2	2	1	1	1	1	24
Rye	3	3	1	1	1	1	30
White	2	2	1	1	1	1	24
Wholemeal	2	2	1	1	1	1	24
Organic	3	3	2	2	1	1	36
Total per week (Total over 6 week sampling period)	18 (54)	18 (54)	9 (27)	9 (27)	8 (24)	8 (24)	210

Notes
[1]Excluding private label brands

Table 2: Sampling frame for private label breads[1]

Bread category	No. of samples per week		Total no. of samples
	Wellington	Christchurch	
Fibre white	0	0	0
Fruited	0	1	3
Mixed grain	4	5	27
Rye	1	1	6
White	5	6	33
Wholemeal	4	5	27
Organic	0	0	0
Total per week (Total over 6 week sampling period)	14 (42)	18 (54)	96

Notes
[1]Does not include all private label brands, only those identified through a supermarket and a limited internet search

Table 3: Sampling frame for bread products

Bread product category	No. of samples per week		Total no. of samples
	Wellington	Christchurch	
Bread rolls plain	3	3	18
English muffins	3	3	18
Hamburger buns	4	4	24
Pita breads plain	4	4	24
Pizza bases	4	4	24
Tortillas/ flat breads	4	4	24
Total per week (Total over 6 week sampling period)	22 (66)	22 (66)	132

Table 4: Bread and bread product sampling schedule

Region	Wellington			Christchurch			
Week	No. of breads[1]	No. of private label breads	No. of bread products	No. of breads[1]	No. of private label breads	No. of bread products	Total
1	35	14	22	0	0	0	71
2	0	0	0	35	18	22	75
3	35	14	22	0	0	0	71
4	0	0	0	35	18	22	75
5	35	14	22	0	0	0	71
6	0	0	0	35	18	22	75
Total	105	42	66	105	54	66	438

Notes
[1]Excluding private label brands

4.3 LABORATORY METHODOLOGY

RJ Hill Laboratories Ltd (Hill Laboratories) were contracted to analyse breads for iodine and sodium. All analyses were performed at Hill Laboratories – Food & Bioanalytical Division, Waikato Innovation Park, Ruakura Lane, Hamilton. Hill Laboratories are an accredited laboratory under International Accreditation New Zealand (IANZ) although not specifically for these analytes and matrix.

Breads were delivered by courier to Hill Laboratories. Bread loaves were analysed as received. Three slices of bread were randomly selected from the bread package, homogenised and stored in the freezer at -18 ºC until required. Remaining bread was discarded. The samples were thawed for analysis and were ground or crushed to form ground sample fraction before analysing for iodine and sodium.

Iodine analysis included tetramethylammonium hydroxide (TMAH) micro digestion, at 90ºC for 1 hour, with filtration, followed by analysis using inductively coupled plasma – mass spectrometry (ICP-MS) (15).The limit of detection (LOD) was reported as 0.010 milligrams per kilogram (mg/kg). One iodine analysis per composite bread sample was completed. Results were reported on an as received basis.

Sodium analysis involved nitric and hydrochloric acid micro digestions, at 85ºC for 1 hour, followed by analysis using inductively coupled plasma – optical emission spectroscopy (ICP-OES)[3]. The LOD was reported as 0.005 grams per 100 grams (g/100g). One sodium analysis per composite bread sample was completed. Results were reported on an as received basis.

[3] In-house method based on the principles of APHA "Standard Methods for the Examination of Water and Wastewater" (22nd Edition), Methods 3030Fa and 3125.

4.4 DIETARY MODELLING OF NUTRITIONAL DATA

4.4.1 DIAMOND data sources

The Food Standards Australia New Zealand (FSANZ) Dietary Modelling of Nutritional Data (DIAMOND) computer program was used to conduct the dietary intake estimates of children 5-14 years of age. The data sources used in DIAMOND included the food consumption data from the CNS02 and food composition data from two key sources: the 2006 New Zealand Food Composition Database (NZFCD) and 2003/04 New Zealand Total Diet Survey (NZTDS).

The CNS02 is a cross sectional population survey which collected information on the food and nutrient intakes, eating patterns, and anthropometric and clinical measures of New Zealand children during 2002. This survey collected data on 3275 children aged 5- 14 years of age with over-sampling of Maori and Pacific Island children to enable sub-group analysis. The 24-hour recall method was used to collect information on all food and drink consumed over a 24-hour period. This method was repeated on a second day in a sub-sample of the surveyed population in order to estimate usual nutrient intakes (10).

The NZFCD contains iodine concentrations which are a combination of analytical values, borrowed values and product label data. The data collected in the 2003/04 NZTDS are analytical values. Iodine concentrations from both data sources were used to provide the most accurate and up-to-date iodine concentrations to estimate iodine intakes.

4.4.2 Determining pre- and post- fortification iodine intakes in DIAMOND

In order to estimate iodine intakes pre-fortification of bread with iodine, all foods (including bread) consumed in the CNS02 were attributed an iodine concentration based on the 2006 NZFCD and 2003/04 NZTDS data.

To estimate iodine intakes post-fortification all foods (excluding bread) were attributed an iodine concentration based on the 2006 NZFCD and 2003/04 NZTDS data as above, however specific products consumed in the CNS02 were attributed a median iodine concentration based on the data collected in this survey (discussed more below). There were a number of specific products, such as crumpets, collected in the 2010 survey (14) that were not collected in this survey. For those products, the iodine concentration from the 2010 survey was used.

4.4.3 Bread matching

The breads and bread products collected in the analytical survey were categorised into 14 broad groups (fibre white; fruited bread; mixed grain; rye; white; wholemeal; organic and unleavened; rolls, white; rolls, mixed grain; English muffins; hamburger buns; pita breads; pizza bases; and tortillas/ flat breads). Each was attributed a unique bread code (e.g. white bread = B1, fibre white = B2, wholemeal = B3 etc). Where possible, specific bread descriptors reported in the CNS02 were matched with breads collected in the analytical survey and a unique bread code applied to that bread (for example, Johnny's Rye bread reported in the CNS02 and collected in the analytical survey might have the code B77). In addition to the 14 broad groupings above, there were a further 62 product matches, totalling 76 unique codes. All bread and bread products consumed in the CNS02 were attributed one of the 76 codes.

4.4.4 Calculating mean and median iodine concentrations for bread codes

From the raw data set, any analytical values identified as outliers were included if the value was considered to be accurate after cross checking with the laboratory. Both the mean and median iodine concentration was derived for each of the 76 unique codes taking into account each analytical value obtained. Due to a skew in the data, each bread type consumed in the CNS02 was assigned the median iodine concentration.

4.4.5 Foods that contain bread as an ingredient

There are a number of foods in the CNS02 data set that contain bread or bread products as an ingredient in a recipe. In order to obtain accurate dietary intakes estimates, the unique bread codes were mapped to recipes in the CNS02 data set as necessary. For example, for a ham sandwich that contains 50% bread and 50% ham, the iodine concentration for white bread code B1 was attributed to the food at a rate of 50%.

4.4.6 Moisture retention factor

A toasted bread factor of 1.1 was applied to the median iodine concentrations of all breads consumed in the CNS02 that were reported as 'toasted'. Multiplying toasted breads by a factor of 1.1 takes account of the moisture loss through toasting, increasing the mean iodine concentration of toasted bread by 10%.

Although the description of the moisture retention methodology above is correct, a minor error was identified in the calculation of the hydrations at baseline from the 2012 report (14). The issue has been resolved in this survey and, given the minor nature of the issue, has not impacted significantly (a difference of 1µg in some cases) on the rounded baseline mean iodine intakes reported in 2012 and this report. This error is unlikely to have significantly impacted on the post-fortification mean iodine intakes in this report.

4.4.7 Dietary models

Two models were run in the DIAMOND computer program to estimate the mean iodine intake of children following mandatory iodine fortification both with and without the use of iodised discretionary salt. One model included iodine intakes from food only and the other included iodine intakes from food plus iodised discretionary salt. These are summarised in Table 5 below.

Table 5: Summary of iodine intake models

Model	Description
Food only	In this model it was assumed that none of the respondents in the CNS02[1] consumed discretionary iodised salt. Therefore no discretionary iodised salt was added to the total intake of iodine consumed from food.
Food plus iodised discretionary salt	In this model it was assumed that all of the respondents in the CNS02[1] consumed discretionary iodised salt. Therefore for all respondents, 1g of iodised salt with an iodine concentration of 48 micrograms (µg) was added to the total iodine intake consumed from food.

Notes
[1]CNS02 = 2002 New Zealand Children's Nutrition Survey

Where discretionary iodised salt use was modelled, 1g of iodised salt (at an iodine concentration of 48µg) was used. The iodine concentration was based on a 2009 report on the level of iodine in retail salt (16). One gram of discretionary salt per day was chosen to be consistent with dietary modelling fortification scenarios, conducted by the Life In New Zealand (LINZ) Research Group at the University of Otago, and due to the lack of more recent data (3).

5 Results

5.1 IODINE CONCENTRATIONS OF BREAD

A total of 428 breads and bread products were collected and analysed for iodine and sodium content. Of all of the breads and bread products, 30 unique brands and 118 unique types[4] were sampled. All of these products were grouped into 14 categories: fibre white; fruited bread; mixed grain; rye; white; wholemeal; organic and unleavened; rolls, white; rolls, mixed grain; English muffins; hamburger buns; pita breads; pizza bases; and tortillas/ flat breads. Due to a number of brands not being available at the time of purchase, the sample size of each bread and bread product category differs from that originally proposed. Overall, 10 less breads and bread products were sampled. The median iodine concentrations are provided in Table 6.

Table 6: Median iodine concentrations (µg/100g and per serving) by bread and bread product category

Bread and bread product category[1]	n	Median iodine (µg/100g bread (95% CIs))	Median iodine (µg/ serving)	Estimated serving size (g)[2]
Fibre white	30	49.3 (36.6, 51.4)	14.8 - 22.2	30 - 45
Fruited	31	30.1 (28.6, 33.9)	9.0 - 13.5	30 - 45
Mixed grain	45	40.0 (36.6, 44.8)	12.0 - 18.0	30 - 45
Rye	26	32.9 (27.2, 38.5)	9.9 - 14.8	30 - 45
White	51	41.3 (37.4, 45.3)	12.4 - 18.6	30 - 45
Wholemeal	48	38.8 (35.1, 44.9)	11.7 - 17.5	30 - 45
Organic and unleavened[3]	48	1.6 (1.47, 2.05)	0.5 - 0.7	30 - 45
Bread rolls, white	27	53.5 (27.5, 59.1)	26.2	49
Bread rolls, mixed grain	6	41.1 (34.2, 86.1)	21.8	53
English style muffins	18	43.9 (37.8, 48.6)	35.1	80
Hamburger buns	27	51.1 (46.2, 59.9)	25.0	49
Pita breads	24	27.7 (25.7, 31.0)	22.7	82
Pizza bases[3]	24	0.5 (0.5, 7.9)	1.0	201
Tortillas/ flat breads, plain[3]	23	34.7 (27.2, 40.9)	27.8	80
Total	428			

Notes
1 Where an iodine concentration was found to be below the limit of detection, i.e. <0.01mg/kg, one half the limit of detection value was used (0.005mg/kg or 0.5µg/100g).
2 Sourced from the Concise New Zealand Food Composition Tables 7th ed. 2006
3 Organic breads and unleavened bread, pizza bases and tortillas are exempt from mandatory fortification requirements.

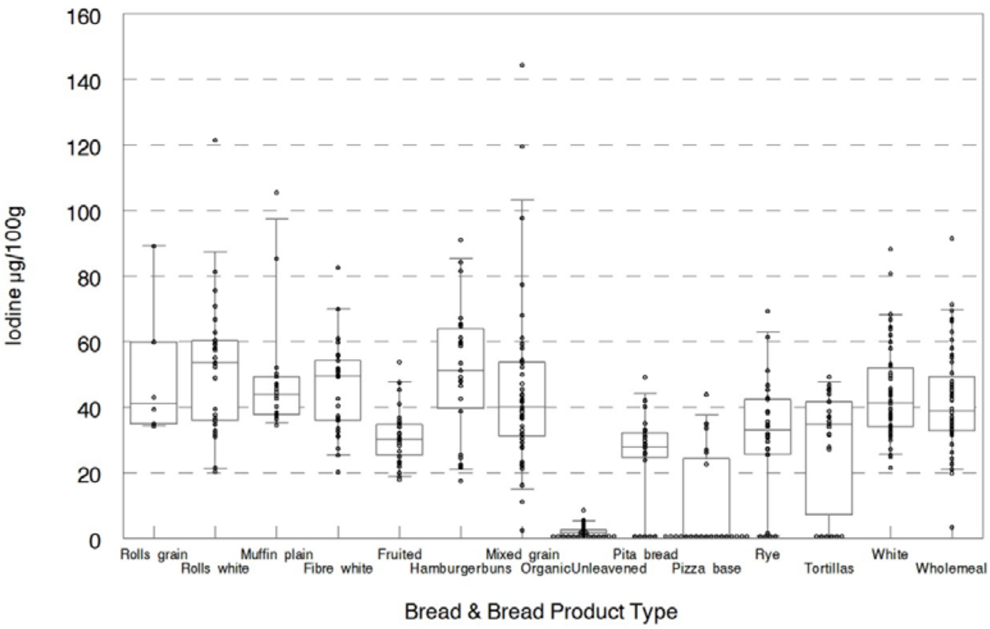
4 Products classified as one unique type included those of the same brand with the same descriptor, but may have been in different package or slice sizes. For example, sandwich and toast versions of the same bread were classified as one unique type; bread products in different sizes (12 or 8 pack) were counted as one type; and long rolls and standard rolls of the same brand and formulation were also classified as one type.

The median iodine concentrations of breads that are expected to meet mandatory fortification requirements (fibre white, fruited, mixed grain, rye, white and wholemeal) ranged between 30.1µg – 49.3µg/100g. In contrast, the median iodine concentration of organic and unleavened breads, pizza bases and tortillas/ flat breads, which are not required to meet mandatory fortification requirements were 1.6 µg, 0.5µg and 34.7 µg/100g, respectively. Of the breads and bread products required to be fortified, bread rolls (white), hamburger buns and fibre white bread and were found to have the highest median iodine concentrations of 53.5 µg/100g, 51.1µg/100g and 49.3 µg/100g respectively.

Per serving of bread (30-45g) (excluding organic and unleavened breads), the median iodine concentration was between 9.0 (fruited) and 22.2 µg (fibre white). Of the bread products, English muffins provided the highest median iodine concentration per weight-based serving (35.1µg per 80g serve).

The box plot provided in Figure 2 illustrates the range of iodine concentrations within and between bread and bread product categories. Of the breads expected to meet mandatory fortification requirements, fruit bread had the lowest and most narrow range in iodine concentration (17.9 – 53.7µg /100g), and mixed grain breads had the widest range (2.4 - 144.2µg/100g).

Figure 2: Box plots of iodine concentrations (µg/100g) by bread and bread-type product[1]

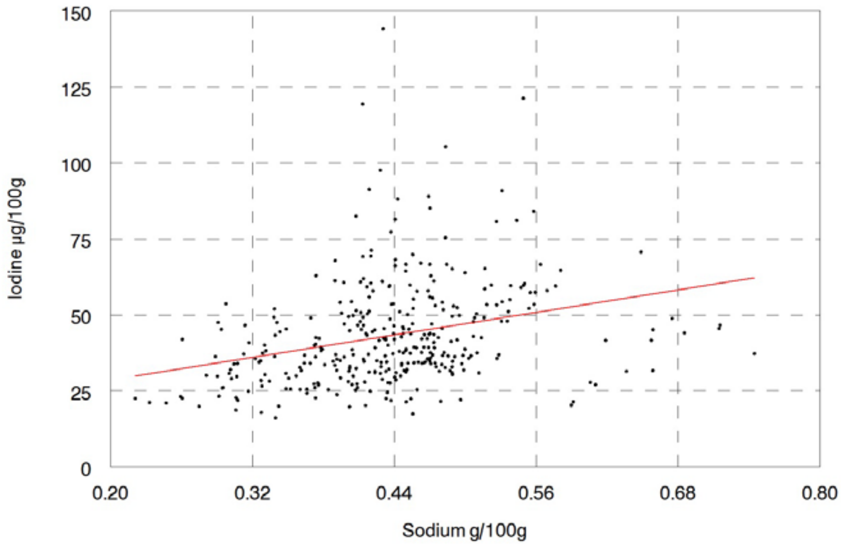


Notes

[1] The boundary of the box closest to zero indicates the 25th percentile, the line within the box marks the median, and the boundary of the box farthest from zero indicates the 75th percentile. Extremes of the whiskers at the top and bottom of the box indicate the 10th and 90th percentiles. Identified outliers are at the top and bottom of the 10th and 90th percentiles.

The scatter plot in Figure 3 shows that there is a weak to moderate positive correlation between iodine and sodium in bread (Pearson correlation =0.29). The regression equation is y = 16.28 + 61.57x, with the coefficient of determination = 0.09.

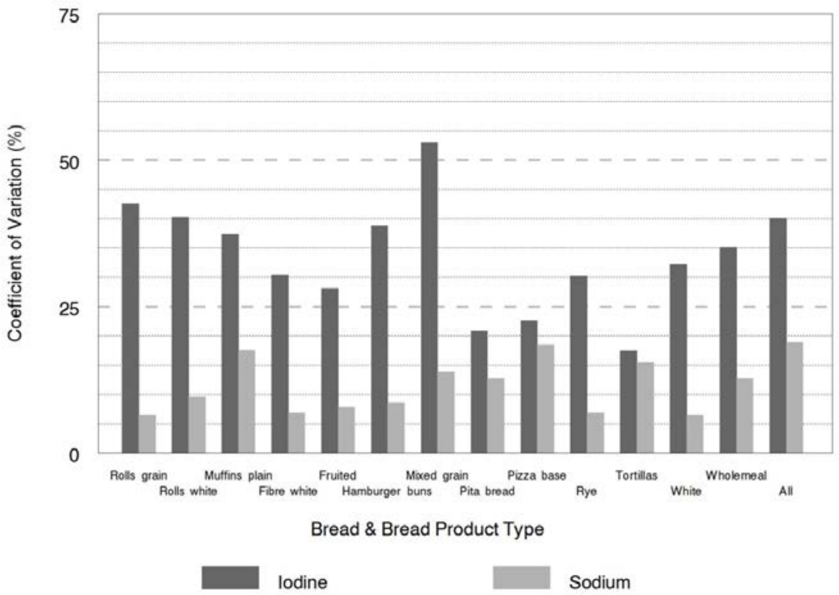
Figure 3: Scatter-plot and regression line for iodine (µg/100g) versus sodium (g/100g) concentrations in bread[1]



Notes
[1]Scatter plot of the iodine versus sodium concentration where iodine is equal to or greater than 12 µg/100g

Figure 4 below shows the difference of co-efficient of variation between iodine and sodium. The co-efficient of variation describes the standard deviation as a percentage of the sample mean. This graph shows there was greater variation in iodine (40%) compared to sodium (19%) concentrations for all bread types.

Figure 4: Graph of the percentage of co-efficient of variation for sodium and iodine concentrations in bread



5.2 ESTIMATED DIETARY IODINE INTAKE OF CHILDREN 5-14 YEARS OF AGE

Table 7 below provides the estimated mean, 5th and 95th percentile iodine intakes of children from food only at baseline and post-fortification for different age and gender groups. The 5th and 95th percentile illustrates the iodine intake for low and high consumers respectively. This model best reflects the change in iodine intakes from the replacement of non-iodised salt with iodised salt in bread.

Table 7: Estimated mean iodine intakes (µg/day) of children from food only at baseline and post-fortification

Age group (yrs)	Gender	n[1]	Mean iodine intakes (5th, 95th percentile) µg/day	
			Baseline	Post-fortification
5-8 yrs	Males	663	47 (24, 73)	89 (70, 106)
	Females	622	39 (28, 50)	83 (43, 126)
	All	1286	43 (26, 65)	86 (51, 115)
9-13 yrs	Males	857	51 (24, 85)	106 (58, 172)
	Females	818	41 (23, 63)	85 (51, 120)
	All	1675	46 (23, 76)	96 (52, 152)
14 yrs	Males	163	59 (25, 96)	125 (53, 194)
	Females	152	42 (23, 69)	86 (55, 116)
	All	314	51 (23, 95)	106 (55, 175)
5-14 yrs	Males	1683	50 (24, 83)	101 (62, 163)
	Females	1592	40 (24, 60)	84 (48, 122)
	All	3275	45 (54, 75)	93 (52, 144)

Notes
[1]Totals may not add up exactly due to rounding of population weighting applied to the CNS02 survey data.

Estimated mean iodine intakes from food only for all children 5-14 years of age increased from 45µg/day to 93µg/ day post-fortification of bread with iodine. For all males and all females aged 5-14 years of age, estimated mean iodine intakes were 101µg/day and 93µg/ day respectively. Males have a higher iodine intake from food compared to females across all age groups.

Table 8 provides the mean, 5th and 95th percentile estimated iodine intakes from food plus iodised discretionary salt at baseline and post-fortification for different age and gender groups. This model assumes that all survey respondents consume 1g of iodised discretionary salt (containing 48µg of iodine).

Table 8: Estimated mean iodine intakes (µg/day) of children from food plus iodised discretionary salt* at baseline and post-fortification

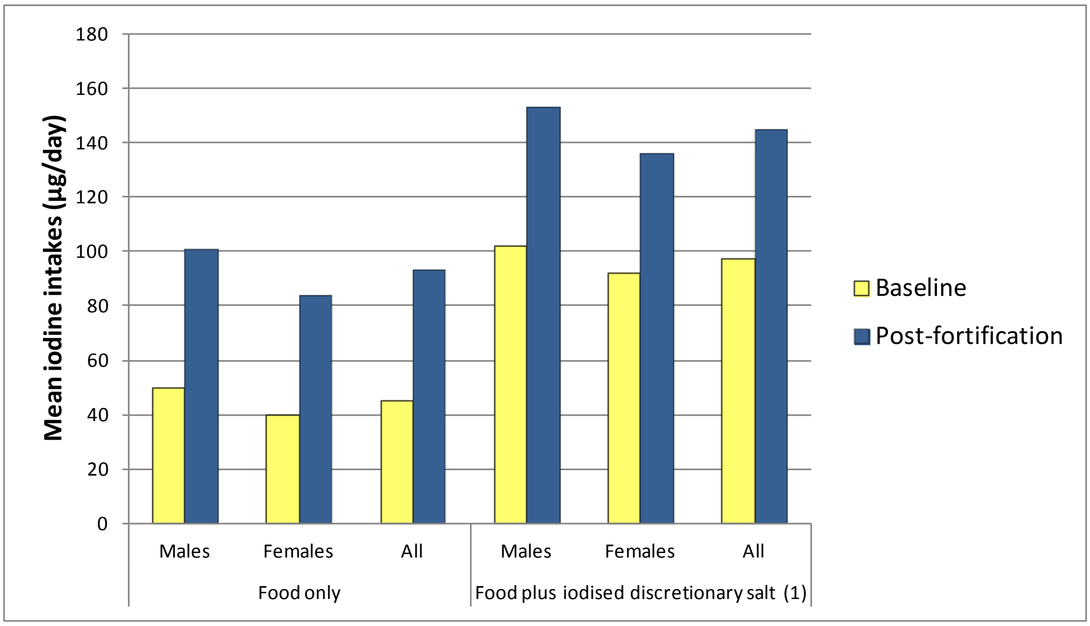
Age group (yrs)	Gender	n[1]	Mean iodine intakes (5th, 95th percentile) µg/day	
			Baseline	Post-fortification[2]
5-8 yrs	Males	663	97 (78, 122)	142 (120, 165)
	Females	622	90 (80, 103)	133 (95, 179)
	All	1286	94 (79, 115)	138 (102, 171)
9-13 yrs	Males	857	102 (74, 143)	158 (109, 228)
	Females	818	93 (76, 116)	137 (104, 176)
	All	1675	98 (75, 132)	148 (105, 207)
14 yrs	Males	163	112 (74, 159)	178 (105, 252)
	Females	152	94 (76, 123)	138 (109, 171)
	All	314	103 (76, 157)	159 (109, 232)
5-14 yrs	Males	1683	102 (75, 138)	153 (114, 219)
	Females	1592	92 (77, 113)	136 (100, 176)
	All	3275	97 (76, 129)	145 (105, 199)

Notes
1 Totals may not add up exactly due to rounding of population weighting applied to the CNS02 survey data
2 Includes 1g discretionary iodised salt (48µg iodine) for each respondent

When 48µg of iodine from 1g of iodised discretionary salt was added to the model, the estimated mean iodine intakes of children 5-14 years of age increased from 97µg/day to 145µg/ day post-fortification. For all males and all females aged 5-14 years of age, estimated mean iodine intakes were 153µg/day and 136µg/day respectively. Of the age groups, children 14 years of age had the highest dietary iodine intake of 159µg/day (178µg/day for males and 138µg/day for females).

Figure 5 below illustrates the variation in mean iodine intakes for all children 5-14 years of age at baseline and post-fortification for the two models. Mean iodine intakes have improved post fortification regardless of whether iodised discretionary salt was added or not.

Figure 5: Comparison of mean iodine intakes (µg/day) of children 5 – 14 years of age from food only or food plus iodised discretionary salt



Notes
[1]Includes 1g discretionary iodised salt (48µg iodine) for each respondent

5.3 ASSESSMENT OF DIETARY INTAKES AGAINST NUTRIENT REFERENCE VALUES

The percentage of the population with usual intakes below the estimated average requirement (EAR) reflects the prevalence of inadequate dietary intakes. The EAR is defined as *"a daily nutrient level estimated to meet the requirements of half the healthy individuals in a particular life stage and gender group"* (5). Table 9 presents the prevalence of inadequate intakes in the population at baseline and post fortification.

Table 9: Percentage of children with estimated mean iodine intakes less than the Estimated Average Requirement (EAR) from food only or food plus iodised discretionary salt

Age group (yrs)	Gender	n[1]	EAR (µg/day)	Food only		[2]Food plus iodised discretionary salt	
				Baseline[3] (%)	Post-fortification[4] (%)	Baseline[3] (%)	Post-fortification[4] (%)
5-8 yrs	Males	663		90	3	0	0
	Females	622	65	100	26	0	0
	All	1286		95	14	0	0
9-13 yrs	Males	857		90	14	6	0
	Females	818	75	99	29	4	0
	All	1675		94	21	5	0
14 yrs	Males	163		92	23	29	<1
	Females	152	95	98	78	67	0
	All	314		95	49	48	<1
5-14 yrs	Males	1683		90	10	6	<1
	Females	1592	*	99	32	8	0
	All	3275		95	21	7	<1

Notes
1 Totals may not add up exactly due to rounding of population weighting applied to the CNS02 survey data
2 Includes 1g discretionary iodised salt (48µg iodine) for each respondent
3 Percent < EAR at baseline
4 Percent < EAR post-fortification

Symbols
*EARs as per age group above

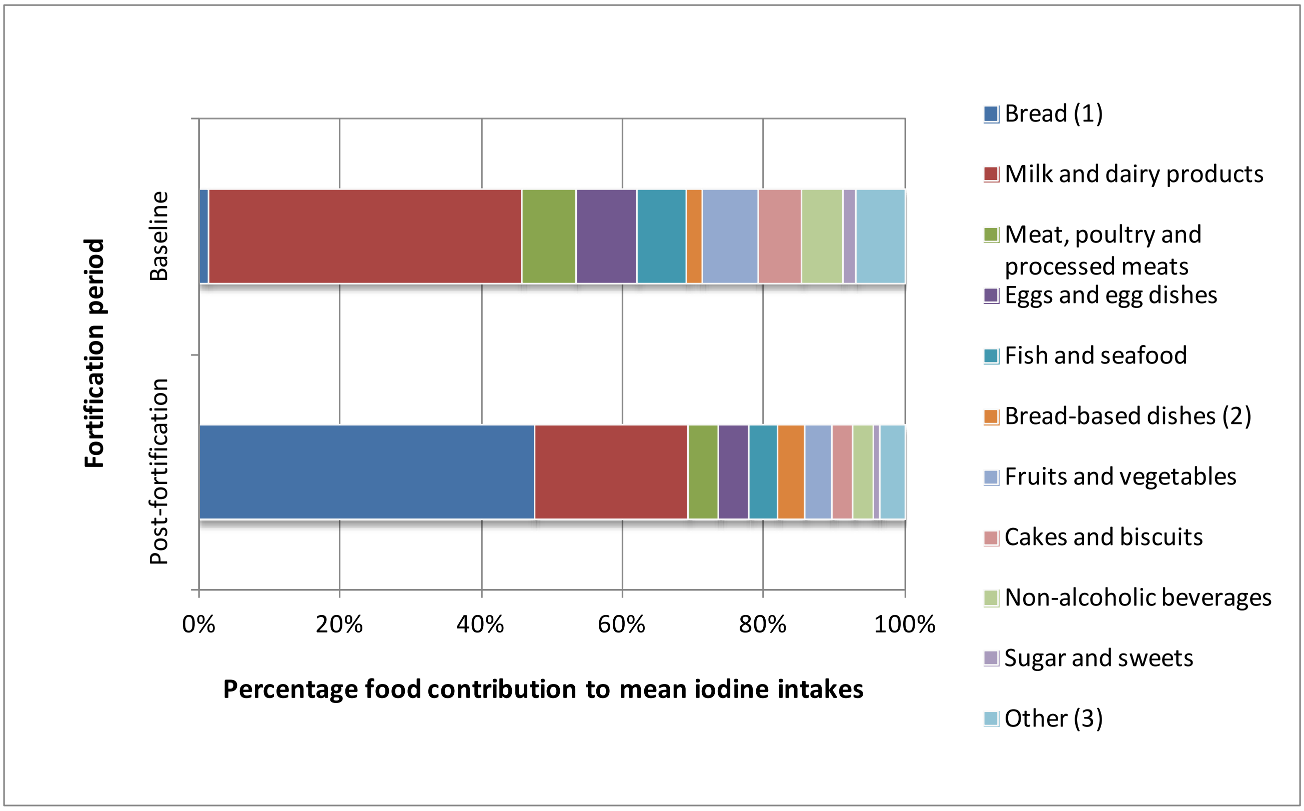
In the model which included iodine intakes from food only, the percentage of all children with iodine intakes less than the EAR reduced from 95% (90% male and 99% females) at baseline to 21% (10% male and 32% female) post-fortification. Across the age and gender groups, females 14 years of age improved the least with iodine intakes less than the EAR reducing from 98% to 78% post-fortification. The greatest improvement was in 5-8 year old males where iodine intakes less than the EAR reduced from 90% to 3% post-fortification.

When all respondents were assumed to use 1g of iodised discretionary salt per day (48µg iodine), the percentage of children with mean iodine intakes less than the EAR reduced from 7% to <1% post-fortification. The greatest improvement was in female children 14 years of age where the percentage of children with iodine intakes less than the EAR reduced from 67% to 0% post-fortification.

The Upper Level of Intake (UL) is used to estimate the percentage of the population at risk of adverse effects from excessive nutrient intakes (5). Although not presented here, no children had iodine intakes above the UL at baseline or post-fortification from food only. When iodised discretionary salt was included, <1% of children in all age and gender groups had iodine intakes above UL at baseline and post-fortification.

Figure 6 illustrates which foods are key contributors to mean iodine intakes at baseline and post-fortification.

Figure 6: Percentage contribution of main food groups to mean iodine intakes of children 5-14 years old at baseline and post-fortification



Notes
[1] Bread = bread, rolls, pita bread, tortillas, pizza bases, specialty breads, bagels, English muffins, crumpets and fruit buns
[2] Bread-based dishes = sandwiches, filled rolls, filled pita breads and wraps, burgers, hot dogs and ready to eat pizzas
[3] Other = puddings/ desserts; pies and pasties; nuts and seeds; soups and stocks; savoury sauces and condiments; breakfast cereals; snack bars and snack foods; dietary supplements; butter, margarines, fats and oils; and alcoholic beverages

At baseline, milk and dairy products (40%), grains and pasta (9%), egg and egg dishes (8%), poultry and processed meats (7%) fruit and vegetables (7%), meat and fish and seafood (6%) were among the key contributors to mean iodine intakes. Following fortification of bread with iodine, the top five main food contributors were bread (45%), milk and dairy products (21%), grains and pasta (5%), meat, poultry and processed meats (4%) and egg and egg dishes (4%). Bread and bread-based dishes provided 1.9% of iodine intakes at baseline compared to 3.6% at post-fortification.

The first 11 categories in Figure 6 (bread; milk and dairy products; grains and pasta, meat, poultry and processed meats; egg and egg dishes; fish and seafood; bread-based dishes; fruits and vegetables, cakes and biscuits; non-alcoholic beverages; and sugar and sweets) represent approximately 94% and 97% of all foods at baseline and post-fortification respectively.

6 Discussion

In September 2009, mandatory fortification of bread with iodine was introduced to address the re-emergence of mild iodine deficiency in New Zealand (3). The introduction of mandatory fortification required bread manufacturers to replace salt used in breadmaking with iodised salt (at a concentration of between 25 and 65mg of iodine/kg of salt) (4, 17). Organic and unleavened breads were exempt from mandatory fortification requirements (4).

In 2010, MPI (formerly the Ministry for Agriculture and Forestry) conducted an analytical survey to measure the iodine and sodium concentration of bread following introduction of mandatory fortification. This data was used to estimate the iodine intake of New Zealand children 5-14 years of age and reported in 2012 (14).

The aim of this study was to conduct a follow up analytical survey of breads and bread products for sale in New Zealand and to re-estimate the iodine intakes of New Zealand children 5-14 years of age.

6.1 IODINE CONCENTRATIONS OF BREAD

The survey results indicate that breads and bread products available for sale in New Zealand are consistently being fortified with iodine through the replacement of salt with iodised salt. The median iodine concentration of breads required to meet mandatory fortification requirements (fibre white, fruited, mixed grain, rye, white and wholemeal) were in the range of 30.1µg – 45.9µg/100g. These concentrations were similar to that found in the 2010 survey: 29.0µg – 49.0µg/100g. Of these breads, fruited bread provided the least iodine both in this survey (30.1µg/100g) and in 2010 (29.0µg/100g). This is likely due to a different recipe formulation and the addition of fruit reducing the proportion of salt per 100g of bread. Fibre white bread provided the highest median iodine concentration both in this study (49.3µg/100g) and in 2010 (48.5 µg/100g). Organic and unleavened breads, which are not subject to mandatory fortification requirements, had a low median (95% CI) iodine concentration of 1.6 (1.5, 2.1) µg/100g, as was expected.

Those bread products also subject to mandatory fortification requirements include bread rolls, English styled muffins, hamburger buns and pita breads. White bread rolls had a higher median (95% CI) iodine concentration compared to mixed grain bread rolls; 53.5 (27.5, 59.1) µg/100g and 41.1 (34.2, 86.1) µg/100g respectively. This difference is likely due to the higher proportion of grain reducing the overall iodine concentration of mixed grain bread rolls. Pita breads had a lower iodine concentration per 100g compared to the other bread products, which is also likely due to the unique recipe formulation.

Tortilla and flat breads, which are not subject to mandatory fortification requirements, had a similar median iodine concentration (34.7 (27.2, 40.9) µg/100g) to that of fortified breads. This finding highlights that communication regarding the mandatory fortification standards may not be clear, or that manufacturers are voluntarily opting to fortify these products. An analysis of pizza bases also found some evidence of iodised salt use with the median (95% CI) iodine concentration of 0.5 (0.5, 7.9) µg/100g.

The range of iodine concentrations across all bread types is confirmed by the large co-efficient of variation of 40%. The range of sodium concentrations across all bread types was much narrower with a co-efficient of variation of 19%. These results are slightly different to that reported in 2010 (49.4% for iodine and 14.1% for sodium) as those bread products which have been voluntarily fortified have also been included. Some of the variation in iodine concentrations observed in this survey and between surveys can be explained by the varying amount of salt, and therefore iodine, being added by bread manufacturers. Furthermore, iodised salt for use in bread is required to contain iodine at a concentration between 25-65 mg per kg salt, although salt manufacturers are encouraged to aim for the midpoint of the fortification range at 45mg per kg salt (17). Other factors that have been reported to influence the iodine concentration of foods include uneven distribution of iodine in bags of salt due to insufficient mixing or iodine particle size and environmental and storage conditions (22).

Given that iodised salt is added to most bread, one would expect iodine and sodium concentrations of bread to be strongly correlated. For those breads identified to be fortified with iodine, a weak to moderate, but positive relationship was found between iodine and sodium concentrations (Pearson correlation = 0.290, $p<0.01$). This is comparable to that found in 2010 (Pearson correlation =0.289, $p<0.01$). The likely attributable factors include an uneven distribution of iodine in bags of salt before addition to the breadmaking process and/or the range of iodine concentrations permitted in the manufacture of iodised salt. It is unlikely that the lack of strong correlation is due to the addition of sodium from other sources permitted to be added to bread such as food additives or processing aids, which provide an overall minimal contribution to sodium concentrations (3).

6.2 ESTIMATED IODINE INTAKES

Both the baseline and post-fortification mean iodine intakes were calculated using the second day adjustment method in the DIAMOND computer program. The second-day adjustment method provides a better estimate of usual intakes compared to using single day iodine intake data only (18).

The estimated mean iodine intakes for all children 5-14 years of age from food only increased from 45µg/day at baseline to 93µg/day post fortification of bread with iodine. Compared to the 2012 report, the mean iodine intake has reduced by 4µg/day (14). This small change is most likely due to actual instead of estimated[5] iodine concentrations of bread products being used. Although an issue with hydration factors was identified in the 2012 report and subsequently resolved, this is unlikely to have had an impact given that the baseline iodine intake for all children 5-14 years of age has not changed.

The estimated mean iodine intakes for all children 5-14 years of age from food plus iodised discretionary salt increased from 97µg/day at baseline to 145µg/day post fortification. Similar to the food only model, intakes at post fortification were 4µg/day less in this study compared with 2012. This change is primarily reflective of actual iodine concentrations of some bread products being included in the dietary intake estimates.

Post-fortification iodine intakes of 93 Dunedin children 10-13 years of age were estimated by Rose and colleagues (10) prior to the implementation of mandatory fortification. It was predicted that iodine intakes would increase from a baseline of 54µg/day (estimated from the urinary iodine concentration) to 75-104µg/day post-fortification (an increase of 21-50 µg/day). The range of post-fortification iodine intakes is slightly lower than that of children 9-13 years of age in our study (96 – 148 µg/day). It is important to note that in the study by

[5] In the previous report, bread products such as hamburger buns and pita bread that were consumed in the CNS02 were attributed an iodine concentration based on white bread.

Rose and colleagues, the estimated iodine concentration of bread was based on the premise that 90% sodium in bread comes from salt and that salt manufacturers would aim for the mid fortification range of 45mg iodine per kg salt (10, 17). In the 2008 proposal to consider mandatory fortification in New Zealand, FSANZ reported that estimated iodine intakes would be 106µg for 5-8 year olds, 119µg for 9-13 year olds and 137µg for 14 year olds at post-fortification (3). Although these estimates did not take into account second-day adjusted data, they were within the range of the iodine estimates found in this study (86-138µg for 5-8 year olds, 96 – 148µg for 9-13 year olds and 106-159µg for 14 year olds).

6.3 IODINE INTAKES IN RELATION TO THE EAR AND UL

The percentage of a population with estimated iodine intakes below the EAR provides information on the prevalence of inadequate iodine intakes. For children 5-8, 9-13 and 14 years of age, the EARs are 65, 75 and 95µg/day respectively. In contrast, the percentage of a population with estimated iodine intakes above the UL estimates the percentage of the population at potential risk of adverse effects from excess iodine intakes. For children 5-8, 9-13 and 14 years of age, the ULs are 300, 600 and 900µg/day respectively(5).

In this study, the percentage of children with mean iodine intakes less than the EAR reduced considerably across all age groups post-fortification of bread with iodine when iodised discretionary salt was, and was not, included. Using the model that included iodine intakes from food only, the percentage of all children below the EAR reduced from 95% to 21% post fortification. In 2010, the percentage of all children below the EAR was 18% at post fortification, 3% lower than in this study. This change reflects the small decrease in the mean iodine intake of 4µg/day and, as discussed in the previous section, is likely due to using actual instead of estimated iodine concentrations for bread products in the dietary intake estimates. In the iodised discretionary salt model, that included 48µg iodine (from 1g of iodised salt) for all children, the percentage of children below the EAR reduced from 7% at baseline to <1% post-fortification. This result is consistent with that found in 2010[6], despite the updated bread and bread product iodine concentration data.

As depicted in the food only model, mandatory fortification of bread with iodine alone has had a significant impact on the estimated iodine intake of New Zealand children 5-14 years of age. It is still of concern however that 78% of females 14 years of age have iodine intakes below EAR when iodised discretionary salt is not taken into account. Compared to other sub-population groups, the difference is partially reflected by the higher EAR for this age group (95µg/day).

Based on the model that includes iodised discretionary salt, it is clear that the voluntary use of iodised salt in cooking or at the table can provide a significant contribution to the iodine intakes of children. For example, in children 14 years of age, the percentage of children with iodine intakes less than the EAR reduced from 48% at baseline to <1% post-fortification. The New Zealand Ministry of Health currently recommends that healthy children and young people *"prepare foods or choose pre-prepared foods, snacks and drinks that are low in salt"*, however has the caveat that: *"if using salt, use iodised salt*" (6). This remains an important key message if children are to achieve adequate iodine intakes at current bread fortification levels.

[6] Due to rounding to the nearest whole number, the 2010 report stated that the percentage of children 5-14 years of age with iodine intakes at post fortification was 0% in the model that included iodised salt. In this report, this has been clarified by using <1% for a percentage between 0.1and 1.

In both the food only and food plus iodised discretionary salt models, less than 1% of children in all age and gender categories had iodine intakes higher than the UL at post-fortification. These results show that not only has fortification of the bread supply with iodine been effective in reducing the prevalence of children below the EAR, it has also been effective in preventing children from consuming iodine intakes above the UL even when discretionary iodised salt is included in the diet.

The iodine ULs for children 4-8, 9-13 and 14-18 years have been extrapolated from the adult recommendation on a metabolic body weight basis (5). Of key interest, the Department of Health and Ageing in Australia and the New Zealand Ministry of Health are jointly leading a review of the Nutrient Reference Values (which include the EAR, RDI, AI and UL) for Australia and New Zealand. Iodine has been identified as one of the first key nutrients to be reviewed. An Expert Working Group was formed in October 2013, and is chaired by Emeritus Professor Christine Thomson. More information on the review and future public consultation can be found here: (http://www.health.gov.au/internet/main/publishing.nsf/Content/nutrient-ref-values).

6.4 FOOD CONTRIBUTORS TO IODINE INTAKES

The median iodine concentration of a slice of bread (required to contain iodised salt) was 9.0 – 22.2µg per slice (30-45g) in this study. This range is similar to that found in the 2010 bread survey: 9.5 – 23.7µg per slice (30-45g). Based on serving size, English styled muffins provided the most iodine of the bread products at 35.1µg per 80g serve. The next highest were tortillas/ flat breads and bread rolls (white) at 27.8µg per 80g serve and 26.2µg per 49g serve, respectively.

At post-fortification, bread was the major food contributor to iodine intakes (45%) providing almost half of the dietary iodine intakes of 5-14 year olds. For dietary modelling purposes, bread was defined to include rolls, fruit buns, English-styled muffins, bagels, paninis, pita breads, paninis, tortillas and pizza bases. In comparing these results to the previous study, the contribution of bread to iodine intake has reduced by 2% (from 47% to 45%). As mentioned previously, the decrease is likely due to actual instead of estimated iodine concentrations of bread products being used in the dietary intake estimates (e.g. the iodine concentration of white bread being used for hamburger buns and pita breads in the previous study). Depending on the recipe formulation, the iodine concentration of breads and bread products can be very different. For example, the iodine concentration of pita bread (27.7 µg/100g) is much lower than that of white bread (41.3µg/100g); which primarily due to amount of iodised salt used. Therefore, depending on consumption patterns any incorrect assumptions can under or overestimate iodine intakes.

The iodine intake from bread-based dishes was no different to that reported in 2012, where iodine intakes increased from 2% at baseline to 4% at post-fortification. This reflects the consistency of iodine intakes from bread alone in both this and the previous study (as bread-based dishes are not likely to be made of bread products, which were more accurately captured in this study).

Skeaff and colleagues (19) measured the iodine status of 147 children 8-10 years of age living in Dunedin and Wellington during November 2010 and February 2011. Using a food frequency questionnaire, it was estimated that bread provided 28% of the total dietary iodine intake. Iodine intakes from bread are substantially different to our study (45%), which is likely attributed to the method of data collection, the fact that the iodine concentration of bread was determined using sodium content of bread, and the assumption that 90% of sodium comes from iodised salt at a concentration of 45mg iodine per kg salt. It is also possible that the difference is reflective of a change in consumption patterns since 2002, however this cannot be confirmed.

Milk and dairy products are the second highest contributor to iodine intakes; declining from 40% at baseline to 21% post-fortification. The overall decline is primarily due to the increase in iodine intake from bread, as dietary intakes remained constant between baseline and post-fortification. It is worth noting that the contribution of milk and dairy products to iodine intake increased by 1% since this study was conducted in 2010, which is most likely due to rounding differences.

This study did not estimate iodine intakes from discretionary iodised salt due to the lack of available data on its use in cooking and at the table. It is likely that iodised salt provides some iodine in the diet of children as the 2008/09 National Adults Nutrition Survey reported that 16.3% of males and 14.7% females always add salt to food after cooking or preparation. It was also found that of those who used salt in the home, 85.7% used iodised salt (11). Furthermore, New Zealand manufacturer of iodised salt, Dominion Salt Ltd, has reported that approximately 70% of iodised salt for retail sale in New Zealand is iodised (Personal Communication, Dominion Salt, July 2011).

6.5 MONITORING CHANGES TO THE FOOD SUPPLY

In aiming to accurately estimate iodine intakes, it is critical that both robust and up to date food composition data is used in dietary intake assessments. In order to achieve this, changes to the food supply must be carefully monitored and taken into consideration in reporting intake estimates.

Prior to the introduction of mandatory fortification of bread with iodine, in 2007 the New Zealand National Heart Foundation (NHF) began actively working with bread manufacturers to reduce the sodium content of bread of the bread supply. At the time, a best practice target of 450mg/100g was put in place, and within seven months of commencement, the NHF reported a sodium reduction of 50-150mg/100g (20). Given that bread is now a key source of iodine in the diet of New Zealand children, any further reduction to the salt content of bread will likely impact iodine intakes.

A further area of consideration is the uptake of voluntary iodine fortification of the food supply. While iodised salt is required to contain iodine at a concentration of 25-65mg/kg salt (17), the addition of iodised salt to foods is not restricted. In conducting this work, it became evident that one manufacturer of instant noodles, that are available for sale in New Zealand, is using iodised salt instead of regular salt in their recipe. A single instant noodle product, which has wide appeal and likely to be consumed frequently by certain population groups, has the potential to significantly impact on overall iodine intakes if fortified. Without further investigation, the extent of this trend is not known.

It is therefore important that any future work in this area considers new product developments and public health initiatives that may impact on the iodine content of the food supply. Above all, it is imperative that the iodine status of New Zealand children is measured regularly to ensure iodine levels remain within a safe range.

6.6 STUDY LIMITATIONS

The sampling frame for private label bread brands and bread products was subject to selection bias as market share data was not available to categorise these. For these products, prominent brands in supermarkets were identified as those most likely to be purchased and therefore consumed by more children.

Dietary intake assessments rely on robust food composition data. Due to the poor reliability of iodine concentrations in the NZFCDB, iodine intakes were not measured in the most recent New Zealand Adult Nutrition Survey (21). To overcome the limitations associated with using the NZFCDB data alone, the iodine concentrations used were a combination of data from the 2006 NZFCDB (which includes both analytical and estimated values), and the 2003/04 NZTDS (which includes analytical values only). These data sets are the same used in the 2010 survey, so that any change in dietary intake estimates would be attributed to the updated bread data. One downside to this is that the recent voluntary fortification of certain foods, such as instant noodles, has not been taken into account in iodine intake estimates.

Despite including a more comprehensive selection of breads in this survey compared to 2010, a number of bread type products such as bagels, paninis and specialty breads identified in the CNS02 were not included in this survey. For these products, the assumption was made that the iodine content was the same as the type of bread it most closely represented. White bagels, paninis and specialty breads, for example, were attributed the same iodine concentration as white bread.

The CNS02 survey data was collected in 2002 and is the most recent national consumption data available for children 5-14 years of age. Our iodine intake estimates assume that food consumption patterns of children, in particular iodine-containing foods, have not changed significantly between 2002 and 2011.

The previous report included a model which showed the impact of 1g discretionary iodised salt (at 48 µg iodine), for those who reported its use in cooking and/ or at the table, on iodine intake. We did not include this model, as it was realised post-publishing that the use of iodised salt in the home could not be verified at the time of the 24-hour recall. The most recent 2008/09 New Zealand Adults Nutrition Survey obtained product packaging from the respondent at the time of the recall, enabling verification of the response (21). The two models reported in this study show the range of estimated iodine intakes based on the potential use of iodised discretionary salt. It is likely that the true iodine intake estimate is somewhere within this range.

7 Conclusion

Since the introduction of mandatory fortification of bread with iodine in 2009, our dietary modelling shows that the prevalence of children with inadequate iodine intakes has reduced considerably.

The percentage of children with intakes less than the EAR reduced from 95% to 21% when iodine intakes from food only were estimated; and from 7% to <1% when 1g of iodised discretionary salt was included. Less than 1% of children in all age and gender groups were found to be at risk of consuming excessive iodine intakes when iodised salt was and was not included.

For children 5-14 years of age, the median iodine intake is estimated to be between 93-145µg/day. Of the key food groups (which exclude discretionary iodised salt) bread (45%) is the most significant contributor to iodine intakes of children followed by milk and dairy products (21%).

Broadening the scope of bread products to include products such as hamburger buns, pizza bases and tortillas has enabled MPI to refine its assessment of the impact of mandatory iodine fortification on dietary iodine intake estimates. In particular, it has highlighted the influence of product recipe formulation on overall iodine intakes.

Continued monitoring of the iodine concentrations of bread and bread products is essential to ensure that if any further recipe formulation is undertaken, it will not have an adverse impact on the iodine intakes of New Zealand children.

The design of future monitoring surveys should take into account the extent of voluntary iodine fortification to ensure a more accurate estimate of the iodine intake from foods. In addition to this, methods to quantify discretionary salt use should be explored to ensure the contribution of iodine from discretionary salt is adequately captured in intake estimates.

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